CANNONDESIGN

SUBMITTAL IDENTIFICATION SHEET

To be completed by Contractor/CM

WEBSTER UNIVERSITY ISB
PROJECT NAME

8274 BIG BEND BLVD
ADDRESS

NUMBER

WEBSTER UNIVERSITY
OWNER

CANNON DESIGN
ARCHITECT / ENGINEER

Joe Voypick
SUBMITTED BY

051200-014
CONTRACTOR / CM SUBMITTAL NO.

CANNON DESIGN SUBMITTAL NO.

DRAWING / DETAIL REFERENCE

051200
SPECIFICATION SECTION / PARAGRAPH

Atlas Iron Works
MANUFACTURER / SUPPLIER

ITEM / PRODUCT ID

REQUIRED DATE

PRIORITY

◯ CRITICAL

ITEM BEING SUBMITTED (check only one)

- ◯ Shop Drawings
- ◉ Samples (_____ copies)
- ◯ LEED Submittal
- ◯ Certification / Qualifications
- ◯ Record Documents
- ◯ Product Data
- ◯ Coordination Drawing
- ◯ Calculations
- ◯ Schedules
- ◯ O&M Manuals
- ◯ Other Design Calculations

ITEM BEING SUBMITTED FOR (check only one)

- ◉ Action
- ◯ Information Only
- ◯ Record

REMARKS OR DEVIATIONS

IT IS THE RESPONSIBILITY OF THE FABRICATOR TO COORDINATE CONNECTION DESIGN CALCULATIONS WITH THE STEEL SHOP DRAWINGS.

CONTRACTOR / CM CERTIFICATION
(SUBMITTALS NOT CERTIFIED WILL BE RETURNED WITHOUT REVIEW)

PARIC

PARIC CORPORATION
SUBMITTAL STAMP

THIS SHOP DRAWING HAS BEEN REVIEWED BY PARIC CORPORATION

Subcontractor remains responsible for dimensions, quantities, coordination with other trades and compliance with contract documents.

By:
Devin D. Gates

Joe Voypick
REVIEWED BY

6/2/16
DATE

To be completed by Reviewer

05 1200-014
CANNON DESIGN SUBMITTAL NUMBER

6/2/16
RECEIVED DATE

- ◯ A. No Exceptions Taken
  No further review of submittal is required.
- ◯ B. Make Corrections Noted
  Incorporate corrections in work; resubmission is not required.
- ◯ C. Revise and Resubmit
  Revise as noted, and resubmit for review.
- ◯ D. Rejected
  Submittal is not in compliance with Contract Documents; provide new submittal.
- ◯ E. For Record / Information Only
  Submittal was reviewed for Record / Information purposes only.
- ◯ F. Not Required for Review
  Submittal is not required by Contract Documents and has not been reviewed.

Review is for conformance with the design concept of this project and for general compliance with contract documents. Contractor is responsible for quantities, dimensions and compliance with contract documents and for information that pertains to fabrication processes, construction techniques and coordination of this work with all trades which will be affected thereby. This review is null and void if submittal deviates from contract documents and does not indicate or note deviations.

A/E COMMENTS

◯ See attached sheet(s) for additional comments

SHOP DRAWING / SUBMITTAL REVIEW

- ☐ NO EXCEPTION TAKEN
- ☐ EXCEPTIONS NOTED, RESUBMITTAL NOT REQUIRED
- ☐ REJECTED
- ☒ REVIEWED FOR INFORMATION ONLY
- ☐ REVISE AND RESUBMIT AS NOTED

Checking is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for: Dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of the construction, coordination of his work with that of all other trades and the satisfactory performance of his work.

DAVID MASON & ASSOCIATES, INC.

REVIEW BY: JYW DATE: 06/13/2016

REVIEWED BY

DATE

77 Westport Plaza
Suite 250
St. Louis, MO 63146

TRANSMITTAL

No. 15051-0070

Paric Corporation

PROJECT: 15051-Webster University Interdisciplinary Science Building

DATE: 06/02/2016

TO: Cannon Design
1100 Clark Ave
St Louis MO 63102

RE: Structural Steel Connection Design Calc Package 02

ATTN: Kelvin Patel

JOB: 15051

WE ARE SENDING:	SUBMITTED FOR:	ACTION TAKEN:
☐ Shop Drawings	☑ Approval	☑ Approved as Submitted
☐ Letter	☐ Your Use	☐ Approved as Noted
☐ Prints	☐ As Requested	☐ Returned After Loan
☐ Change Order	☐ Review and Comment	☐ Resubmit
☐ Plans		☐ Submit
☐ Samples	**SENT VIA:**	☐ Returned
☐ Specifications	☐ Attached	☐ Returned for Corrections
☑ Other: Design Calculations	☐ Separate Cover Via:	☐ Due Date:

Item	*Package*	*Code*	*Rev.*	*Copies*	*Date*	*Description*	*Status*
Submittal		051200-014	1		06/02/2016	Structural Steel Connection Design Calc Package 02	Submitted

NOTES:

CC: Paric Corporation, Kathy Bathe

Project Coordinator: Paric Corporation, Kathy Bathe

Signed: _____
Devin Gates

WEBSTER UNVI.

INTERDISCIPLINARY SCIENCE BUILDING

STRUCTURAL STEEL CONNECTION DESIGN

PROJECT No. 16013

PACKAGE NO. 2

05/25/2016

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SC-01(F) BEAM TO W-SHAPE COLUMN FLANGE DOUBLE ANGLE CONNECTION (ALL BOLTED)

Connection ID	Beam Size	Beam Web Thickness (inch)	Design Reaction (kip)	Double Angle Size*	Min No Of Bolts	3/4" Dia. A325N Bolt Rows	Bolt Spacing (inch) "Spa."	Bolt Gage on Column Flange** (inch) "Ga."	Beam Side Bolt Edge Distance (inch)		Column Side Bolt Edge Distance (inch)	
									Vertical "L_{evb}"	Horizontal "L_{ehb}"	Vertical "L_{evc}"	Horizontal "L_{ehc}"
SC-01-18F	W18x40	5/16"	⩽40	L4x4x5/16	5	3	3	6	1.25	1.25	1.25	Varies⩾1.125"
SC-01-19F			⩽70			5						
SC-01-20F	W18x50	3/8"	⩽40	L4x4x5/16	5	3	3	6	1.25	1.25	1.25	
SC-01-21F	W21x50	3/8"	⩽40	L4x4x5/16	6	4	3	6	1.25	1.25	1.25	
SC-01-22F	W24x76	7/16"	⩽70	L4x4x5/16	7	5	3	6.25	1.25	1.25	1.25	
SC-01-23F	W27x84	1/2"	⩽140	L4x4x5/16	7	8	3	6.25	1.25	1.25	1.25	
SC-01-24F	W12x14	3/16"	⩽15	L4x4x5/16	3	2	3	6	1.25	1.25	1.25	

*Horizontal Short Slotted Hole on Angle Outstanding Legs against Support Column.

**Use L4X3 1/2x5/16 for column W10x33,W10x39,W10x45, and W12x40. Short angle legs against Column Flange. Bolt Gage =5". Use stagger bolt pattern P=1.75 inch. See SC-03 shear tab connection for connection detail if beam is not deep enough for stagger pattern.

Horizontal SSL on supporting angles against column flanges

Current Date: 2016-05-25 6:03 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange1.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-01-18F

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W18x40

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	40.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	8.02	16.05	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.9[in] - max(0.927[in], 0[in]) - max(0.927[in], 0[in]) = **16.05**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	40.00	DL	0.63	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	40.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(3 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	40.00	DL	0.52	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.313$[in]$ =$ **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*2.66$[in2]$) =$ **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	40.00	DL	0.63	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in]$ - 3*0.875$[in]$ =$ **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.313$[in]$ =$ **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*1.84$[in2]$) =$ **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	63.66	40.00	DL	0.63	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (3 - 1)*3$[in]$)*0.313$[in]$ =$ **2.27**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **1.58**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\text{min}(0.6*58000$[lb/in2]$*1.58$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 2.27[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **63.66**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	63.65	40.00	DL	0.63	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	40.00	DL	0.48	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	40.00	DL	0.52	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	40.00	DL	0.63	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	59.79	40.00	DL	0.67	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.187[in2])) = **59.79**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	10.59	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 40[kip]/(0.442[in2]*6) = **15082.96**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15082.96[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **60438.91**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*60438.91[lb/in2]*0.442[in2] = **13.36**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 40[kip]/(0.442[in2]*6) = **15082.96**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15082.96[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **60438.91**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*60438.91[lb/in2]*0.442[in2] = **13.36**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/((*1/*Ω)*p*F_u))$^{0.5}$ = ((3.33*13.36[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.09**[in] p. 9-12

α' = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.09[in]/0.313[in])^2 - 1) = **6.04** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.09[in])^2*(1 + 0.729) = **0.141** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/((*1/*Ω)*p*F_u))$^{0.5}$ = ((3.33*13.36[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.14**[in] p. 9-12

α' = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.14[in]/0.313[in])^2 - 1) = **6.87** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.14[in])^2*(1 + 0.705) = **0.128** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.128 + (3 - 2)*0.141)/3 = **0.132** p. 9-13

T_{avail} = 6 * (B*Q) = 6 * (13.36[kip]*0.132) = **10.59**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	55.28	40.00	DL	0.72	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 5.95[in] - 0.813[in]/2) = **5.54**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

*(1/*Ω)R_n = *(1/*Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*5.54[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.315[in]*65000[lb/in2]*1 = **55.28**[kip] Eq. J3-6

Shear yielding	[Kip]	112.77	40.00	DL	0.35	Eq. J4-3

A_g = L_p*t_p = 17.9[in]*0.315[in] = **5.64**[in2] Sec. D3-1

*(1/*Ω)R_n = *(1/*Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.64[in2] = **112.77**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	196.56	40.00	DL	0.20	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

*(1/*Ω)R_n = 2 * ((*1/*Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.56[in]*65000[lb/in2]*1) = **196.56**[kip] Eq. J3-6

Global critical strength ratio **0.72**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 6:04 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange1.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-01-19F

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W18x40

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	70.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	8.02	16.05	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.9[in] - max(0.927[in], 0[in]) - max(0.927[in], 0[in]) = **16.05**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	70.00	DL	0.66	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	70.00	DL	0.47	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(5 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	70.00	DL	0.54	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.313$[in]$ =$ **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.53$[in2]$) =$ **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	70.00	DL	0.64	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in]$ - 5*0.875$[in]$ =$ **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.313$[in]$ =$ **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.16$[in2]$) =$ **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	70.00	DL	0.67	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (5 - 1)*3$[in]$)*0.313$[in]$ =$ **4.14**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (5 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **2.91**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.91$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 4.14[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **104.16**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	106.08	70.00	DL	0.66	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	70.00	DL	0.47	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	70.00	DL	0.54	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	70.00	DL	0.64	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.29	70.00	DL	0.70	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.187[in2])) = **100.29**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.14	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 70[kip]/(0.442[in2]*10) = **15837.1**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15837.1[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **57610.86**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*57610.86[lb/in2]*0.442[in2] = **12.73**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 70[kip]/(0.442[in2]*10) = **15837.1**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15837.1[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **57610.86**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*57610.86[lb/in2]*0.442[in2] = **12.73**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*12.73[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} =$ **1.07**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.07[in]/0.313[in])^2 - 1) =$ **5.73** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.07[in])^2*(1 + 0.729) =$ **0.148** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =$ **1.51**[in] p. 9-12

$b' = b - d/2 = 2.71[in] - 0.75[in]/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34[in]/1.51[in] =$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813[in]/2.75[in] =$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*12.73[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))^{0.5} =$ **1.12**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.12[in]/0.313[in])^2 - 1) =$ **6.52** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.12[in])^2*(1 + 0.705) =$ **0.134** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.134 + (5 - 2)*0.148)/5 =$ **0.142** p. 9-13

$T_{avail} = 10 * (B*Q) = 10 * (12.73[kip]*0.142) =$ **18.14**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	92.14	70.00	DL	0.76	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.95[in] - 0.813[in]/2) =$ **2.54**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*2.54[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.315[in]*65000[lb/in2]*1 =$ **92.14**[kip] Eq. J3-6

Shear yielding	[Kip]	112.77	70.00	DL	0.62	Eq. J4-3

$A_g = L_p*t_p = 17.9[in]*0.315[in] =$ **5.64**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.64[in2] =$ **112.77**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	327.60	70.00	DL	0.21	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.56[in]*65000[lb/in2]*1) =$ **327.6**[kip] Eq. J3-6

Global critical strength ratio **0.76**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 6:05 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange1.cnx\

Steel connections

Results

Connection name : DA BCF All bolted

Connection ID : SC-01-20F

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W18x50

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	40.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	8.03	16.06	✔	p. 10-8
$L_{min} = T/2 = 16.06_{[in]}/2 = \mathbf{8.03}_{[in]}$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18_{[in]} - \max(0.972_{[in]}, 0_{[in]}) - \max(0.972_{[in]}, 0_{[in]}) = \mathbf{16.06}_{[in]}$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1_{[in]} + 0_{[in]} = \mathbf{1}_{[in]}$						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	40.00	DL	0.63	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	40.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(3 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	40.00	DL	0.52	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.313$[in]$ =$ **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*2.66$[in2]$) =$ **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	40.00	DL	0.63	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in]$ - 3*0.875$[in]$ =$ **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.313$[in]$ =$ **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*1.84$[in2]$) =$ **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	63.66	40.00	DL	0.63	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (3 - 1)*3$[in]$)*0.313$[in]$ =$ **2.27**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **1.58**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\text{min}(0.6*58000$[lb/in2]$*1.58$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 2.27[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **63.66**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	63.65	40.00	DL	0.63	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	40.00	DL	0.48	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	40.00	DL	0.52	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	40.00	DL	0.63	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	59.79	40.00	DL	0.67	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.187[in2])) = **59.79**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	10.59	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 40[kip]/(0.442[in2]*6) = **15082.96**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15082.96[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **60438.91**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*60438.91[lb/in2]*0.442[in2] = **13.36**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 40[kip]/(0.442[in2]*6) = **15082.96**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15082.96[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **60438.91**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*60438.91[lb/in2]*0.442[in2] = **13.36**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*13.36[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} =$ **1.09**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.09[in]/0.313[in])^2 - 1) =$ **6.04** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.09[in])^2*(1 + 0.729) =$ **0.141** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =$ **1.51**[in] p. 9-12

$b' = b - d/2 = 2.71[in] - 0.75[in]/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34[in]/1.51[in] =$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813[in]/2.75[in] =$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*13.36[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))^{0.5} =$ **1.14**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.14[in]/0.313[in])^2 - 1) =$ **6.87** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.14[in])^2*(1 + 0.705) =$ **0.128** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.128 + (3 - 2)*0.141)/3 =$ **0.132** p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (13.36[kip]*0.132) =$ **10.59**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	62.30	40.00	DL	0.64	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 6[in] - 0.813[in]/2) =$ **5.59**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*5.59[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.355[in]*65000[lb/in2]*1 =$ **62.3**[kip] Eq. J3-6

Shear yielding	[Kip]	127.80	40.00	DL	0.31	Eq. J4-3

$A_g = L_p*t_p = 18[in]*0.355[in] =$ **6.39**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.39[in2] =$ **127.8**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	235.17	40.00	DL	0.17	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.67[in]*65000[lb/in2]*1) =$ **235.17**[kip] Eq. J3-6

Global critical strength ratio **0.67**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 6:06 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange1.cnx\

Steel connections

Results

Connection name : **DA BCF All bolted**
Connection ID : **SC-01-21F**

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W21x50

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	40.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	11.50	9.36	18.72	✔	p. 10-8
$L_{min} = T/2 = 18.72$[in]$/2 =$ **9.36**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.8[in] - max(1.04[in], 0[in]) - max(1.04[in], 0[in]) = **18.72**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	84.86	40.00	DL	0.47	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (4*10.61$[kip]$) =$ **84.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	116.23	40.00	DL	0.34	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(4 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **116.23**[kip]						Eq. J3-6
Shear yielding	[Kip]	103.50	40.00	DL	0.39	Eq. J4-3
$A_g = L_p*t_p = 11.5$[in]$*0.313$[in]$ =$ **3.59**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*3.59$[in2]$) =$ **103.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	87.00	40.00	DL	0.46	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 11.5$[in]$ - 4*0.875$[in]$ =$ **8**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8$[in]$*0.313$[in]$ =$ **2.5**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*2.5$[in2]$) =$ **87**[kip]						Eq. J4-4
Block shear	[Kip]	83.91	40.00	DL	0.48	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (4 - 1)*3$[in]$)*0.313$[in]$ =$ **3.2**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **2.25**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.25$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 3.2[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **83.91**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	84.86	40.00	DL	0.47	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (4*10.61$[kip]$) =$ **84.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	116.23	40.00	DL	0.34	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(4/(1*4))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.313[in]*58000[lb/in2]*1) = **116.23**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	103.50	40.00	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 11.5[in]*0.313[in] = **3.59**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*3.59[in2]) = **103.5**[kip] Eq. J4-3

Shear rupture	[Kip]	87.00	40.00	DL	0.46	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 11.5[in] - 4*0.875[in] = **8**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.313[in] = **2.5**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*2.5[in2]) = **87**[kip] Eq. J4-4

Block shear	[Kip]	80.04	40.00	DL	0.50	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (4 - 1)*3[in])*0.313[in] = **3.2**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **2.25**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.25[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*3.2[in2] + 1*58000[lb/in2]*0.187[in2])) = **80.04**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	14.36	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 40[kip]/(0.442[in2]*8) = **11312.22**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*11312.22[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **74579.19**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*74579.19[lb/in2]*0.442[in2] = **16.48**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 40[kip]/(0.442[in2]*8) = **11312.22**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*11312.22[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **74579.19**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*74579.19[lb/in2]*0.442[in2] = **16.48**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*16.48[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} =$ **1.21**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.21[in]/0.313[in])^2 - 1) =$ **7.58** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.21[in])^2*(1 + 0.729) =$ **0.114** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =$ **1.51**[in] p. 9-12

$b' = b - d/2 = 2.71[in] - 0.75[in]/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34[in]/1.51[in] =$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813[in]/2.75[in] =$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*16.48[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))^{0.5} =$ **1.27**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.27[in]/0.313[in])^2 - 1) =$ **8.6** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.27[in])^2*(1 + 0.705) =$ **0.103** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.103 + (4 - 2)*0.114)/4 =$ **0.109** p. 9-13

$T_{avail} = 8 * (B*Q) = 8 * (16.48[kip]*0.109) =$ **14.36**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	88.92	40.00	DL	0.45	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.9[in] - 0.813[in]/2) =$ **5.49**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*5.49[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.38[in]*65000[lb/in2]*1 =$ **88.92**[kip] Eq. J3-6

Shear yielding	[Kip]	158.08	40.00	DL	0.25	Eq. J4-3

$A_g = L_p*t_p = 20.8[in]*0.38[in] =$ **7.9**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.9[in2] =$ **158.08**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	262.08	40.00	DL	0.15	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.56[in]*65000[lb/in2]*1) =$ **262.08**[kip] Eq. J3-6

Global critical strength ratio **0.50**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 6:06 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange1.cnx\

Steel connections

Results

Connection name : **DA BCF All bolted**
Connection ID : **SC-01-22F**

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W24x76

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	70.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	10.77	21.54	✔	p. 10-8
$L_{min} = T/2 = 21.54[in]/2 =$ **10.77**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.9[in] - \max(1.18[in], 0[in]) - \max(1.18[in], 0[in]) =$ **21.54**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] =$ **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	70.00	DL	0.66	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	70.00	DL	0.47	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(5 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	70.00	DL	0.54	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.313$[in]$ =$ **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.53$[in2]$) =$ **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	70.00	DL	0.64	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in]$ - 5*0.875$[in]$ =$ **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.313$[in]$ =$ **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.16$[in2]$) =$ **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	70.00	DL	0.67	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (5 - 1)*3$[in]$)*0.313$[in]$ =$ **4.14**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (5 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **2.91**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.91$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 4.14[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **104.16**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	106.08	70.00	DL	0.66	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	70.00	DL	0.47	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	70.00	DL	0.54	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	70.00	DL	0.64	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.29	70.00	DL	0.70	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.187[in2])) = **100.29**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.14	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 70[kip]/(0.442[in2]*10) = **15837.1**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15837.1[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **57610.86**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*57610.86[lb/in2]*0.442[in2] = **12.73**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 70[kip]/(0.442[in2]*10) = **15837.1**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*15837.1[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **57610.86**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*57610.86[lb/in2]*0.442[in2] = **12.73**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*12.73[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} =$ **1.07**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.07[in]/0.313[in])^2 - 1) =$ **5.73** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.07[in])^2*(1 + 0.729) =$ **0.148** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =$ **1.51**[in] p. 9-12

$b' = b - d/2 = 2.71[in] - 0.75[in]/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34[in]/1.51[in] =$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813[in]/2.75[in] =$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*12.73[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))^{0.5} =$ **1.12**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.12[in]/0.313[in])^2 - 1) =$ **6.52** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.12[in])^2*(1 + 0.705) =$ **0.134** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.134 + (5 - 2)*0.148)/5 =$ **0.142** p. 9-13

$T_{avail} = 10 * (B*Q) = 10 * (12.73[kip]*0.142) =$ **18.14**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	128.70	70.00	DL	0.54	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.95[in] - 0.813[in]/2) =$ **5.54**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*5.54[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.44[in]*65000[lb/in2]*1 =$ **128.7**[kip] Eq. J3-6

Shear yielding	[Kip]	210.32	70.00	DL	0.33	Eq. J4-3

$A_g = L_p*t_p = 23.9[in]*0.44[in] =$ **10.52**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*10.52[in2] =$ **210.32**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	391.95	70.00	DL	0.18	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.67[in]*65000[lb/in2]*1) =$ **391.95**[kip] Eq. J3-6

Global critical strength ratio **0.70**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 6:07 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange1.cnx\

Steel connections

Results

Connection name : DA BCF All bolted

Connection ID : SC-01-23F

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W27x84

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	140.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	23.50	12.11	24.22	✔	p. 10-8
$L_{min} = T/2 = 24.22$[in]$/2 =$ **12.11**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 26.7$[in] $- \max(1.24$[in]$, 0$[in]$) - \max(1.24$[in]$, 0$[in]$) =$ **24.22**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	169.73	140.00	DL	0.82	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (8*10.61$[kip]$) =$ **169.73**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	246.73	140.00	DL	0.57	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(8 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **246.73**[kip]						Eq. J3-6
Shear yielding	[Kip]	211.50	140.00	DL	0.66	Eq. J4-3
$A_g = L_p*t_p = 23.5$[in]$*0.313$[in]$ =$ **7.34**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*7.34$[in2]$) =$ **211.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	179.44	140.00	DL	0.78	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 23.5$[in]$ - 8*0.875$[in]$ =$ **16.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 16.5$[in]$*0.313$[in]$ =$ **5.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.16$[in2]$) =$ **179.44**[kip]						Eq. J4-4
Block shear	[Kip]	164.91	140.00	DL	0.85	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (8 - 1)*3$[in]$)*0.313$[in]$ =$ **6.95**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (8 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **4.9**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*4.9$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 6.95[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **164.91**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	169.73	140.00	DL	0.82	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (8*10.61$[kip]$) =$ **169.73**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	246.73	140.00	DL	0.57	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(8/(1*8))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.313[in]*58000[lb/in2]*1) = **246.73**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	211.50	140.00	DL	0.66	Eq. J4-3

A_g = L_p*t_p = 23.5[in]*0.313[in] = **7.34**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*7.34[in2]) = **211.5**[kip] Eq. J4-3

Shear rupture	[Kip]	179.44	140.00	DL	0.78	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 23.5[in] - 8*0.875[in] = **16.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 16.5[in]*0.313[in] = **5.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*5.16[in2]) = **179.44**[kip] Eq. J4-4

Block shear	[Kip]	161.04	140.00	DL	0.87	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (8 - 1)*3[in])*0.313[in] = **6.95**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (8 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **4.9**[in2] Sec. J4-3

IsStressUniform → **True** Sec. J4-3

U_{bs} = 1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.9[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*6.95[in2] + 1*58000[lb/in2]*0.187[in2])) = **161.04**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	29.45	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 140[kip]/(0.442[in2]*16) = **19796.38**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*19796.38[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **42763.57**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*42763.57[lb/in2]*0.442[in2] = **9.45**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 140[kip]/(0.442[in2]*16) = **19796.38**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*19796.38[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **42763.57**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*42763.57[lb/in2]*0.442[in2] = **9.45**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*9.45[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} =$ **0.92**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((0.92[in]/0.313[in])^2 - 1) =$ **4.11** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/0.92[in])^2*(1 + 0.729) =$ **0.2** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =$ **1.51**[in] p. 9-12

$b' = b - d/2 = 2.71[in] - 0.75[in]/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34[in]/1.51[in] =$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813[in]/2.75[in] =$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*9.45[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))^{0.5} =$ **0.961**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((0.961[in]/0.313[in])^2 - 1) =$ **4.7** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/0.961[in])^2*(1 + 0.705) =$ **0.18** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.18 + (8 - 2)*0.2)/8 =$ **0.195** p. 9-13

$T_{avail} = 16 * (B*Q) = 16 * (9.45[kip]*0.195) =$ **29.45**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	215.28	140.00	DL	0.65	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85[in] - 0.813[in]/2) =$ **2.44**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*2.44[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.46[in]*65000[lb/in2]*1 =$ **215.28**[kip] Eq. J3-6

Shear yielding	[Kip]	245.64	140.00	DL	0.57	Eq. J4-3

$A_g = L_p*t_p = 26.7[in]*0.46[in] =$ **12.28**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*12.28[in2] =$ **245.64**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	566.28	140.00	DL	0.25	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.605[in]*65000[lb/in2]*1) =$ **566.28**[kip] Eq. J3-6

Global critical strength ratio **0.87**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 6:09 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01F Beam to Column Flange Shear Double Angle All Bolted\B2C Flange3.cnx\

Steel connections

Results

Connection name : DA BCF All bolted

Connection ID : SC-01-24F

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W12x14

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	5.50	5.43	10.85	✔	p. 10-8
$L_{min} = T/2 = 10.85$[in]$/2 =$ **5.43**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 11.9[in] - max(0.525[in], 0[in]) - max(0.525[in], 0[in]) = **10.85**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.2$[in], 12 [in]$) =$ **4.8**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	42.43	15.00	DL	0.35	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (2*10.61$[kip]$) =$ **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	50.98	15.00	DL	0.29	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(2 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **50.98**[kip]						Eq. J3-6
Shear yielding	[Kip]	49.50	15.00	DL	0.30	Eq. J4-3
$A_g = L_p*t_p = 5.5$[in]$*0.313$[in]$ =$ **1.72**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*1.72$[in2]$) =$ **49.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	40.78	15.00	DL	0.37	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 5.5$[in]$ - 2*0.875$[in]$ =$ **3.75**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 3.75$[in]$*0.313$[in]$ =$ **1.17**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*1.17$[in2]$) =$ **40.78**[kip]						Eq. J4-4
Block shear	[Kip]	43.41	15.00	DL	0.35	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (2 - 1)*3$[in]$)*0.313$[in]$ =$ **1.33**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **0.918**[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\text{min}(0.6*58000$[lb/in2]$*0.918$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 1.33[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **43.41**[kip]						Eq. J4-5
Angle (Support side)						
Bolts shear	[Kip]	42.43	15.00	DL	0.35	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2]$ =$ **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (2*10.61$[kip]$) =$ **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	50.98	15.00	DL	0.29	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(2/(1*2))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*0.313[in]*58000[lb/in2]*1) = **50.98**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	49.50	15.00	DL	0.30	Eq. J4-3

A_g = L_p*t_p = 5.5[in]*0.313[in] = **1.72**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*1.72[in2]) = **49.5**[kip] Eq. J4-3

Shear rupture	[Kip]	40.78	15.00	DL	0.37	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 5.5[in] - 2*0.875[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.313[in] = **1.17**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.17[in2]) = **40.78**[kip] Eq. J4-4

Block shear	[Kip]	39.54	15.00	DL	0.38	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (2 - 1)*3[in])*0.313[in] = **1.33**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **0.918**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.918[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*1.33[in2] + 1*58000[lb/in2]*0.187[in2])) = **39.54**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	6.82	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 15[kip]/(0.442[in2]*4) = **8484.16**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*8484.16[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **85184.39**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*85184.39[lb/in2]*0.442[in2] = **18.83**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 15[kip]/(0.442[in2]*4) = **8484.16**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*8484.16[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **85184.39**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*85184.39[lb/in2]*0.442[in2] = **18.83**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*18.83[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} = \mathbf{1.3}$[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.3[in]/0.313[in])^2 - 1) = \mathbf{8.73}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.3[in])^2*(1 + 0.729) = \mathbf{0.1}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = \mathbf{1.51}$[in] p. 9-12

$b' = b - d/2 = 2.71[in] - 0.75[in]/2 = \mathbf{2.34}$[in] p. 9-12

$\rho = b'/a' = 2.34[in]/1.51[in] = \mathbf{1.55}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813[in]/2.75[in] = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*18.83[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))^{0.5} = \mathbf{1.36}$[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.36[in]/0.313[in])^2 - 1) = \mathbf{9.91}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.36[in])^2*(1 + 0.705) = \mathbf{0.0905}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0905 + (2 - 2)*0.1)/2 = \mathbf{0.0905}$ p. 9-13

$T_{avail} = 4 * (B*Q) = 4 * (18.83[kip]*0.0905) = \mathbf{6.82}$[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	23.40	15.00	DL	0.64	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45[in] - 0.813[in]/2) = \mathbf{4.04}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*4.04[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*0.2[in]*65000[lb/in2]*1 = \mathbf{23.4}$[kip] Eq. J3-6

Shear yielding	[Kip]	47.60	15.00	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 11.9[in]*0.2[in] = \mathbf{2.38}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.38[in2] = \mathbf{47.6}$[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	131.04	15.00	DL	0.11	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) = \mathbf{1.20E+31}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}$[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31[in], 2.4*0.75[in]) + \text{min}(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*0.56[in]*65000[lb/in2]*1) = \mathbf{131.04}$[kip] Eq. J3-6

Global critical strength ratio **0.64**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

SC-01(W) BEAM TO W-SHAPE COLUMN WEB DOUBLE ANGLE CONNECTION (ALL BOLTED)

Connection ID	Beam Size	Beam Web Thickness (inch)	Design Reaction (kip) "R"	Double Angle Size**	Min No Of Bolts	3/4" Dia. A325N Bolt Rows	Bolt Spacing (inch) "Spa."	Bolt Gage on Column (inch) "Ga"**	Beam Side Bolt Edge Distance (inch)		Column Side Bolt Edge Distance (inch)	
									Vertical "Levb"	Horizontal "Lehb"	Vertical "Levc"	Horizontal "Lehc"
SC-01-20W	W12x14	3/16"	⩽10	L4x4x5/16	3	2	3	6	1.25	1.25	1.25	
SC-01-21W	W24x62	7/16"	≤90	L4x4x5/16	7	6	3	6.25	1.25	1.25	1.25	Varies⩾ 1.125"
SC-01-22W	W24x84	1/2"	≤90	L4x4x5/16	7	6	3	6.25	1.25	1.25	1.25	
SC-01-23W	W30x90	1/2"	⩽80	L4x4x5/16		5	3	6.25	1.25	1.25	1.25	
SC-01-24W	W30x116	9/16"	≤90	L4x4x5/16		6	3	6.25	1.25	1.25	1.25	
SC-01-25W			⩽120			8						
SC-01-26W	W30X132	5/8"	⩽130	L4x4x5/16		8	3	6.25	1.25	1.25	1.25	

1. Short Slotted Hole on angle leg attached to supporting column
2. Blocking (Narrow down) beam flanges only to fit between column flanges
3. **Use L4x3 1/2x5/16 at W10s Column Web Connection for narrow space (7.5-8 inch wide). Short leg against column web. Gage= 5 inch. Stagger the bolt with P=1.75 inch.
4. See SC-03 connection details if beam depth is not enough for stagger pattern.
5. When beam with Ga1=6" frames into column web with beam Ga2=6.25" from the other side of column. Use Ga.=min (Ga1. Ga2)

Use stagger bolts. P=1.5 inch. For Column W10s web framing, see item 3 above.

Current Date: 2016-05-25 5:41 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : DA BCW All bolted

Connection ID : SC-01-20W

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W12x14

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	5.50	5.43	10.85	✔	p. 10-8
$L_{min} = T/2 = 10.85$[in]$/2 =$ **5.43**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 11.9$[in] $- \max(0.525$[in]$, 0$[in]$) -$ $\max(0.525$[in]$, 0$[in]$) =$ **10.85**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.2$[in], 12 [in]$) =$ **4.8**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Angle (Beam side)

Bolts shear	[Kip]	42.43	10.00	DL	0.24	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (2*10.61\text{[kip]}) = \mathbf{42.43}\text{[kip]}$ Tables (7-1..14)

Bolt bearing under shear load	[Kip]	50.98	10.00	DL	0.20	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25\text{[in]} - 0.813\text{[in]}/2) = \mathbf{0.844}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*$
$0.75\text{[in]})*(2 - 1))*0.313\text{[in]}*58000\text{[lb/in2]}*1) = \mathbf{50.98}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	49.50	10.00	DL	0.20	Eq. J4-3

$A_g = L_p*t_p = 5.5\text{[in]}*0.313\text{[in]} = \mathbf{1.72}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000\text{[lb/in2]}*1.72\text{[in2]}) = \mathbf{49.5}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	40.78	10.00	DL	0.25	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 5.5\text{[in]} - 2*0.875\text{[in]} = \mathbf{3.75}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 3.75\text{[in]}*0.313\text{[in]} = \mathbf{1.17}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000\text{[lb/in2]}*1.17\text{[in2]}) = \mathbf{40.78}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	43.41	10.00	DL	0.23	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*$
$0.875\text{[in]})*0.313\text{[in]} = \mathbf{0.254}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25\text{[in]} + (2 - 1)*3\text{[in]})*0.313\text{[in]} = \mathbf{1.33}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25\text{[in]} + (2 - 1)*(3\text{[in]} - 0.875\text{[in]}) -$
$0.875\text{[in]}/2)*0.313\text{[in]} = \mathbf{0.918}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$
$A_{nt})) = 2 * (0.5*\min(0.6*58000\text{[lb/in2]}*0.918\text{[in2]} + 1*58000\text{[lb/in2]}*0.254\text{[in2]}, 0.6*36000\text{[lb/in2]}*$
$1.33\text{[in2]} + 1*58000\text{[lb/in2]}*0.254\text{[in2]})) = \mathbf{43.41}\text{[kip]}$ Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	42.43	10.00	DL	0.24	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000\text{[lb/in2]}*0.442\text{[in2]} = \mathbf{10.61}\text{[kip]}$ Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (2*10.61\text{[kip]}) = \mathbf{42.43}\text{[kip]}$ Tables (7-1..14)

Bolt bearing under shear load	[Kip]	50.98	10.00	DL	0.20	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25\text{[in]} - 0.813\text{[in]}/2) = \mathbf{0.844}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*$
$d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(2/(1*2))*(\min(1.2*0.844\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*$
$2.19\text{[in]}, 2.4*0.75\text{[in]})*(2 - 1))*0.313\text{[in]}*58000\text{[lb/in2]}*1) = \mathbf{50.98}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	49.50	10.00	DL	0.20	Eq. J4-3

$A_g = L_p*t_p$ = 5.5[in]*0.313[in] = **1.72**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * $((1/\Omega)$*0.60*F_y*$A_g)$ = 2 * (0.667*0.60*36000[lb/in2]*1.72[in2]) = **49.5**[kip] Eq. J4-3

Shear rupture	[Kip]	40.78	10.00	DL	0.25	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h$ = 5.5[in] - 2*0.875[in] = **3.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 3.75[in]*0.313[in] = **1.17**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * $((1/\Omega)$*0.60*F_u*$A_{nv})$ = 2 * (0.5*0.60*58000[lb/in2]*1.17[in2]) = **40.78**[kip] Eq. J4-4

Block shear	[Kip]	39.54	10.00	DL	0.25	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.25[in] + (2 - 1)*3[in])*0.313[in] = **1.33**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.25[in] + (2 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.313[in] = **0.918**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * $((1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*
A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.918[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*
1.33[in2] + 1*58000[lb/in2]*0.187[in2])) = **39.54**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	6.82	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts})$ = 10[kip]/(0.442[in2]*4) = **5656.11**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)$*$F_{nv})$, 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] -
90000[lb/in2]*5656.11[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

$f_v = F/(A_b*N_{bolts})$ = 10[kip]/(0.442[in2]*4) = **5656.11**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)$*$F_{nv})$, 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] -
90000[lb/in2]*5656.11[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min($a + d/2$, 1.25*$b + d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =
1.51[in] p. 9-12

$b' = b - d/2$ = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

$\rho = b'/a'$ = 2.34[in]/1.51[in] = **1.55** p. 9-12

$\delta = 1 - d'/p$ = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*3[in]*58000[lb/
in2]))$^{0.5}$ = **1.33**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1)$ = (1/(0.729*(1 + 1.55)))*((1.33[in]/0.313[in])^2 - 1) =
9.25 p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta)$ = (0.313[in]/1.33[in])^2*(1 + 0.729) = **0.0948** p. 9-13

a' = Min($a + d/2$, 1.25*$b + d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =

1.51[in] p. 9-12

$b' = b - d/2 = 2.71$[in] $- 0.75$[in]$/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34$[in]$/1.51$[in] $=$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813$[in]$/2.75$[in] $=$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.89$[kip]$*2.34$[in]$)/(0.5*2.75$[in]$*58000$[lb/in2]$))^{0.5} =$ **1.39**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.39$[in]$/0.313$[in]$)^2 - 1) =$ **10.5** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313$[in]$/1.39$[in]$)^2*(1 + 0.705) =$ **0.0857** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0857 + (2 - 2)*0.0948)/2 =$ **0.0857** p. 9-13

$T_{avail} = 4 * (B*Q) = 4 * (19.89$[kip]$*0.0857) =$ **6.82**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	23.40	10.00	DL	0.43	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45$[in]$ - 0.813$[in]$/2) =$ **4.04**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*4.04$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*0.2$[in]$*65000$[lb/in2]$*1 =$ **23.4**[kip] Eq. J3-6

Shear yielding	[Kip]	47.60	10.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 11.9$[in]$*0.2$[in]$ =$ **2.38**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.38$[in2]$ =$ **47.6**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	109.98	10.00	DL	0.09	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in]$ - 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*0.47$[in]$*65000$[lb/in2]$*1) =$ **109.98**[kip] Eq. J3-6

Global critical strength ratio **0.43**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available

tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 5:45 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : DA BCW All bolted

Connection ID : SC-01-21W

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W24x62

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	90.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	17.50	10.76	21.52	✔	p. 10-8
$L_{min} = T/2 = 21.52$[in]$/2 =$ **10.76**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.7$[in] $- \max(1.09$[in]$, 0$[in]$) - \max(1.09$[in]$, 0$[in]$) =$ **21.52**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Beam						
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	127.30	90.00	DL	0.71	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (6*10.61[kip]) = **127.3**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	181.48	90.00	DL	0.50	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(6 - 1))*0.313[in]*58000[lb/in2]*1) = **181.48**[kip] Eq. J3-6

Shear yielding	[Kip]	157.50	90.00	DL	0.57	Eq. J4-3

A_g = L_p*t_p = 17.5[in]*0.313[in] = **5.47**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.47[in2]) = **157.5**[kip] Eq. J4-3

Shear rupture	[Kip]	133.22	90.00	DL	0.68	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 17.5[in] - 6*0.875[in] = **12.25**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 12.25[in]*0.313[in] = **3.83**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.83[in2]) = **133.22**[kip] Eq. J4-4

Block shear	[Kip]	124.41	90.00	DL	0.72	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.313[in] = **0.254**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (6 - 1)*3[in])*0.313[in] = **5.08**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **3.57**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.57[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]* 5.08[in2] + 1*58000[lb/in2]*0.254[in2])) = **124.41**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	127.30	90.00	DL	0.71	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (6*10.61[kip]) = **127.3**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	181.48	90.00	DL	0.50	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2* d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(6/(1*6))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(6 - 1))*0.313[in]*58000[lb/in2]*1) = **181.48**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	157.50	90.00	DL	0.57	Eq. J4-3

$A_g = L_p * t_p$ = 17.5[in]*0.313[in] = **5.47**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.47[in2]) = **157.5**[kip] Eq. J4-3

Shear rupture	[Kip]	133.22	90.00	DL	0.68	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h$ = 17.5[in] - 6*0.875[in] = **12.25**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p$ = 12.25[in]*0.313[in] = **3.83**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.83[in2]) = **133.22**[kip] Eq. J4-4

Block shear	[Kip]	120.54	90.00	DL	0.75	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (6 - 1)*3[in])*0.313[in] = **5.08**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (6 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.313[in] = **3.57**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*
A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.57[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*
5.08[in2] + 1*58000[lb/in2]*0.187[in2])) = **120.54**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	21.91	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b * N_{bolts})$ = 90[kip]/(0.442[in2]*12) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] -
90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

$f_v = F/(A_b * N_{bolts})$ = 90[kip]/(0.442[in2]*12) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] -
90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =
1.51[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*11.79[kip]*2.34[in])/(0.5*3[in]*58000[lb/
in2]))$^{0.5}$ = **1.03**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.03[in]/0.313[in])^2 - 1) =
5.27 p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.03[in])^2*(1 + 0.729) = **0.16** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =

1.51[in] p. 9-12

$b' = b - d/2 = 2.71$[in] $- 0.75$[in]$/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34$[in]$/1.51$[in] $=$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813$[in]$/2.75$[in] $=$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*11.79$[kip]$*2.34$[in]$)/(0.5*2.75$[in]$*58000$[lb/in2]$))^{0.5} =$ **1.07**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.07$[in]$/0.313$[in]$)^2 - 1) =$ **6** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313$[in]$/1.07$[in]$)^2*(1 + 0.705) =$ **0.145** p. 9-13

HasEqualLengths $\rightarrow$ **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.145 + (6 - 2)*0.16)/6 =$ **0.155** p. 9-13

$T_{avail} = 12 * (B*Q) = 12 * (11.79$[kip]$*0.155) =$ **21.91**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	150.93	90.00	DL	0.60	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35$[in]$ - 0.813$[in]$/2) =$ **3.94**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*3.94$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(6 - 1))*0.43$[in]$*65000$[lb/in2]$*1 =$ **150.93**[kip] Eq. J3-6

Shear yielding	[Kip]	203.82	90.00	DL	0.44	Eq. J4-3

$A_g = L_p*t_p = 23.7$[in]$*0.43$[in]$ =$ **10.19**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*10.19$[in2]$ =$ **203.82**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	242.19	90.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in]$ - 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(6 - 1))*0.345$[in]$*65000$[lb/in2]$*1) =$ **242.19**[kip] Eq. J3-6

Global critical strength ratio **0.75**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available

tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 5:41 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : **DA BCW All bolted**

Connection ID : **SC-01-22W**

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W24x84

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	90.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	17.50	10.78	21.56	✔	p. 10-8
$L_{min} = T/2 = 21.56$[in]$/2 =$ **10.78**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 24.1$[in] $- \max(1.27$[in]$, 0$[in]$) - \max(1.27$[in]$, 0$[in]$) =$ **21.56**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Beam						
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	127.30	90.00	DL	0.71	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (6*10.61[kip]) = **127.3**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	181.48	90.00	DL	0.50	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(6 - 1))*0.313[in]*58000[lb/in2]*1) = **181.48**[kip] Eq. J3-6

Shear yielding	[Kip]	157.50	90.00	DL	0.57	Eq. J4-3

A_g = L_p*t_p = 17.5[in]*0.313[in] = **5.47**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.47[in2]) = **157.5**[kip] Eq. J4-3

Shear rupture	[Kip]	133.22	90.00	DL	0.68	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 17.5[in] - 6*0.875[in] = **12.25**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 12.25[in]*0.313[in] = **3.83**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.83[in2]) = **133.22**[kip] Eq. J4-4

Block shear	[Kip]	124.41	90.00	DL	0.72	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.313[in] = **0.254**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (6 - 1)*3[in])*0.313[in] = **5.08**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **3.57**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.57[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]* 5.08[in2] + 1*58000[lb/in2]*0.254[in2])) = **124.41**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	127.30	90.00	DL	0.71	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (6*10.61[kip]) = **127.3**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	181.48	90.00	DL	0.50	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2* d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(6/(1*6))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(6 - 1))*0.313[in]*58000[lb/in2]*1) = **181.48**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	157.50	90.00	DL	0.57	Eq. J4-3

$A_g = L_p * t_p$ = 17.5[in]*0.313[in] = **5.47**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.47[in2]) = **157.5**[kip] Eq. J4-3

Shear rupture	[Kip]	133.22	90.00	DL	0.68	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h$ = 17.5[in] - 6*0.875[in] = **12.25**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p$ = 12.25[in]*0.313[in] = **3.83**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.83[in2]) = **133.22**[kip] Eq. J4-4

Block shear	[Kip]	120.54	90.00	DL	0.75	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (6 - 1)*3[in])*0.313[in] = **5.08**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (6 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.313[in] = **3.57**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*
A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.57[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*
5.08[in2] + 1*58000[lb/in2]*0.187[in2])) = **120.54**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	21.91	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b * N_{bolts})$ = 90[kip]/(0.442[in2]*12) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] -
90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

$f_v = F/(A_b * N_{bolts})$ = 90[kip]/(0.442[in2]*12) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] -
90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =
1.51[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*11.79[kip]*2.34[in])/(0.5*3[in]*58000[lb/
in2]))$^{0.5}$ = **1.03**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.03[in]/0.313[in])^2 - 1) =
5.27 p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.03[in])^2*(1 + 0.729) = **0.16** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) =

1.51[in] p. 9-12

$b' = b - d/2 = 2.71$[in] $- 0.75$[in]$/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34$[in]$/1.51$[in] $=$ **1.55** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813$[in]$/2.75$[in] $=$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*11.79$[kip]$*2.34$[in]$)/(0.5*2.75$[in]$*58000$[lb/in2]$))^{0.5} =$ **1.07**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.07$[in]$/0.313$[in]$)^2 - 1) =$ **6** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313$[in]$/1.07$[in]$)^2*(1 + 0.705) =$ **0.145** p. 9-13

HasEqualLengths $\rightarrow$ **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.145 + (6 - 2)*0.16)/6 =$ **0.155** p. 9-13

$T_{avail} = 12 * (B*Q) = 12 * (11.79$[kip]$*0.155) =$ **21.91**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	164.97	90.00	DL	0.55	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.55$[in]$ - 0.813$[in]$/2) =$ **4.14**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*4.14$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(6 - 1))*0.47$[in]$*65000$[lb/in2]$*1 =$ **164.97**[kip] Eq. J3-6

Shear yielding	[Kip]	226.54	90.00	DL	0.40	Eq. J4-3

$A_g = L_p*t_p = 24.1$[in]$*0.47$[in] $=$ **11.33**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*11.33$[in2] $=$ **226.54**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	329.94	90.00	DL	0.27	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in]$ - 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(6 - 1))*0.47$[in]$*65000$[lb/in2]$*1) =$ **329.94**[kip] Eq. J3-6

Global critical strength ratio **0.75**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available

tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

F: Required shear force for combined tension and shear

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

Current Date: 2016-05-25 5:43 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : **DA BCW All bolted**

Connection ID : **SC-01-23W**

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W30x90

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	80.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	13.49	26.98	✔	p. 10-8
$L_{min} = T/2 = 26.98$[in]$/2 =$ **13.49**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 29.5$[in] $- \max(1.26$[in]$, 1.26$[in]$) - \max(1.26$[in]$, 1.26$[in]$) =$ **26.98**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.08	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.295$[in], 12 [in]$) =$ **7.08**[in]						Sec. J3.5

Beam

Top cope length	[in]	3.86	--	59.00	✔	
$c_{max} = 2*d = 2*29.5$[in] = **59**[in]						
Bottom cope length	[in]	3.86	--	59.00	✔	
$c_{max} = 2*d = 2*29.5$[in] = **59**[in]						
Top cope depth	[in]	1.26	--	7.50	✔	
$d_{ctmax} = \min(d/2, d_{top} - w) = \min(29.5$[in]$/2, 7.5$[in] - 0[in]$) =$ **7.5**[in]						
Bottom cope depth	[in]	1.26	--	7.50	✔	
$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(29.5$[in]$/2, 29.5$[in] - 14.5[in] - 7.5[in] - 0[in]$) =$ **7.5**[in]						

Vertical edge distance	[in]	7.49	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	80.00	DL	0.75	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	80.00	DL	0.54	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*$ 0.75[in]$)*(5 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	80.00	DL	0.61	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.313$[in] = **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.53$[in2]$) =$ **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	80.00	DL	0.73	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in] $- 5*0.875$[in] $=$ **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.313$[in] = **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.16$[in2]$) =$ **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	80.00	DL	0.77	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.313$[in] $=$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (5 - 1)*3$[in]$)*0.313$[in] $=$ **4.14**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (5 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in] $=$ **2.91**[in2]						Sec. J4-3
IsStressUniform → **True**						

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*
A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*
4.14[in2] + 1*58000[lb/in2]*0.254[in2])) = **104.16**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	106.08	80.00	DL	0.75	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (5*10.61[kip]) = **106.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	148.85	80.00	DL	0.54	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*
d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*
2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	80.00	DL	0.61	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	80.00	DL	0.73	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.29	80.00	DL	0.80	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*
A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*
4.14[in2] + 1*58000[lb/in2]*0.187[in2])) = **100.29**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.14	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 80[kip]/(0.442[in2]*10) = **18099.55**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*18099.55[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **49126.7**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*49126.7[lb/in2]*0.442[in2] = **10.86**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 80[kip]/(0.442[in2]*10) = **18099.55**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*18099.55[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **49126.7**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*49126.7[lb/in2]*0.442[in2] = **10.86**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*10.86[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **0.986**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((0.986[in]/0.313[in])^2 - 1) = **4.81** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/0.986[in])^2*(1 + 0.729) = **0.174** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*10.86[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.03**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.03[in]/0.313[in])^2 - 1) = **5.48** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.03[in])^2*(1 + 0.705) = **0.157** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.157 + (5 - 2)*0.174)/5 = **0.167** p. 9-13

T_{avail} = 10 * (B*Q) = 10 * (10.86[kip]*0.167) = **18.14**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	137.48	80.00	DL	0.58	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 7.49[in] - 0.813[in]/2) = **7.08**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = (1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*7.08[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.47[in]*65000[lb/in2]*1 = **137.48**[kip] Eq. J3-6

Shear yielding	[Kip]	253.61	80.00	DL	0.32	Eq. J4-3

A_g = L_p*t_p = 26.98[in]*0.47[in] = **12.68**[in2] Sec. D3-1

(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*12.68[in2] = **253.61**[kip] Eq. J4-3

Shear rupture	[Kip]	207.17	80.00	DL	0.39	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 26.98[in] - 5*0.875[in] = **22.61**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p$ = 22.61[in]*0.47[in] = **10.62**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*10.62[in2] = **207.17**[kip] Eq. J4-4

Block shear	[Kip]	165.09	80.00	DL	0.48	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.25[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.47[in] = **0.852**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (7.49[in] + (5 - 1)*3[in])*0.47[in] = **9.16**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (7.49[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.47[in] = **7.31**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*7.31[in2] + 1*65000[lb/in2]*0.852[in2], 0.6*50000[lb/in2]*9.16[in2] + 1*65000[lb/in2]*0.852[in2]) = **165.09**[kip] Eq. J4-5

Flexural yielding	[Kip]	391.78	80.00	DL	0.20	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*57.02[in3]/4.36[in] = **391.78**[kip] p. 9-6

Flexural rupture	[Kip]	425.28	80.00	DL	0.19	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*57.02[in3]/4.36[in] = **425.28**[kip] p. 9-6

Local web buckling	[Kip]	391.78	80.00	DL	0.20	p. 9-8, p. 9-7

$h_o = d - d_c$ = 29.5[in] - 2.52[in] = **26.98**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3.86[in]<=2*29.5[in]) and (1.26[in]<=0.2*29.5[in]) and (3.86[in]<=2*29.5[in]) and (1.26[in]<=0.2*29.5[in]) = **True** p. 9-8

$f_d = 3.5 - 7.5*(d_c/d)$ = 3.5 - 7.5*(1.26[in]/29.5[in]) = **3.18** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d$ = 0.62*π*2.90E+07[lb/in2]*0.47[in]^2/(3.86[in]*26.98[in])*3.18 = **3.81E+05**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 3.81E+05[lb/in2])*57.02[in3]/4.36[in] = **391.78**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	172.58	80.00	DL	0.46	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.295[in]*65000[lb/in2]*1) = **172.58**[kip] Eq. J3-6

Global critical strength ratio **0.80**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

c: Coped length

C_2: Edge distance increment

c_b: Bottom cope length

c_t: Top cope length

c_{max}: Maximum coped length

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{cbmax}: Maximum bottom coped depth

d_{ct}: Top cope depth

d_{ctmax}: Maximum top coped depth

d_h: Nominal hole dimension

d_{top}: Beam top edge distance

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

e: Load eccentricity

E: Elastic modulus

F: Required shear force for combined tension and shear

F_{cr}: Critical stress, flexural stress buckling

f_d: Plate buckling model adjustment factor for beam coped at both flanges

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

h_o: Reduced beam depth

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsBeamCopedAtBothFlanges: Is beam coped at both flanges

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

L: Angle length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

w: Weld size

Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 5:44 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : DA BCW All bolted

Connection ID : SC-01-24W

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W30x116

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	90.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	17.50	13.50	27.00	✔	p. 10-8
$L_{min} = T/2 = 27[in]/2 = \mathbf{13.5}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 30[in] - \max(1.5[in], 1.5[in]) - \max(1.5[in], 1.5[in]) = \mathbf{27}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Top cope length	[in]	5.82	--	60.00	✔	
$c_{max} = 2*d = 2*30$[in] = **60**[in]						
Bottom cope length	[in]	5.82	--	60.00	✔	
$c_{max} = 2*d = 2*30$[in] = **60**[in]						
Top cope depth	[in]	1.50	--	6.25	✔	
$d_{ctmax} = \min(d/2, d_{top} - w) = \min(30$[in]$/2, 6.25$[in] - 0[in]$) =$ **6.25**[in]						
Bottom cope depth	[in]	1.50	--	6.25	✔	
$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(30$[in]$/2, 30$[in] - 17.5[in] - 6.25[in] - 0[in]$) =$ **6.25**[in]						

Vertical edge distance	[in]	6.00	1.00		--	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00		--	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	127.30	90.00	DL	0.71	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (6*10.61$[kip]$) =$ **127.3**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	181.48	90.00	DL	0.50	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(6 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **181.48**[kip]						Eq. J3-6
Shear yielding	[Kip]	157.50	90.00	DL	0.57	Eq. J4-3
$A_g = L_p*t_p = 17.5$[in]$*0.313$[in]$ =$ **5.47**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*5.47$[in2]$) =$ **157.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	133.22	90.00	DL	0.68	Eq. J4-4
$L_h = d_h +$ 1/16 [in] $= 0.813$[in] + 1/16 [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 17.5$[in]$ - 6*0.875$[in]$ =$ **12.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 12.25$[in]$*0.313$[in]$ =$ **3.83**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.83$[in2]$) =$ **133.22**[kip]						Eq. J4-4
Block shear	[Kip]	124.41	90.00	DL	0.72	Eq. J4-5
$dh_h = d_h +$ 1/16 [in] $= 0.813$[in] + 1/16 [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h +$ 1/16 [in] $= 0.813$[in] + 1/16 [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (6 - 1)*3$[in]$)*0.313$[in]$ =$ **5.08**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (6 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **3.57**[in2]						Sec. J4-3
IsStressUniform → **True**						

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.57[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*5.08[in2] + 1*58000[lb/in2]*0.254[in2])) = **124.41**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	127.30	90.00	DL	0.71	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (6*10.61[kip]) = **127.3**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	181.48	90.00	DL	0.50	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(6/(1*6))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*0.313[in]*58000[lb/in2]*1) = **181.48**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	157.50	90.00	DL	0.57	Eq. J4-3

A_g = L_p*t_p = 17.5[in]*0.313[in] = **5.47**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.47[in2]) = **157.5**[kip] Eq. J4-3

Shear rupture	[Kip]	133.22	90.00	DL	0.68	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 17.5[in] - 6*0.875[in] = **12.25**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 12.25[in]*0.313[in] = **3.83**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.83[in2]) = **133.22**[kip] Eq. J4-4

Block shear	[Kip]	120.54	90.00	DL	0.75	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (6 - 1)*3[in])*0.313[in] = **5.08**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **3.57**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.57[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*5.08[in2] + 1*58000[lb/in2]*0.187[in2])) = **120.54**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	21.91	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 90[kip]/(0.442[in2]*12) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 90[kip]/(0.442[in2]*12) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*11.79[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.03**[in] p. 9-12

α' = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.03[in]/0.313[in])^2 - 1) = **5.27** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.03[in])^2*(1 + 0.729) = **0.16** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*11.79[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.07**[in] p. 9-12

α' = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.07[in]/0.313[in])^2 - 1) = **6** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.07[in])^2*(1 + 0.705) = **0.145** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.145 + (6 - 2)*0.16)/6 = **0.155** p. 9-13

T_{avail} = 12 * (B*Q) = 12 * (11.79[kip]*0.155) = **21.91**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	198.32	90.00	DL	0.45	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 6[in] - 0.813[in]/2) = **5.59**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = (1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*5.59[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*0.565[in]*65000[lb/in2]*1 = **198.32**[kip] Eq. J3-6

Shear yielding	[Kip]	305.10	90.00	DL	0.29	Eq. J4-3

A_g = L_p*t_p = 27[in]*0.565[in] = **15.26**[in2] Sec. D3-1

(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*15.26[in2] = **305.1**[kip] Eq. J4-3

Shear rupture	[Kip]	239.63	90.00	DL	0.38	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 27[in] - 6*0.875[in] = **21.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p$ = 21.75[in]*0.565[in] = **12.29**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*12.29[in2] = **239.63**[kip] Eq. J4-4

Block shear	[Kip]	211.26	90.00	DL	0.43	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.25[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.565[in] = **1.02**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (6[in] + (6 - 1)*3[in])*0.565[in] = **11.87**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (6[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.565[in] = **9.15**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*9.15[in2] + 1*65000[lb/in2]*1.02[in2], 0.6*50000[lb/in2]*11.87[in2] + 1*65000[lb/in2]*1.02[in2]) = **211.26**[kip] Eq. J4-5

Flexural yielding	[Kip]	325.47	90.00	DL	0.28	p. 9-6

(1/Ω)R_n = *(1/Ω)*F_y*S_{net}/e = 0.599*50000[lb/in2]*68.65[in3]/6.32[in] = **325.47**[kip] p. 9-6

Flexural rupture	[Kip]	353.29	90.00	DL	0.25	p. 9-6

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*68.65[in3]/6.32[in] = **353.29**[kip] p. 9-6

Local web buckling	[Kip]	325.47	90.00	DL	0.28	p. 9-8, p. 9-7

$h_o = d - d_c$ = 30[in] - 3[in] = **27**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (5.82[in]<=2*30[in]) and (1.5[in]<=0.2*30[in]) and (5.82[in]<=2*30[in]) and (1.5[in]<=0.2*30[in]) = **True** p. 9-8

$f_d = 3.5 - 7.5*(d_c/d)$ = 3.5 - 7.5*(1.5[in]/30[in]) = **3.13** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d$ = 0.62*π*2.90E+07[lb/in2]*0.565[in]^2/(5.82[in]*27[in])*3.13 = **3.59E+05**[lb/in2] p. 9-8

(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 3.59E+05[lb/in2])*68.65[in3]/6.32[in] = **325.47**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	329.94	90.00	DL	0.27	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*0.47[in]*65000[lb/in2]*1) = **329.94**[kip] Eq. J3-6

Global critical strength ratio **0.75**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

c: Coped length

C_2: Edge distance increment

c_b: Bottom cope length

c_t: Top cope length

c_{max}: Maximum coped length

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{cbmax}: Maximum bottom coped depth

d_{ct}: Top cope depth

d_{ctmax}: Maximum top coped depth

d_h: Nominal hole dimension

d_{top}: Beam top edge distance

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

e: Load eccentricity

E: Elastic modulus

F: Required shear force for combined tension and shear

F_{cr}: Critical stress, flexural stress buckling

f_d: Plate buckling model adjustment factor for beam coped at both flanges

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

h_o: Reduced beam depth

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsBeamCopedAtBothFlanges: Is beam coped at both flanges

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

L: Angle length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

w: Weld size

Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 5:44 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : DA BCW All bolted

Connection ID : SC-01-25W

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W30x116

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	120.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	23.50	13.50	27.00	✔	p. 10-8
$L_{min} = T/2 = 27[in]/2 = \mathbf{13.5}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 30[in] - \max(1.5[in], 1.5[in]) - \max(1.5[in], 1.5[in]) = \mathbf{27}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Top cope length	[in]	5.82	--	60.00	✔	
$c_{max} = 2*d = 2*30$[in] = **60**[in]						
Bottom cope length	[in]	5.82	--	60.00	✔	
$c_{max} = 2*d = 2*30$[in] = **60**[in]						
Top cope depth	[in]	1.50	--	3.25	✔	
$d_{ctmax} = \min(d/2, d_{top} - w) = \min(30$[in]$/2, 3.25$[in] - 0[in]$) =$ **3.25**[in]						
Bottom cope depth	[in]	1.50	--	3.25	✔	
$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(30$[in]$/2, 30$[in] - 23.5[in] - 3.25[in] - 0[in]$) =$ **3.25**[in]						

Vertical edge distance	[in]	3.00	1.00		--	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00		--	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	169.73	120.00	DL	0.71	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (8*10.61$[kip]$) =$ **169.73**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	246.73	120.00	DL	0.49	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(8 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **246.73**[kip]						Eq. J3-6
Shear yielding	[Kip]	211.50	120.00	DL	0.57	Eq. J4-3
$A_g = L_p*t_p = 23.5$[in]$*0.313$[in]$ =$ **7.34**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*7.34$[in2]$) =$ **211.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	179.44	120.00	DL	0.67	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 23.5$[in]$ - 8*0.875$[in]$ =$ **16.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 16.5$[in]$*0.313$[in]$ =$ **5.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.16$[in2]$) =$ **179.44**[kip]						Eq. J4-4
Block shear	[Kip]	164.91	120.00	DL	0.73	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (8 - 1)*3$[in]$)*0.313$[in]$ =$ **6.95**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (8 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **4.9**[in2]						Sec. J4-3
IsStressUniform → **True**						

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.9[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*6.95[in2] + 1*58000[lb/in2]*0.254[in2])) = **164.91**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	169.73	120.00	DL	0.71	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (8*10.61[kip]) = **169.73**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	246.73	120.00	DL	0.49	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(8/(1*8))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.313[in]*58000[lb/in2]*1) = **246.73**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	211.50	120.00	DL	0.57	Eq. J4-3

A_g = L_p*t_p = 23.5[in]*0.313[in] = **7.34**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*7.34[in2]) = **211.5**[kip] Eq. J4-3

Shear rupture	[Kip]	179.44	120.00	DL	0.67	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 23.5[in] - 8*0.875[in] = **16.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 16.5[in]*0.313[in] = **5.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*5.16[in2]) = **179.44**[kip] Eq. J4-4

Block shear	[Kip]	161.04	120.00	DL	0.75	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (8 - 1)*3[in])*0.313[in] = **6.95**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (8 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **4.9**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.9[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*6.95[in2] + 1*58000[lb/in2]*0.187[in2])) = **161.04**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	29.45	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 120[kip]/(0.442[in2]*16) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 120[kip]/(0.442[in2]*16) = **16968.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*16968.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **53368.78**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*53368.78[lb/in2]*0.442[in2] = **11.79**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*11.79[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.03**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((1.03[in]/0.313[in])^2 - 1) = **5.27** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.03[in])^2*(1 + 0.729) = **0.16** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*11.79[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.07**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.07[in]/0.313[in])^2 - 1) = **6** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.07[in])^2*(1 + 0.705) = **0.145** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.145 + (8 - 2)*0.16)/8 = **0.156** p. 9-13

T_{avail} = 16 * (B*Q) = 16 * (11.79[kip]*0.156) = **29.45**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	264.42	120.00	DL	0.45	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3[in] - 0.813[in]/2) = **2.59**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = (1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.59[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.565[in]*65000[lb/in2]*1 = **264.42**[kip] Eq. J3-6

Shear yielding	[Kip]	305.10	120.00	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 27[in]*0.565[in] = **15.26**[in2] Sec. D3-1

(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*15.26[in2] = **305.1**[kip] Eq. J4-3

Shear rupture	[Kip]	220.35	120.00	DL	0.54	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 27[in] - 8*0.875[in] = **20**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 20[in] * 0.565[in] = \mathbf{11.3}[in2]$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 65000[lb/in2] * 11.3[in2] = \mathbf{220.35}[kip]$ Eq. J4-4

Block shear	[Kip]	225.40	120.00	DL	0.53	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p = (2.25[in] + (1 - 1) * 3[in] - (1 - 0.5) * 0.875[in]) * 0.565[in] = \mathbf{1.02}[in2]$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1) * s) * t_p = (3[in] + (8 - 1) * 3[in]) * 0.565[in] = \mathbf{13.56}[in2]$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p = (3[in] + (8 - 1) * (3[in] - 0.875[in]) - 0.875[in]/2) * 0.565[in] = \mathbf{9.85}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 65000[lb/in2] * 9.85[in2] + 1 * 65000[lb/in2] * 1.02[in2], 0.6 * 50000[lb/in2] * 13.56[in2] + 1 * 65000[lb/in2] * 1.02[in2]) = \mathbf{225.4}[kip]$ Eq. J4-5

Flexural yielding	[Kip]	325.47	120.00	DL	0.37	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e = 0.599 * 50000[lb/in2] * 68.65[in3]/6.32[in] = \mathbf{325.47}[kip]$ p. 9-6

Flexural rupture	[Kip]	353.29	120.00	DL	0.34	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e = 0.5 * 65000[lb/in2] * 68.65[in3]/6.32[in] = \mathbf{353.29}[kip]$ p. 9-6

Local web buckling	[Kip]	325.47	120.00	DL	0.37	p. 9-8, p. 9-7

$h_o = d - d_c = 30[in] - 3[in] = \mathbf{27}[in]$ p. 9-7

$IsBeamCopedAtBothFlanges = (c_t <= 2 * d)$ and $(d_{ct} <= 0.2 * d)$ and $(c_b <= 2 * d)$ and $(d_{cb} <= 0.2 * d) = (5.82[in] <= 2 * 30[in])$ and $(1.5[in] <= 0.2 * 30[in])$ and $(5.82[in] <= 2 * 30[in])$ and $(1.5[in] <= 0.2 * 30[in]) = \mathbf{True}$ p. 9-8

$f_d = 3.5 - 7.5 * (d_c/d) = 3.5 - 7.5 * (1.5[in]/30[in]) = \mathbf{3.13}$ p. 9-8

$F_{cr} = 0.62 * \pi * E * t_w^2/(c * h_o) * f_d = 0.62 * \pi * 2.90E+07[lb/in2] * 0.565[in]^2/(5.82[in] * 27[in]) * 3.13 = \mathbf{3.59E+05}[lb/in2]$ p. 9-8

$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e = 0.599 * \min(50000[lb/in2], 3.59E+05[lb/in2]) * 68.65[in3]/6.32[in] = \mathbf{325.47}[kip]$ p. 9-7

Support

Bolt bearing under shear load	[Kip]	439.92	120.00	DL	0.27	Eq. J3-6

$L_{c\text{-}end} = \max(0.0, L_e - d_h/2) = \max(0.0, 1.20E+31[in] - 0.813[in]/2) = \mathbf{1.20E+31}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - d_h) = \max(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c) = 2 * (0.5 * (\min(1.2 * 1.20E+31[in], 2.4 * 0.75[in]) + \min(1.2 * 2.19[in], 2.4 * 0.75[in]) * (8 - 1)) * 0.47[in] * 65000[lb/in2] * 1) = \mathbf{439.92}[kip]$ Eq. J3-6

Global critical strength ratio **0.75**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

c: Coped length

C_2: Edge distance increment

c_b: Bottom cope length

c_t: Top cope length

c_{max}: Maximum coped length

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{cbmax}: Maximum bottom coped depth

d_{ct}: Top cope depth

d_{ctmax}: Maximum top coped depth

d_h: Nominal hole dimension

d_{top}: Beam top edge distance

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

e: Load eccentricity

E: Elastic modulus

F: Required shear force for combined tension and shear

F_{cr}: Critical stress, flexural stress buckling

f_d: Plate buckling model adjustment factor for beam coped at both flanges

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

h_o: Reduced beam depth

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsBeamCopedAtBothFlanges: Is beam coped at both flanges

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

L: Angle length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

w: Weld size

Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 5:42 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-01W Beam to Column Web Shear Double Angle All Bolted\B2C WEB5.cnx\

Steel connections

Results

Connection name : **DA BCW All bolted**

Connection ID : **SC-01-26W**

Family: Beam - Column web (BCW)

Type: Angle(s)

Description: W30x132

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	130.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	23.50	13.50	27.00	✔	p. 10-8
$L_{min} = T/2 = 27[in]/2 = \mathbf{13.5}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 30.3[in] - \max(1.65[in], 1.65[in]) - \max(1.65[in], 1.65[in]) = \mathbf{27}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9

Angle (Support side)

Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in]						Sec. J3.5

Beam

Top cope length	[in]	5.82	--	60.60	✔	
$c_{max} = 2*d = 2*30.3$[in] = **60.6**[in]						
Bottom cope length	[in]	5.82	--	60.60	✔	
$c_{max} = 2*d = 2*30.3$[in] = **60.6**[in]						
Top cope depth	[in]	1.65	--	3.40	✔	
$d_{ctmax} = \min(d/2, d_{top} - w) = \min(30.3$[in]$/2, 3.4$[in] - 0[in]$) =$ **3.4**[in]						
Bottom cope depth	[in]	1.65	--	3.40	✔	
$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(30.3$[in]$/2, 30.3$[in] - 23.5[in] - 3.4[in] - 0[in]$) =$ **3.4**[in]						

Vertical edge distance	[in]	3.00	1.00		--	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00		--	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	169.73	130.00	DL	0.77	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (8*10.61$[kip]$) =$ **169.73**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	246.73	130.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in]$ - 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(8 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **246.73**[kip]						Eq. J3-6
Shear yielding	[Kip]	211.50	130.00	DL	0.61	Eq. J4-3
$A_g = L_p*t_p = 23.5$[in]$*0.313$[in]$ =$ **7.34**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*7.34$[in2]$) =$ **211.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	179.44	130.00	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 23.5$[in]$ - 8*0.875$[in]$ =$ **16.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 16.5$[in]$*0.313$[in]$ =$ **5.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.16$[in2]$) =$ **179.44**[kip]						Eq. J4-4
Block shear	[Kip]	164.91	130.00	DL	0.79	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.313$[in]$ =$ **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (8 - 1)*3$[in]$)*0.313$[in]$ =$ **6.95**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (8 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in]$ =$ **4.9**[in2]						Sec. J4-3
IsStressUniform → **True**						

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.9[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*6.95[in2] + 1*58000[lb/in2]*0.254[in2])) = **164.91**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	169.73	130.00	DL	0.77	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (8*10.61[kip]) = **169.73**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	246.73	130.00	DL	0.53	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(8/(1*8))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.313[in]*58000[lb/in2]*1) = **246.73**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	211.50	130.00	DL	0.61	Eq. J4-3

A_g = L_p*t_p = 23.5[in]*0.313[in] = **7.34**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*7.34[in2]) = **211.5**[kip] Eq. J4-3

Shear rupture	[Kip]	179.44	130.00	DL	0.72	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 23.5[in] - 8*0.875[in] = **16.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 16.5[in]*0.313[in] = **5.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*5.16[in2]) = **179.44**[kip] Eq. J4-4

Block shear	[Kip]	161.04	130.00	DL	0.81	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.187**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (8 - 1)*3[in])*0.313[in] = **6.95**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (8 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **4.9**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.9[in2] + 1*58000[lb/in2]*0.187[in2], 0.6*36000[lb/in2]*6.95[in2] + 1*58000[lb/in2]*0.187[in2])) = **161.04**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	29.45	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 130[kip]/(0.442[in2]*16) = **18382.35**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*18382.35[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **48066.18**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*48066.18[lb/in2]*0.442[in2] = **10.62**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 130[kip]/(0.442[in2]*16) = **18382.35**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*18382.35[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **48066.18**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*48066.18[lb/in2]*0.442[in2] = **10.62**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*10.62[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **0.975**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.55)))*((0.975[in]/0.313[in])^2 - 1) = **4.69** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/0.975[in])^2*(1 + 0.729) = **0.178** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.71[in] + 0.75[in]/2) = **1.51**[in] p. 9-12

b' = b - d/2 = 2.71[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.51[in] = **1.55** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/((1/Ω)*p*F_u))$^{0.5}$ = ((3.33*10.62[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.02**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.55)))*((1.02[in]/0.313[in])^2 - 1) = **5.35** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.02[in])^2*(1 + 0.705) = **0.16** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.16 + (8 - 2)*0.178)/8 = **0.173** p. 9-13

T_{avail} = 16 * (B*Q) = 16 * (10.62[kip]*0.173) = **29.45**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	287.82	130.00	DL	0.45	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3[in] - 0.813[in]/2) = **2.59**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = (1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.59[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(8 - 1))*0.615[in]*65000[lb/in2]*1 = **287.82**[kip] Eq. J3-6

Shear yielding	[Kip]	332.10	130.00	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 27[in]*0.615[in] = **16.61**[in2] Sec. D3-1

(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*16.61[in2] = **332.1**[kip] Eq. J4-3

Shear rupture	[Kip]	239.85	130.00	DL	0.54	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 27[in] - 8*0.875[in] = **20**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 20[in] * 0.615[in] = \mathbf{12.3}[in2]$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 65000[lb/in2] * 12.3[in2] = \mathbf{239.85}[kip]$ Eq. J4-4

Block shear	[Kip]	245.35	130.00	DL	0.53	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p = (2.25[in] + (1 - 1) * 3[in] - (1 - 0.5) * 0.875[in]) * 0.615[in] = \mathbf{1.11}[in2]$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1) * s) * t_p = (3[in] + (8 - 1) * 3[in]) * 0.615[in] = \mathbf{14.76}[in2]$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p = (3[in] + (8 - 1) * (3[in] - 0.875[in]) - 0.875[in]/2) * 0.615[in] = \mathbf{10.72}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 65000[lb/in2] * 10.72[in2] + 1 * 65000[lb/in2] * 1.11[in2], 0.6 * 50000[lb/in2] * 14.76[in2] + 1 * 65000[lb/in2] * 1.11[in2]) = \mathbf{245.35}[kip]$ Eq. J4-5

Flexural yielding	[Kip]	354.27	130.00	DL	0.37	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e = 0.599 * 50000[lb/in2] * 74.72[in3]/6.32[in] = \mathbf{354.27}[kip]$ p. 9-6

Flexural rupture	[Kip]	384.56	130.00	DL	0.34	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e = 0.5 * 65000[lb/in2] * 74.72[in3]/6.32[in] = \mathbf{384.56}[kip]$ p. 9-6

Local web buckling	[Kip]	354.27	130.00	DL	0.37	p. 9-8, p. 9-7

$h_o = d - d_c = 30.3[in] - 3.3[in] = \mathbf{27}[in]$ p. 9-7

$IsBeamCopedAtBothFlanges = (c_t <= 2 * d) \text{ and } (d_{ct} <= 0.2 * d) \text{ and } (c_b <= 2 * d) \text{ and } (d_{cb} <= 0.2 * d) = (5.82[in] <= 2 * 30.3[in]) \text{ and } (1.65[in] <= 0.2 * 30.3[in]) \text{ and } (5.82[in] <= 2 * 30.3[in]) \text{ and } (1.65[in] <= 0.2 * 30.3[in]) = \mathbf{True}$ p. 9-8

$f_d = 3.5 - 7.5 * (d_c/d) = 3.5 - 7.5 * (1.65[in]/30.3[in]) = \mathbf{3.09}$ p. 9-8

$F_{cr} = 0.62 * \pi * E * t_w^2/(c * h_o) * f_d = 0.62 * \pi * 2.90E+07[lb/in2] * 0.615[in]^2/(5.82[in] * 27[in]) * 3.09 = \mathbf{4.21E+05}[lb/in2]$ p. 9-8

$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e = 0.599 * \min(50000[lb/in2], 4.21E+05[lb/in2]) * 74.72[in3]/6.32[in] = \mathbf{354.27}[kip]$ p. 9-7

Support

Bolt bearing under shear load	[Kip]	439.92	130.00	DL	0.30	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) = \mathbf{1.20E+31}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c) = 2 * (0.5 * (\min(1.2 * 1.20E+31[in], 2.4 * 0.75[in]) + \min(1.2 * 2.19[in], 2.4 * 0.75[in]) * (8 - 1)) * 0.47[in] * 65000[lb/in2] * 1) = \mathbf{439.92}[kip]$ Eq. J3-6

Global critical strength ratio **0.81**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

a': Distance for prying action

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

B: Available tensile strength per bolt

B: Available strength of all bolts

b': Distance for prying action

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

c: Coped length

C_2: Edge distance increment

c_b: Bottom cope length

c_t: Top cope length

c_{max}: Maximum coped length

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{cbmax}: Maximum bottom coped depth

d_{ct}: Top cope depth

d_{ctmax}: Maximum top coped depth

d_h: Nominal hole dimension

d_{top}: Beam top edge distance

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

e: Load eccentricity

E: Elastic modulus

F: Required shear force for combined tension and shear

F_{cr}: Critical stress, flexural stress buckling

f_d: Plate buckling model adjustment factor for beam coped at both flanges

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

h_o: Reduced beam depth

HasEqualLengths: Has equal tributary length for interior and exterior bolts

IsBeamCopedAtBothFlanges: Is beam coped at both flanges

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

L: Angle length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

e_{dmin}: Minimum edge distance

n: Bolts rows number

N_{bolts}: Number of bolts

n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

w: Weld size

Z_{net}: Net plastic section modulus

SC-02 BEAM TO WF COLUMN WEB USING EXTENDED SHEAR TAB

Connection ID	Beam Size	Design Reaction (kip) "R"	Beam Skew Angles (Deg) "β1"	Beam Slop Angles (Deg) "β2"	Single Plate (A36 Steel)				Bolt Size and Grade	Bolt Rows x Col "Row"	Bolt Spacing（inch） "Spa."	Distance between Weld to Bolts Max (inch) "e"
					Plate Size (inch) "t_p"	Plate weld size to support Column* (inch) "w"	Bolt edge distance					
							Vertical "L_{ev}" (inch)	Horizontal "L_{eh}" (inch)				
SC-02-12	W14x22	15	20	0	1/2“	5/16“	1.75	2	1" A490N	3x2	3	7 1/8
SC-02-13	W16x31	20	26	0	3/8“	1/4“	1.75	2	1" A490N	4x1	3	8 7/16
SC-02-14	W18x35	40	26	0	1/2“	5/16“	1.75	2	1" A490N	5x2	3	9 9/16
SC-02-15	W27x84	70	26	0	5/8“	7/16“	1.75	2	1" A490N	7x2	3	10 15/16
SC-02-16	W10X17	10	0	0	1/2"	5/16"	1.75	2	1" A490N	2x2	3	7 13/16
SC-02-17	W16X31	15	0	0	1/2"	5/16"	1.75	2	1" A490N	4x1	3	8 13/16
SC-02-18	W16X31	35	0	0	5/8"	7/16"	1.75	2	1" A490N	4x2	3	8 13/16
SC-02-19	W18X35	30	0	0	1/2"	5/16"	1.75	2	1" A490N	5x1	3	8 13/16
SC-02-20	W14x22	10	26	0	3/8“	1/4“	1.75	2	1" A490N	3x1	3	8 3/8
SC-02-21	W14x22	15	26	0	1/2“	5/16“	1.75	2	1" A490N	3x2	3	8 3/8
SC-02-22	W16x26	20	26	6.9	1/2“	5/16“	1.75	2	1" A490N	4x1	3	8 7/16
SC-02-23	W21x44	30	26	6.9	1/2“	5/16“	1.75	2	1" A490N	5x1	3	9 9/16
SC-02-24	W24x55	35	26	6.9	1/2“	5/16“	1.75	2	1" A490N	5x1	3	9 9/16

*Short Slotted Hole on Shear Tab,Using Standard Hole when with slop angle

Stabilizer Plate 3/8" Plate T&B of Extended Plate, filling between flanges

Make sure eccentricity values not greater than values in Table.

Plate or beam bolt horizontal edge distance no less than 2 inch.

Current Date: 2016-05-25 5:08 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-12**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.55	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.342 = **0.548**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	3.85	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.30	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	39.29	15.00	DL	0.38	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 1.67*23.55[kip]*1 = **39.29**[kip]						Tables (7-1..14)

Flexure with the Von-Mises shear reduction	[Kip*ft]	19.60	10.75	DL	0.55	p. 10-103
$A_g = L_p * t_p = 9.5$[in]$*0.5$[in] $= \mathbf{4.75}$[in2]						Sec. D3-1
$f_v = V/A_g = 15$[kip]$/4.75$[in2] $= \mathbf{3157.89}$[lb/in2]						p. 10-103
$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*36000$[lb/in2]$)^2 - 3*3157.89$[lb/in2]$^2))^{1/2} = \mathbf{20851.44}$[lb/in2]						p. 10-103
$Z_x = t_p * L^2/4 = 0.5$[in]$*9.5$[in]$^2/4 = \mathbf{11.28}$[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr} * Z = 20851.44$[lb/in2]$*11.28$[in3] $= \mathbf{19.6}$[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	49.29	15.00	DL	0.30	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(1.67/(2*3))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$))*(3 - 1))*0.5$[in]$*58000$[lb/in2]$*2 = \mathbf{49.29}$[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	68.40	15.00	DL	0.22	Eq. J4-3
$A_g = L_p * t_p = 9.5$[in]$*0.5$[in] $= \mathbf{4.75}$[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.75$[in2] $= \mathbf{68.4}$[kip]						Eq. J4-3
Shear rupture	[Kip]	53.29	15.00	DL	0.28	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$L_e = L - n*L_h = 9.5$[in] $- 3*1.13$[in] $= \mathbf{6.13}$[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p = 6.13$[in]$*0.5$[in] $= \mathbf{3.06}$[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.06$[in2] $= \mathbf{53.29}$[kip]						Eq. J4-4
Block shear	[Kip]	63.15	15.00	DL	0.24	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1.31$[in] $+ 1/16$ [in] $= \mathbf{1.38}$[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*1.38$[in]$)*0.5$[in] $= \mathbf{1.47}$[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (3 - 1)*3$[in]$)*0.5$[in] $= \mathbf{3.88}$[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (3 - 1)*(3$[in]$ - 1.13$[in]$) - 1.13$[in]$/2)*0.5$[in] $= \mathbf{2.47}$[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **False**						
$U_{bs} = 0.5$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*58000$[lb/in2]$*2.47$[in2]$ + 0.5*58000$[lb/in2]$*1.47$[in2]$, 0.6*36000$[lb/in2]$*3.88$[in2]$ + 0.5*58000$[lb/in2]$*1.47$[in2]$) = \mathbf{63.15}$[kip]						Eq. J4-5
Flexural rupture	[Kip]	34.20	15.00	DL	0.44	p. 9-6
$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(9.5$[in]$^2 - 3$[in]$^2*3*(3^2 - 1)*1.13$[in]$/9.5$[in]$) = \mathbf{8.08}$[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*8.08$[in3]$/6.86$[in] $= \mathbf{34.2}$[kip]						p. 9-6

Plate (support side)

Weld capacity	[Kip]	120.93	15.00	DL	0.12	Tables 8-4 .. 8-11
$e = 0$						p. 10-135
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*13.03$[in]$) =$ **120.93**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	29.31	15.00	DL	0.51	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.85$[in]$ - 1.06$[in]$/2) =$ **3.32**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$ $(n - 1))*t_p*F_u*n_c = 0.5*(1.67/(2*3))*(\min(1.2*3.32$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$ 1[in]$)*(3 - 1))*0.23$[in]$*65000$[lb/in2]$*2 =$ **29.31**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	63.02	15.00	DL	0.24	Eq. J4-3
$A_g = L_p*t_p = 13.7$[in]$*0.23$[in]$ =$ **3.15**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.15$[in2]$ =$ **63.02**[kip]						Eq. J4-3

Support

Welds rupture	[Kip/ft]	173.16	13.81	DL	0.08	p. 9-5
$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.37$[in]$ =$ **14.43**[kip/in]						p. 9-5
$e = 0$						p. 10-135
$D_{min} = P/((1/\Omega)*C*C_1*L) = 7.5$[kip]$/(0.5*1.86$[kip/in]$*1*13.03$[in]$) =$ **0.62**						tables 8-4..11
$HasWeldsOnBothSides \rightarrow$ **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.62/16$ [in] $=$ **1.15**[kip/in]						p. 9-5

Global critical strength ratio **0.55**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-13**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W16x31

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	6.60	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.275[in], 12 [in]) = **6.6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.28	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	3.45	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.24	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	30.34	20.00	DL	0.66	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.29*23.55[kip]*1 = **30.34**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	24.72	13.96	DL	0.56	p. 10-103
A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2]						Sec. D3-1
f_v = V/A_g = 20[kip]/4.69[in2] = **4266.67**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((1/Ω)*F_y)^2 - 3*f_v^2))^1/2 = (max(0, (0.599*36000[lb/in2])^2 - 3*4266.67[lb/in2]^2))^1/2 = **20250.58**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.375[in]*12.5[in]^2/4 = **14.65**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20250.58$[lb/in2]$*14.65$[in3] = **24.72**[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	29.56	20.00	DL	0.68	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in] $- 1.06$[in]$/2) =$ **1.22**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.29/(1*4))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(4 - 1))*0.375$[in]$*58000$[lb/in2]$*1 =$ **29.56**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	67.50	20.00	DL	0.30	Eq. J4-3

$A_g = L_p*t_p = 12.5$[in]$*0.375$[in] = **4.69**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.69$[in2] = **67.5**[kip] Eq. J4-3

Shear rupture	[Kip]	52.20	20.00	DL	0.38	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h = 12.5$[in] $- 4*1.13$[in] = **8**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8$[in]$*0.375$[in] = **3**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3$[in2] = **52.2**[kip] Eq. J4-4

Block shear	[Kip]	57.81	20.00	DL	0.35	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.31$[in] $+ 1/16$ [in] = **1.38**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$
1.38[in]$)*0.375$[in] = **0.492**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in] $+ (4 - 1)*3$[in]$)*0.375$[in] = **4.03**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in] $+ (4 - 1)*(3$[in] $- 1.13$[in]$) -$
1.13[in]$/2)*0.375$[in] = **2.55**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*2.55$[in2] $+ 1*58000$[lb/in2]$*0.492$[in2]$, 0.6*36000$[lb/in2]$*4.03$[in2] $+ 1*58000$[lb/in2]$*0.492$[in2]$) =$ **57.81**[kip] Eq. J4-5

Flexural rupture	[Kip]	37.38	20.00	DL	0.54	p. 9-6

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375$[in]$/4*(12.5$[in]$^2 - 3$[in]$^2*4*(4^2 -$
$1)*1.13$[in]$/12.5$[in]$) =$ **10.09**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*10.09$[in3]$/7.83$[in] = **37.38**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	111.52	20.00	DL	0.18	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*4*15.02$[in]$) =$ **111.52**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	26.99	20.00	DL	0.74	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.45\text{[in]} - 1.06\text{[in]}/2) = \mathbf{2.92}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.29/(1*4))*(\min(1.2*2.92\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(4 - 1))*0.275\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{26.99}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	87.45	20.00	DL	0.23	Eq. J4-3

$A_g = L_p*t_p = 15.9\text{[in]}*0.275\text{[in]} = \mathbf{4.37}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*4.37\text{[in2]} = \mathbf{87.45}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	159.12	15.98	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.34\text{[in]} = \mathbf{13.26}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*15.02\text{[in]}) = \mathbf{0.717}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.717/16\ \text{[in]} = \mathbf{1.33}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.74**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:13 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-14**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W18x35

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	40.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.20	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	7.20	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	2.85	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.20	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	76.82	40.00	DL	0.52	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 3.26*23.55[kip]*1 = **76.82**[kip]						Tables (7-1..14)

Flexure with the Von-Mises shear reduction	[Kip*ft]	49.09	36.53	DL	0.74	p. 10-103

$A_g = L_p * t_p = 15.5\text{[in]} * 0.5\text{[in]} = \mathbf{7.75}\text{[in2]}$ Sec. D3-1

$f_v = V/A_g = 40\text{[kip]}/7.75\text{[in2]} = \mathbf{5161.29}\text{[lb/in2]}$ p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*36000\text{[lb/in2]})^2 - 3*5161.29\text{[lb/in2]}^2))^{1/2} = \mathbf{19615.88}\text{[lb/in2]}$ p. 10-103

$Z_x = t_p * L^2/4 = 0.5\text{[in]} * 15.5\text{[in]}^2/4 = \mathbf{30.03}\text{[in3]}$ T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr} * Z = 19615.88\text{[lb/in2]} * 30.03\text{[in3]} = \mathbf{49.09}\text{[kip*ft]}$ p. 10-103

Bolt bearing under shear load	[Kip]	101.81	40.00	DL	0.39	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.22}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(3.26/(2*5))*(\min(1.2*1.22\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(5 - 1))*0.5\text{[in]}*58000\text{[lb/in2]}*2 = \mathbf{101.81}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	111.60	40.00	DL	0.36	Eq. J4-3

$A_g = L_p * t_p = 15.5\text{[in]} * 0.5\text{[in]} = \mathbf{7.75}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000\text{[lb/in2]}*7.75\text{[in2]} = \mathbf{111.6}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	85.91	40.00	DL	0.47	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 15.5\text{[in]} - 5*1.13\text{[in]} = \mathbf{9.88}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 9.88\text{[in]}*0.5\text{[in]} = \mathbf{4.94}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000\text{[lb/in2]}*4.94\text{[in2]} = \mathbf{85.91}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	95.55	40.00	DL	0.42	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.31\text{[in]} + 1/16\text{ [in]} = \mathbf{1.38}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2\text{[in]} + (2 - 1)*3\text{[in]} - (2 - 0.5)*1.38\text{[in]})*0.5\text{[in]} = \mathbf{1.47}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75\text{[in]} + (5 - 1)*3\text{[in]})*0.5\text{[in]} = \mathbf{6.88}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75\text{[in]} + (5 - 1)*(3\text{[in]} - 1.13\text{[in]}) - 1.13\text{[in]}/2)*0.5\text{[in]} = \mathbf{4.34}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{False}$

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*58000\text{[lb/in2]}*4.34\text{[in2]} + 0.5*58000\text{[lb/in2]}*1.47\text{[in2]}, 0.6*36000\text{[lb/in2]}*6.88\text{[in2]} + 0.5*58000\text{[lb/in2]}*1.47\text{[in2]}) = \mathbf{95.55}\text{[kip]}$ Eq. J4-5

Flexural rupture	[Kip]	66.64	40.00	DL	0.60	p. 9-6

$L_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5\text{[in]}/4*(15.5\text{[in]}^2 - 3\text{[in]}^2*5*(5^2 - 1)*1.13\text{[in]}/15.5\text{[in]}) = \mathbf{20.23}\text{[in3]}$ 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000\text{[lb/in2]}*20.23\text{[in3]}/8.81\text{[in]} = \mathbf{66.64}\text{[kip]}$ p. 9-6

Plate (support side)

Weld capacity	[Kip]	156.38	40.00	DL	0.26	Tables 8-4 .. 8-11
$e = 0$						p. 10-135
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*16.85$[in]$) =$ **156.38**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	74.42	40.00	DL	0.54	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85$[in]$ - 1.06$[in]$/2) =$ **2.32**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$ $(n - 1))*t_p*F_u*n_c = 0.5*(3.26/(2*5))*(\min(1.2*2.32$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$ 1[in]$)*(5 - 1))*0.3$[in]$*65000$[lb/in2]$*2 =$ **74.42**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	106.20	40.00	DL	0.38	Eq. J4-3
$A_g = L_p*t_p = 17.7$[in]$*0.3$[in]$ =$ **5.31**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*5.31$[in2]$ =$ **106.2**[kip]						Eq. J4-3

Support

Welds rupture	[Kip/ft]	182.52	28.49	DL	0.16	p. 9-5
$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.39$[in]$ =$ **15.21**[kip/in]						p. 9-5
$e = 0$						p. 10-135
$D_{min} = P/((1/\Omega)*C*C_1*L) = 20$[kip]$/(0.5*1.86$[kip/in]$*1*16.85$[in]$) =$ **1.28**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.28/16$ [in] $=$ **2.37**[kip/in]						p. 9-5

Global critical strength ratio **0.74**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:13 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-15**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W27x84

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	70.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.46[in], 12 [in]) = **11.04**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.46[in], 12 [in]) = **11.04**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.35	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.11	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	7	7	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.625[in] = **0.0326**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	126.94	70.00	DL	0.55	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 5.39*23.55[kip]*1 = **126.94**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	117.84	71.88	DL	0.61	p. 10-103
A_g = L_p*t_p = 21.5[in]*0.625[in] = **13.44**[in2]						Sec. D3-1
f_v = V/A_g = 70[kip]/13.44[in2] = **5209.3**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*5209.3[lb/in2^2]))$^{1/2}$ = **19577.76**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.625[in]*21.5[in]^2/4 = **72.23**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 19577.76$[lb/in2]$*72.23$[in3]$ = \mathbf{117.84}$[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	215.10	70.00	DL	0.33	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(5.39/(2*7))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(7 - 1))*0.625$[in]$*58000$[lb/in2]$*2 = \mathbf{215.1}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	193.50	70.00	DL	0.36	Eq. J4-3

$A_g = L_p*t_p = 21.5$[in]$*0.625$[in]$ = \mathbf{13.44}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*13.44$[in2]$ = \mathbf{193.5}$[kip] Eq. J4-3

Shear rupture	[Kip]	148.17	70.00	DL	0.47	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$L_e = L - n*L_h = 21.5$[in]$ - 7*1.13$[in]$ = \mathbf{13.63}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 13.63$[in]$*0.625$[in]$ = \mathbf{8.52}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*8.52$[in2]$ = \mathbf{148.17}$[kip] Eq. J4-4

Block shear	[Kip]	159.93	70.00	DL	0.44	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.31$[in]$ + 1/16$ [in]$ = \mathbf{1.38}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*$
1.38[in]$)*0.625$[in]$ = \mathbf{1.84}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (7 - 1)*3$[in]$)*0.625$[in]$ = \mathbf{12.34}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (7 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.625$[in]$ = \mathbf{7.77}$[in2] Sec. J4-3

$IsStressUniform \rightarrow \mathbf{False}$

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*7.77$[in2]$ + 0.5*58000$[lb/in2]$*1.84$[in2]$, 0.6*36000$[lb/in2]$*12.34$[in2]$ + 0.5*$
58000[lb/in2]$*1.84$[in2]$) = \mathbf{159.93}$[kip] Eq. J4-5

Flexural rupture	[Kip]	137.35	70.00	DL	0.51	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.625$[in]$/4*(21.5$[in]$^2 - 3$[in]$^2*7*(7^2 -$
$1)*1.13$[in]$/21.5$[in]$) = \mathbf{47.5}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*47.5$[in3]$/10.03$[in]$ = \mathbf{137.35}$[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	330.28	70.00	DL	0.21	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*7*25.42$[in]$) = \mathbf{330.28}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	188.21	70.00	DL	0.37	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35\text{[in]} - 1.06\text{[in]}/2) = \mathbf{3.82}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(5.39/(2*7))*(\min(1.2*3.82\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(7 - 1))*0.46\text{[in]}*65000\text{[lb/in2]}*2 = \mathbf{188.21}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	245.64	70.00	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 26.7\text{[in]}*0.46\text{[in]} = \mathbf{12.28}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*12.28\text{[in2]} = \mathbf{245.64}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	205.92	33.04	DL	0.16	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.44\text{[in]} = \mathbf{17.16}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 35\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*25.42\text{[in]}) = \mathbf{1.48}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.48/16\ \text{[in]} = \mathbf{2.75}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.61**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:21 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-16**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W10x17

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	10.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	5.76	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	5.76	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.55	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	19.68	10.00	DL	0.51	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 0.836*23.55[kip]*1 = **19.68**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	9.19	7.78	DL	0.85	p. 10-103
A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
f_v = V/A_g = 10[kip]/3.25[in2] = **3076.92**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))^1/2 = (max(0, (0.599*36000[lb/in2])^2 - 3*3076.92[lb/in2]^2))^1/2 = **20887.72**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.5[in]*6.5[in]^2/4 = **5.28**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20887.72$[lb/in2]$*5.28$[in3]$ = \mathbf{9.19}$[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	22.95	10.00	DL	0.44	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(0.836/(2*2))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(2 - 1))*0.5$[in]$*58000$[lb/in2]$*2 = \mathbf{22.95}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	46.80	10.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 6.5$[in]$*0.5$[in]$ = \mathbf{3.25}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.25$[in2]$ = \mathbf{46.8}$[kip] Eq. J4-3

Shear rupture	[Kip]	36.98	10.00	DL	0.27	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$L_e = L - n*L_h = 6.5$[in]$ - 2*1.13$[in]$ = \mathbf{4.25}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 4.25$[in]$*0.5$[in]$ = \mathbf{2.13}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.13$[in2]$ = \mathbf{36.98}$[kip] Eq. J4-4

Block shear	[Kip]	46.95	10.00	DL	0.21	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.31$[in]$ + 1/16$ [in]$ = \mathbf{1.38}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*$
1.38[in]$)*0.5$[in]$ = \mathbf{1.47}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (2 - 1)*3$[in]$)*0.5$[in]$ = \mathbf{2.38}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (2 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.5$[in]$ = \mathbf{1.53}$[in2] Sec. J4-3

$IsStressUniform \rightarrow$ **False**

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*1.53$[in2]$ + 0.5*58000$[lb/in2]$*1.47$[in2]$, 0.6*36000$[lb/in2]$*2.38$[in2]$ + 0.5*$
58000[lb/in2]$*1.47$[in2]$) = \mathbf{46.95}$[kip] Eq. J4-5

Flexural rupture	[Kip]	15.23	10.00	DL	0.66	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(6.5$[in]$^2 - 3$[in]$^2*2*(2^2 - 1)*$
1.13[in]$/6.5$[in]$) = \mathbf{4.11}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*4.11$[in3]$/7.83$[in]$ = \mathbf{15.23}$[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	87.61	10.00	DL	0.11	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*9.44$[in]$) = \mathbf{87.61}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	15.40	10.00	DL	0.65	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.55\text{[in]} - 1.06\text{[in]}/2) = \mathbf{3.02}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(0.836/(2*2))*(\min(1.2*3.02\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(2 - 1))*0.24\text{[in]}*65000\text{[lb/in2]}*2 = \mathbf{15.4}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	48.48	10.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 10.1\text{[in]}*0.24\text{[in]} = \mathbf{2.42}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*2.42\text{[in2]} = \mathbf{48.48}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	159.12	12.71	DL	0.08	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.34\text{[in]} = \mathbf{13.26}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 5\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*9.44\text{[in]}) = \mathbf{0.571}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.571/16\ \text{[in]} = \mathbf{1.06}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.85**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:22 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-17**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W16x31

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	6.60	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.275[in], 12 [in]) = **6.6**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.45	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	4.50	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	28.87	15.00	DL	0.52	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.23*23.55[kip]*1 = **28.87**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	34.43	11.05	DL	0.32	p. 10-103
A_g = L_p*t_p = 12.5[in]*0.5[in] = **6.25**[in2]						Sec. D3-1
f_v = V/A_g = 15[kip]/6.25[in2] = **2400**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*2400[lb/in2]^2))$^{1/2}$ = **21152.29**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.5[in]*12.5[in]^2/4 = **19.53**[in3]						T. 17-27
(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 21152.29[lb/in2]*19.53[in3] = **34.43**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	37.50	15.00	DL	0.40	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.23/(1*4))*(\min(1.2*1.22[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*$
$1[in])*(4 - 1))*0.5[in]*58000[lb/in2]*1 = \mathbf{37.5}[kip]$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	90.00	15.00	DL	0.17	Eq. J4-3

$A_g = L_p*t_p = 12.5[in]*0.5[in] = \mathbf{6.25}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*6.25[in2] = \mathbf{90}[kip]$ Eq. J4-3

Shear rupture	[Kip]	69.60	15.00	DL	0.22	Eq. J4-4

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$L_e = L - n*L_h = 12.5[in] - 4*1.13[in] = \mathbf{8}[in]$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8[in]*0.5[in] = \mathbf{4}[in2]$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*4[in2] = \mathbf{69.6}[kip]$ Eq. J4-4

Block shear	[Kip]	77.08	15.00	DL	0.19	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.31[in] + 1/16\ [in] = \mathbf{1.38}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*$
$1.38[in])*0.5[in] = \mathbf{0.656}[in2]$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (4 - 1)*3[in])*0.5[in] = \mathbf{5.38}[in2]$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) -$
$1.13[in]/2)*0.5[in] = \mathbf{3.41}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000[lb/in2]*3.41[in2] + 1*58000[lb/in2]*0.656[in2], 0.6*36000[lb/in2]*5.38[in2] + 1*58000[lb/$
$in2]*0.656[in2]) = \mathbf{77.08}[kip]$ Eq. J4-5

Flexural rupture	[Kip]	44.16	15.00	DL	0.34	p. 9-6

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(12.5[in]^2 - 3[in]^2*4*(4^2 - 1)*$
$1.13[in]/12.5[in]) = \mathbf{13.46}[in3]$ 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000[lb/in2]*13.46[in3]/8.84[in] = \mathbf{44.16}[kip]$ p. 9-6

Plate (support side)

Weld capacity	[Kip]	139.40	15.00	DL	0.11	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86[kip/in]*1*5*15.02[in]) = \mathbf{139.4}[kip]$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	25.68	15.00	DL	0.58	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.45[in] - 1.06[in]/2) = \mathbf{2.92}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$

$(n - 1))*t_p*F_u*n_c = 0.5*(1.23/(1*4))*(\min(1.2*2.92[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.275[in]*65000[lb/in2]*1 = \mathbf{25.68}[kip]$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	87.45	15.00	DL	0.17	Eq. J4-3

$A_g = L_p*t_p = 15.9[in]*0.275[in] = \mathbf{4.37}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.37[in2] = \mathbf{87.45}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	147.42	11.98	DL	0.08	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.315[in] = \mathbf{12.29}[kip/in]$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 7.5[kip]/(0.5*1.86[kip/in]*1*15.02[in]) = \mathbf{0.538}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in] = 0.6*70000[lb/in2]*(2)^{1/2}/2*0.538/16\ [in] = \mathbf{0.999}[kip/in]$ p. 9-5

Global critical strength ratio **0.58**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:23 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-18**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W16x31

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	6.60	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.275[in], 12 [in]) = **6.6**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	6.60	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.275[in], 12 [in]) = **6.6**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.45	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	7	7	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.625[in] = **0.0326**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	55.56	35.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 2.36*23.55[kip]*1 = **55.56**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	40.92	30.02	DL	0.73	p. 10-103
A_g = L_p*t_p = 12.5[in]*0.625[in] = **7.81**[in2]						Sec. D3-1
f_v = V/A_g = 35[kip]/7.81[in2] = **4480**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*4480[lb/in2]^2))$^{1/2}$ = **20111.89**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.625[in]*12.5[in]^2/4 = **24.41**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20111.89$[lb/in2]$*24.41$[in3]$ = \mathbf{40.92}$[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	90.19	35.00	DL	0.39	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(2.36/(2*4))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(4 - 1))*0.625$[in]$*58000$[lb/in2]$*2 = \mathbf{90.19}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	112.50	35.00	DL	0.31	Eq. J4-3

$A_g = L_p*t_p = 12.5$[in]$*0.625$[in]$ = \mathbf{7.81}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*7.81$[in2]$ = \mathbf{112.5}$[kip] Eq. J4-3

Shear rupture	[Kip]	87.00	35.00	DL	0.40	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$L_e = L - n*L_h = 12.5$[in]$ - 4*1.13$[in]$ = \mathbf{8}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8$[in]$*0.625$[in]$ = \mathbf{5}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*5$[in2]$ = \mathbf{87}$[kip] Eq. J4-4

Block shear	[Kip]	99.18	35.00	DL	0.35	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.31$[in]$ + 1/16$ [in]$ = \mathbf{1.38}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*$
1.38[in]$)*0.625$[in]$ = \mathbf{1.84}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (4 - 1)*3$[in]$)*0.625$[in]$ = \mathbf{6.72}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (4 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.625$[in]$ = \mathbf{4.26}$[in2] Sec. J4-3

$IsStressUniform \rightarrow \mathbf{False}$

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*4.26$[in2]$ + 0.5*58000$[lb/in2]$*1.84$[in2]$, 0.6*36000$[lb/in2]$*6.72$[in2]$ + 0.5*$
58000[lb/in2]$*1.84$[in2]$) = \mathbf{99.18}$[kip] Eq. J4-5

Flexural rupture	[Kip]	55.48	35.00	DL	0.63	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.625$[in]$/4*(12.5$[in]$^2 - 3$[in]$^2*4*(4^2 -$
$1)*1.13$[in]$/12.5$[in]$) = \mathbf{16.82}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*16.82$[in3]$/8.79$[in]$ = \mathbf{55.48}$[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	195.16	35.00	DL	0.18	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*7*15.02$[in]$) = \mathbf{195.16}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	49.42	35.00	DL	0.71	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.45\text{[in]} - 1.06\text{[in]}/2) = \mathbf{2.92}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(2.36/(2*4))*(\min(1.2*2.92\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(4 - 1))*0.275\text{[in]}*65000\text{[lb/in2]}*2 = \mathbf{49.42}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	87.45	35.00	DL	0.40	Eq. J4-3

$A_g = L_p*t_p = 15.9\text{[in]}*0.275\text{[in]} = \mathbf{4.37}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*4.37\text{[in2]} = \mathbf{87.45}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	241.02	27.96	DL	0.12	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.515\text{[in]} = \mathbf{20.09}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 17.5\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*15.02\text{[in]}) = \mathbf{1.26}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.26/16\ \text{[in]} = \mathbf{2.33}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.73**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:23 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-19**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W18x35

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	30.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0.125[\text{in}] = \mathbf{1.88}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.20	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.85	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	44.09	30.00	DL	0.68	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.87*23.55[kip]*1 = **44.09**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	51.27	21.98	DL	0.43	p. 10-103
A_g = L_p*t_p = 15.5[in]*0.5[in] = **7.75**[in2]						Sec. D3-1
f_v = V/A_g = 30[kip]/7.75[in2] = **3870.97**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*3870.97[lb/in2]^2))$^{1/2}$ = **20487.71**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.5[in]*15.5[in]^2/4 = **30.03**[in3]						T. 17-27
(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 20487.71[lb/in2]*30.03[in3] = **51.27**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	58.43	30.00	DL	0.51	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.87/(1*5))*(\min(1.2*1.22[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*$
$1[in])*(5 - 1))*0.5[in]*58000[lb/in2]*1 = \mathbf{58.43}[kip]$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	111.60	30.00	DL	0.27	Eq. J4-3

$A_g = L_p*t_p = 15.5[in]*0.5[in] = \mathbf{7.75}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*7.75[in2] = \mathbf{111.6}[kip]$ Eq. J4-3

Shear rupture	[Kip]	85.91	30.00	DL	0.35	Eq. J4-4

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$L_e = L - n*L_h = 15.5[in] - 5*1.13[in] = \mathbf{9.88}[in]$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 9.88[in]*0.5[in] = \mathbf{4.94}[in2]$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*4.94[in2] = \mathbf{85.91}[kip]$ Eq. J4-4

Block shear	[Kip]	93.28	30.00	DL	0.32	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.31[in] + 1/16\ [in] = \mathbf{1.38}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*$
$1.38[in])*0.5[in] = \mathbf{0.656}[in2]$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (5 - 1)*3[in])*0.5[in] = \mathbf{6.88}[in2]$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) -$
$1.13[in]/2)*0.5[in] = \mathbf{4.34}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000[lb/in2]*4.34[in2] + 1*58000[lb/in2]*0.656[in2], 0.6*36000[lb/in2]*6.88[in2] + 1*58000[lb/$
$in2]*0.656[in2]) = \mathbf{93.28}[kip]$ Eq. J4-5

Flexural rupture	[Kip]	66.73	30.00	DL	0.45	p. 9-6

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(15.5[in]^2 - 3[in]^2*5*(5^2 - 1)*$
$1.13[in]/15.5[in]) = \mathbf{20.23}[in3]$ 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000[lb/in2]*20.23[in3]/8.79[in] = \mathbf{66.73}[kip]$ p. 9-6

Plate (support side)

Weld capacity	[Kip]	156.38	30.00	DL	0.19	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86[kip/in]*1*5*16.85[in]) = \mathbf{156.38}[kip]$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	42.71	30.00	DL	0.70	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85[in] - 1.06[in]/2) = \mathbf{2.32}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$

$(n - 1))*t_p*F_u*n_c = 0.5*(1.87/(1*5))*(\min(1.2*2.32[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(5 - 1))*0.3[in]*65000[lb/in2]*1 = \mathbf{42.71}[kip]$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	106.20	30.00	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 17.7[in]*0.3[in] = \mathbf{5.31}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.31[in2] = \mathbf{106.2}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	241.02	21.36	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.515[in] = \mathbf{20.09}[kip/in]$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15[kip]/(0.5*1.86[kip/in]*1*16.85[in]) = \mathbf{0.959}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in] = 0.6*70000[lb/in2]*(2)^{1/2}/2*0.959/16\ [in] = \mathbf{1.78}[kip/in]$ p. 9-5

Global critical strength ratio **0.70**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:31 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : SP BCW
Connection ID : SC-02-20

Family: Beam - Column web (BCW)

Type: Single plate

Description: B:W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	10.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	3.85	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.26	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	18.88	10.00	DL	0.53	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 0.802*23.55[kip]*1 = **18.88**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	14.81	6.07	DL	0.41	p. 10-103
A_g = L_p*t_p = 9.5[in]*0.375[in] = **3.56**[in2]						Sec. D3-1
f_v = V/A_g = 10[kip]/3.56[in2] = **2807.02**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((1/Ω)*F_y)^2 - 3*f_v^2))^1/2 = (max(0, (0.599*36000[lb/in2])^2 - 3*2807.02[lb/in2]^2))^1/2 = **21001.46**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.375[in]*9.5[in]^2/4 = **8.46**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 21001.46$[lb/in2]$*8.46$[in3] = **14.81**[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	17.76	10.00	DL	0.56	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in] $- 1.06$[in]$/2) =$ **1.22**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(0.802/(1*3))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(3 - 1))*0.375$[in]$*58000$[lb/in2]$*1 =$ **17.76**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	51.30	10.00	DL	0.19	Eq. J4-3

$A_g = L_p*t_p = 9.5$[in]$*0.375$[in] = **3.56**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.56$[in2] = **51.3**[kip] Eq. J4-3

Shear rupture	[Kip]	39.97	10.00	DL	0.25	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h = 9.5$[in]$ - 3*1.13$[in] = **6.13**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 6.13$[in]$*0.375$[in] = **2.3**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.3$[in2] = **39.97**[kip] Eq. J4-4

Block shear	[Kip]	47.02	10.00	DL	0.21	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$
1.13[in]$)*0.375$[in] = **0.539**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.91**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (3 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.375$[in] = **1.85**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*1.85$[in2]$ + 1*58000$[lb/in2]$*0.539$[in2]$, 0.6*36000$[lb/in2]$*2.91$[in2]$ + 1*58000$[lb/in2]$*0.539$[in2]$) =$ **47.02**[kip] Eq. J4-5

Flexural rupture	[Kip]	25.65	10.00	DL	0.39	p. 9-6

$L_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375$[in]$/4*(9.5$[in]$^2 - 3$[in]$^2*3*(3^2 -$
$1)*1.13$[in]$/9.5$[in]$) =$ **6.06**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*6.06$[in3]$/6.86$[in] = **25.65**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	96.74	10.00	DL	0.10	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*4*13.03$[in]$) =$ **96.74**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	14.08	10.00	DL	0.71	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.85\text{[in]} - 1.06\text{[in]}/2) = \mathbf{3.32}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(0.802/(1*3))*(\min(1.2*3.32\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(3 - 1))*0.23\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{14.08}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	63.02	10.00	DL	0.16	Eq. J4-3

$A_g = L_p*t_p = 13.7\text{[in]}*0.23\text{[in]} = \mathbf{3.15}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*3.15\text{[in2]} = \mathbf{63.02}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	173.16	9.21	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.37\text{[in]} = \mathbf{14.43}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 5\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*13.03\text{[in]}) = \mathbf{0.413}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.413/16\ \text{[in]} = \mathbf{0.767}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:14 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-21**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	3.85	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.23	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	31.75	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.35*23.55[kip]*1 = **31.75**[kip]						Tables (7-1..14)

Flexure with the Von-Mises shear reduction	[Kip*ft]	19.60	13.70	DL	0.70	p. 10-103
$A_g = L_p * t_p = 9.5$[in]$*0.5$[in] $= \mathbf{4.75}$[in2]						Sec. D3-1
$f_v = V/A_g = 15$[kip]$/4.75$[in2] $= \mathbf{3157.89}$[lb/in2]						p. 10-103
$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*36000$[lb/in2]$)^2 - 3*3157.89$[lb/in2]$^2))^{1/2} = \mathbf{20851.44}$[lb/in2]						p. 10-103
$Z_x = t_p * L^2/4 = 0.5$[in]$*9.5$[in]$^2/4 = \mathbf{11.28}$[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr} * Z = 20851.44$[lb/in2]$*11.28$[in3] $= \mathbf{19.6}$[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	39.83	15.00	DL	0.38	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(1.35/(2*3))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(3 - 1))*0.5$[in]$*58000$[lb/in2]$*2 = \mathbf{39.83}$[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	68.40	15.00	DL	0.22	Eq. J4-3
$A_g = L_p * t_p = 9.5$[in]$*0.5$[in] $= \mathbf{4.75}$[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.75$[in2] $= \mathbf{68.4}$[kip]						Eq. J4-3
Shear rupture	[Kip]	53.29	15.00	DL	0.28	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$L_e = L - n*L_h = 9.5$[in] $- 3*1.13$[in] $= \mathbf{6.13}$[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p = 6.13$[in]$*0.5$[in] $= \mathbf{3.06}$[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.06$[in2] $= \mathbf{53.29}$[kip]						Eq. J4-4
Block shear	[Kip]	65.87	15.00	DL	0.23	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*1.13$[in]$)*0.5$[in] $= \mathbf{1.66}$[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (3 - 1)*3$[in]$)*0.5$[in] $= \mathbf{3.88}$[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (3 - 1)*(3$[in]$ - 1.13$[in]$) - 1.13$[in]$/2)*0.5$[in] $= \mathbf{2.47}$[in2]						Sec. J4-3
$IsStressUniform \rightarrow$ **False**						
$U_{bs} = 0.5$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*58000$[lb/in2]$*2.47$[in2]$ + 0.5*58000$[lb/in2]$*1.66$[in2]$, 0.6*36000$[lb/in2]$*3.88$[in2]$ + 0.5*58000$[lb/in2]$*1.66$[in2]$) = \mathbf{65.87}$[kip]						Eq. J4-5
Flexural rupture	[Kip]	26.62	15.00	DL	0.56	p. 9-6
$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(9.5$[in]$^2 - 3$[in]$^2*3*(3^2 - 1)*1.13$[in]$/9.5$[in]$) = \mathbf{8.08}$[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*8.08$[in3]$/8.81$[in] $= \mathbf{26.62}$[kip]						p. 9-6

Plate (support side)

Weld capacity	[Kip]	120.93	15.00	DL	0.12	Tables 8-4 .. 8-11
$e = 0$						p. 10-135
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*13.03$[in]$) =$ **120.93**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	23.68	15.00	DL	0.63	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.85$[in]$ - 1.06$[in]$/2) =$ **3.32**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$ $(n - 1))*t_p*F_u*n_c = 0.5*(1.35/(2*3))*(\min(1.2*3.32$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$ 1[in]$)*(3 - 1))*0.23$[in]$*65000$[lb/in2]$*2 =$ **23.68**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	63.02	15.00	DL	0.24	Eq. J4-3
$A_g = L_p*t_p = 13.7$[in]$*0.23$[in]$ =$ **3.15**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.15$[in2]$ =$ **63.02**[kip]						Eq. J4-3

Support

Welds rupture	[Kip/ft]	182.52	13.81	DL	0.08	p. 9-5
$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.39$[in]$ =$ **15.21**[kip/in]						p. 9-5
$e = 0$						p. 10-135
$D_{min} = P/((1/\Omega)*C*C_1*L) = 7.5$[kip]$/(0.5*1.86$[kip/in]$*1*13.03$[in]$) =$ **0.62**						tables 8-4..11
$HasWeldsOnBothSides \rightarrow$ **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.62/16$ [in] $=$ **1.15**[kip/in]						p. 9-5

Global critical strength ratio **0.70**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:14 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-22**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W16x26

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	6.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.25[in], 12 [in]) = **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	3.35	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.22	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	27.11	20.00	DL	0.74	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.15*23.55[kip]*1 = **27.11**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	33.91	15.76	DL	0.46	p. 10-103
A_g = L_p*t_p = 12.5[in]*0.5[in] = **6.25**[in2]						Sec. D3-1
f_v = V/A_g = 20[kip]/6.25[in2] = **3200**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*3200[lb/in2]^2))$^{1/2}$ = **20832.17**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.5[in]*12.5[in]^2/4 = **19.53**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20832.17$[lb/in2]$*19.53$[in3]$ = \mathbf{33.91}$[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	35.21	20.00	DL	0.57	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.15/(1*4))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(4 - 1))*0.5$[in]$*58000$[lb/in2]$*1 = \mathbf{35.21}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	90.00	20.00	DL	0.22	Eq. J4-3

$A_g = L_p*t_p = 12.5$[in]$*0.5$[in]$ = \mathbf{6.25}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*6.25$[in2]$ = \mathbf{90}$[kip] Eq. J4-3

Shear rupture	[Kip]	69.60	20.00	DL	0.29	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$L_e = L - n*L_h = 12.5$[in]$ - 4*1.13$[in]$ = \mathbf{8}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8$[in]$*0.5$[in]$ = \mathbf{4}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*4$[in2]$ = \mathbf{69.6}$[kip] Eq. J4-4

Block shear	[Kip]	78.89	20.00	DL	0.25	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$
1.13[in]$)*0.5$[in]$ = \mathbf{0.719}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (4 - 1)*3$[in]$)*0.5$[in]$ = \mathbf{5.38}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (4 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.5$[in]$ = \mathbf{3.41}$[in2] Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*3.41$[in2]$ + 1*58000$[lb/in2]$*0.719$[in2]$, 0.6*36000$[lb/in2]$*5.38$[in2]$ + 1*58000$[lb/in2]$*0.719$[in2]$) = \mathbf{78.89}$[kip] Eq. J4-5

Flexural rupture	[Kip]	44.32	20.00	DL	0.45	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(12.5$[in]$^2 - 3$[in]$^2*4*(4^2 - 1)*$
1.13[in]$/12.5$[in]$) = \mathbf{13.46}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*13.46$[in3]$/8.81$[in]$ = \mathbf{44.32}$[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	139.30	20.00	DL	0.14	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*15.01$[in]$) = \mathbf{139.3}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	21.92	20.00	DL	0.91	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.35\text{[in]} - 1.06\text{[in]}/2) = \mathbf{2.82}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.15/(1*4))*(\min(1.2*2.82\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(4 - 1))*0.25\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{21.92}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	78.50	20.00	DL	0.25	Eq. J4-3

$A_g = L_p*t_p = 15.7\text{[in]}*0.25\text{[in]} = \mathbf{3.93}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*3.93\text{[in2]} = \mathbf{78.5}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	182.52	15.99	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.39\text{[in]} = \mathbf{15.21}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*15.01\text{[in]}) = \mathbf{0.718}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.718/16\ \text{[in]} = \mathbf{1.33}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.91**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:15 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-23**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	30.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.40	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.35	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	4.35	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.18	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	41.26	30.00	DL	0.73	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.75*23.55[kip]*1 = **41.26**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	51.27	23.65	DL	0.46	p. 10-103
A_g = L_p*t_p = 15.5[in]*0.5[in] = **7.75**[in2]						Sec. D3-1
f_v = V/A_g = 30[kip]/7.75[in2] = **3870.97**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*3870.97[lb/in2]^2))$^{1/2}$ = **20487.71**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.5[in]*15.5[in]^2/4 = **30.03**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20487.71$[lb/in2]$*30.03$[in3]$ = \mathbf{51.27}$[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	54.68	30.00	DL	0.55	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.75/(1*5))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(5 - 1))*0.5$[in]$*58000$[lb/in2]$*1 = \mathbf{54.68}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	111.60	30.00	DL	0.27	Eq. J4-3

$A_g = L_p*t_p = 15.5$[in]$*0.5$[in]$ = \mathbf{7.75}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*7.75$[in2]$ = \mathbf{111.6}$[kip] Eq. J4-3

Shear rupture	[Kip]	85.91	30.00	DL	0.35	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$L_e = L - n*L_h = 15.5$[in]$ - 5*1.13$[in]$ = \mathbf{9.88}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 9.88$[in]$*0.5$[in]$ = \mathbf{4.94}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*4.94$[in2]$ = \mathbf{85.91}$[kip] Eq. J4-4

Block shear	[Kip]	95.09	30.00	DL	0.32	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$
1.13[in]$)*0.5$[in]$ = \mathbf{0.719}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (5 - 1)*3$[in]$)*0.5$[in]$ = \mathbf{6.88}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (5 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.5$[in]$ = \mathbf{4.34}$[in2] Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*4.34$[in2]$ + 1*58000$[lb/in2]$*0.719$[in2]$, 0.6*36000$[lb/in2]$*6.88$[in2]$ + 1*58000$[lb/in2]$*0.719$[in2]$) = \mathbf{95.09}$[kip] Eq. J4-5

Flexural rupture	[Kip]	66.64	30.00	DL	0.45	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(15.5$[in]$^2 - 3$[in]$^2*5*(5^2 - 1)*$
1.13[in]$/15.5$[in]$) = \mathbf{20.23}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*20.23$[in3]$/8.81$[in]$ = \mathbf{66.64}$[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	183.76	30.00	DL	0.16	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*19.8$[in]$) = \mathbf{183.76}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	46.63	30.00	DL	0.64	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35\text{[in]} - 1.06\text{[in]}/2) = \mathbf{3.82}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.75/(1*5))*(\min(1.2*3.82\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(5 - 1))*0.35\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{46.63}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	144.90	30.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 20.7\text{[in]}*0.35\text{[in]} = \mathbf{7.25}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*7.25\text{[in2]} = \mathbf{144.9}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	182.52	18.18	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.39\text{[in]} = \mathbf{15.21}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*19.8\text{[in]}) = \mathbf{0.816}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.816/16\ \text{[in]} = \mathbf{1.52}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.73**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:16 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-02 Beam to Column Shear Using Extended Shear Tab\B2C WEB5.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-02-24**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W24x55

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[\text{in}] + 0[\text{in}] = \mathbf{1.75}[\text{in}]$						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.48	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.395[in], 12 [in]) = **9.48**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.39	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	5.80	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.16	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	46.26	35.00	DL	0.76	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 1.96*23.55[kip]*1 = **46.26**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	50.27	24.30	DL	0.48	p. 10-103
A_g = L_p*t_p = 15.5[in]*0.5[in] = **7.75**[in2]						Sec. D3-1
f_v = V/A_g = 35[kip]/7.75[in2] = **4516.13**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*4516.13[lb/in2]^2))$^{1/2}$ = **20087.63**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.5[in]*15.5[in]^2/4 = **30.03**[in3]						T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20087.63$[lb/in2]$*30.03$[in3]$ = \mathbf{50.27}$[kip*ft] p. 10-103

Bolt bearing under shear load	[Kip]	61.31	35.00	DL	0.57	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) = \mathbf{1.22}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.96/(1*5))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(5 - 1))*0.5$[in]$*58000$[lb/in2]$*1 = \mathbf{61.31}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	111.60	35.00	DL	0.31	Eq. J4-3

$A_g = L_p*t_p = 15.5$[in]$*0.5$[in]$ = \mathbf{7.75}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*7.75$[in2]$ = \mathbf{111.6}$[kip] Eq. J4-3

Shear rupture	[Kip]	85.91	35.00	DL	0.41	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$L_e = L - n*L_h = 15.5$[in]$ - 5*1.13$[in]$ = \mathbf{9.88}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 9.88$[in]$*0.5$[in]$ = \mathbf{4.94}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*4.94$[in2]$ = \mathbf{85.91}$[kip] Eq. J4-4

Block shear	[Kip]	95.09	35.00	DL	0.37	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$
1.13[in]$)*0.5$[in]$ = \mathbf{0.719}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (5 - 1)*3$[in]$)*0.5$[in]$ = \mathbf{6.88}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (5 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.5$[in]$ = \mathbf{4.34}$[in2] Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*4.34$[in2]$ + 1*58000$[lb/in2]$*0.719$[in2]$, 0.6*36000$[lb/in2]$*6.88$[in2]$ + 1*58000$[lb/in2]$*0.719$[in2]$) = \mathbf{95.09}$[kip] Eq. J4-5

Flexural rupture	[Kip]	75.30	35.00	DL	0.46	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ = \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(15.5$[in]$^2 - 3$[in]$^2*5*(5^2 - 1)*$
1.13[in]$/15.5$[in]$) = \mathbf{20.23}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*20.23$[in3]$/7.79$[in]$ = \mathbf{75.3}$[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	209.65	35.00	DL	0.17	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*1.86$[kip/in]$*1*5*22.59$[in]$) = \mathbf{209.65}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	59.00	35.00	DL	0.59	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.8\text{[in]} - 1.06\text{[in]}/2) = \mathbf{5.27}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(1.96/(1*5))*(\min(1.2*5.27\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*$
$1\text{[in]})*(5 - 1))*0.395\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{59}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	186.44	35.00	DL	0.19	Eq. J4-3

$A_g = L_p*t_p = 23.6\text{[in]}*0.395\text{[in]} = \mathbf{9.32}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*9.32\text{[in2]} = \mathbf{186.44}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	194.22	18.59	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.415\text{[in]} = \mathbf{16.19}\text{[kip/in]}$ p. 9-5

$e = 0$ p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L) = 17.5\text{[kip]}/(0.5*1.86\text{[kip/in]}*1*22.59\text{[in]}) = \mathbf{0.835}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.835/16\ \text{[in]} = \mathbf{1.55}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.76**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

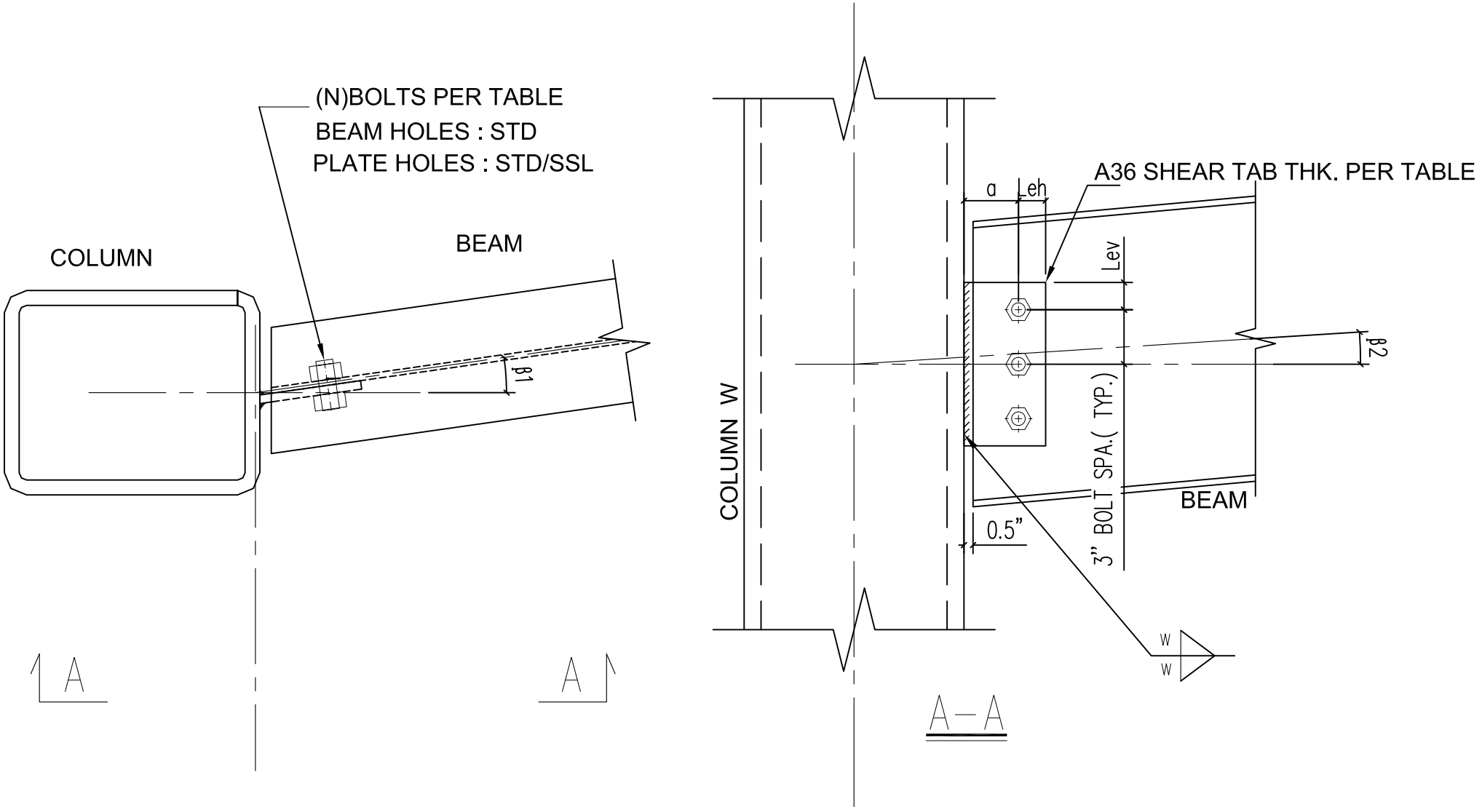
SC-03 BEAM TO COLUMN (WF, HSS, and PIPE) SHEAR TAB CONNECTION

Connection ID	Beam Size	Column	Design Reaction (kip) "R"	SKEW (Degree) "β1"	SLOP (Degree) "β2"	Single Plate (A36 Steel)				Bolt Size and Grade	Bolt Row x Col.	Bolt Spacing (inch) "Spa."	Distance between Weld to Bolts (inch) "a"
						Plate Size (inch) "t_p"	Plate weld size to support Column (inch) "w"	Bolt edge distance					
								Vertical "L_{ev}" (inch)	Horizontal "L_{eh}" (inch)				
SC-03-6	W8X18	W10x45 FLANGE	≤15	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	2x1	3	3
SC-03-7	W24X84	W10x45 FLANGE	≤110	0	0	1/2"	5/16"	1.75	2	1" A490N	7X1	3	3
SC-03-8	W12X14	HSS10x8x5/8	≤10	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	2x1	3	3
SC-03-9	W14X22	HSS10x8x5/8	≤20	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-03-10	W14X22	HSS6x6x3/8	≤20	26	1.1	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-03-11	W14X22	HSS6x6x3/8	≤20	0	6.9	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-03-12	W16X26	HSS6x6x3/8	≤25	0	1.25	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-03-13	W16X26	HSS6x6x3/8	≤25	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-03-14	W16X31	HSS6x6x5/16	≤25	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-03-15	W18X35	HSS10x8x5/8	≤45	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	5X1	3	3
SC-03-16	W18X35	HSS6x6x3/8	≤20	26	1.1	3/8"	1/4"	1.5	1.5	3/4" A325N	3X1	3	3
SC-03-17	W18X35	HSS6x6x3/8	≤20	26	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3X1	3	3
SC-03-18	W21X44	HSS6x6x3/8	≤35	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	5X1	3	3
SC-03-19	W21X44	HSS6x6x3/8	≤20	26	1.1	3/8"	1/4"	1.5	1.5	3/4" A325N	4X1	3	3
SC-03-20	W21X50	HSS6x6x3/8	≤30	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	4X1	3	3
SC-03-21	W24X55	HSS10x8x5/8	≤35	0	1.2	3/8"	1/4"	1.5	1.5	3/4" A325N	5X1	3	3
SC-03-22	W24X62	HSS10x8x5/8	≤70	0	0	3/8"	1/4"	1.75	2	1" A490N	7X1	3	3
SC-03-23	W24X68	HSS10x8x5/8	≤65	0	0	3/8"	1/4"	1.5	1.5	3/4" A325N	7X1	3	3
SC-03-24	W12X14	W12x50 FLANGE	≤15	6	0	3/8"	1/4"	1.5	1.5	3/4" A325N	2X1	3	3
SC-03-25	W14X22	W12x65 FLANGE	≤15	26	1.1	3/8"	1/4"	1.5	1.5	3/4" A325N	3X1	3	3
SC-03-26	W14X22	W10x33 WEB	≤15	6	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3X1	3	3
SC-03-27	W16X26	W12x50 FLANGE	≤15	6	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3X1	3	3
SC-03-28	W16X26	W10x49 WEB	≤20	6	0	3/8"	1/4"	1.5	1.5	3/4" A325N	3X1	3	3
SC-03-29	W36X150	W14x90 FLANGE	≤77	0	0	1/2"(A572 Gr50)	5/16"	1.75	2	1" A490SC	10X1	3	3
SC-03-30	W36X170	W14x90 FLANGE	≤160	0	0	1/2"(A572 Gr50)	5/16"	1.75	2	1" A490SC	10X2	3	3
SC-03-31	W36X170	W12x79 FLANGE	≤75	0	0	3/8"	1/4"	1.25	1.5	3/4" A325N	10X1	3	3
SC-03-32	W14X22	W12x79 FLANGE	≤30	0	0	3/8"	1/4"	1.25	1.5	3/4" A325N	4X1	3	3

*Short Slotted Hole on Shear Tab,Using Standard Hole when with slop angle

*Cope (Narrow down) Beam flanges only to fit between column flanges

SC-03 Beam to Column Shear Tab Connection



Current Date: 2016-05-25 4:44 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-6**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W8x18

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.00	3.44	6.88	✔	p. 10-104
$L_{min} = T/2 = 6.88$[in]$/2 =$ **3.44**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 8.14[in] - max(0.63[in], 0[in]) - max(0.63[in], 0[in]) = **6.88**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23$[in], 12 [in]$) =$ **5.52**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.57	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1 =$ **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \max(0.0, L_e - d_h/2) = \max(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \max(0.0, s - d_h) = \max(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1 =$ **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3

$A_g = L_p * t_p = 6[in] * 0.375[in] = \mathbf{2.25}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 36000[lb/in2] * 2.25[in2] = \mathbf{32.4}[kip]$ Eq. J4-3

Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4

$L_h = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$L_e = L - n * L_h = 6[in] - 2 * 0.875[in] = \mathbf{4.25}[in]$ DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 4.25[in] * 0.375[in] = \mathbf{1.59}[in2]$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 58000[lb/in2] * 1.59[in2] = \mathbf{27.73}[kip]$ Eq. J4-4

Block shear	[Kip]	29.78	15.00	DL	0.50	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p = (1.5[in] + (1 - 1) * 3[in] - (1 - 0.5) * 0.875[in]) * 0.375[in] = \mathbf{0.398}[in2]$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1) * s) * t_p = (1.5[in] + (2 - 1) * 3[in]) * 0.375[in] = \mathbf{1.69}[in2]$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p = (1.5[in] + (2 - 1) * (3[in] - 0.875[in]) - 0.875[in]/2) * 0.375[in] = \mathbf{1.2}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 58000[lb/in2] * 1.2[in2] + 1 * 58000[lb/in2] * 0.398[in2], 0.6 * 36000[lb/in2] * 1.69[in2] + 1 * 58000[lb/in2] * 0.398[in2]) = \mathbf{29.78}[kip]$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega) * C * C_1 * D * L = 0.5 * 3.71[kip/in] * 1 * 4 * 6[in] = \mathbf{44.55}[kip]$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	26.91	15.00	DL	0.56	Eq. J3-6

$L_{c\text{-}end} = \mathrm{Max}(0.0, L_e - d_h/2) = \mathrm{Max}(0.0, 2.57[in] - 0.813[in]/2) = \mathbf{2.16}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \mathrm{Max}(0.0, s - d_h) = \mathrm{Max}(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 2.16[in], 2.4 * 0.75[in]) + \min(1.2 * 2.19[in], 2.4 * 0.75[in]) * (2 - 1)) * 0.23[in] * 65000[lb/in2] * 1 = \mathbf{26.91}[kip]$ Eq. J3-6

Shear yielding	[Kip]	37.44	15.00	DL	0.40	Eq. J4-3

$A_g = L_p * t_p = 8.14[in] * 0.23[in] = \mathbf{1.87}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000[lb/in2] * 1.87[in2] = \mathbf{37.44}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	290.16	30.00	DL	0.10	p. 9-5

$R_n = 0.6 * F_u * t_p = 0.6 * 65000[lb/in2] * 0.62[in] = \mathbf{24.18}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega) * C * C_1 * L) = 15[kip]/(0.5 * 3.71[kip/in] * 1 * 6[in]) = \mathbf{1.35}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16\ [in] = 0.6 * 70000[lb/in2] * (2)^{1/2}/2 * 1.35/16\ [in] = \mathbf{2.5}[kip/in]$ p. 9-5

Global critical strength ratio	**0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 4:48 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-7**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W24x84

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	110.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	21.50	10.78	21.56	✔	p. 10-104
$L_{min} = T/2 = 21.56$[in]$/2 =$ **10.78**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 24.1[in] - max(1.27[in], 0[in]) - max(1.27[in], 0[in]) = **21.56**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	11.28	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.47$[in], 12 [in]$) =$ **11.28**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.05	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	164.85	110.00	DL	0.67	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*60000$[lb/in2]$*0.785$[in2] = **23.55**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 7*23.55$[kip]$*1 =$ **164.85**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	223.48	110.00	DL	0.49	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in] $- 1.06$[in]$/2) =$ **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.22$[in], $2.4*1$[in]$) + \min(1.2*1.94$[in], $2.4*1$[in]$)*(7 - 1))*0.5$[in]$*$ 58000[lb/in2]$*1 =$ **223.48**[kip]						Eq. J3-6
Shear yielding	[Kip]	154.80	110.00	DL	0.71	Eq. J4-3

$A_g = L_p * t_p = 21.5[in] * 0.5[in] = \mathbf{10.75}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 36000[lb/in2] * 10.75[in2] = \mathbf{154.8}[kip]$ Eq. J4-3

Shear rupture	[Kip]	118.54	110.00	DL	0.93	Eq. J4-4

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$L_e = L - n * L_h = 21.5[in] - 7 * 1.13[in] = \mathbf{13.63}[in]$ DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 13.63[in] * 0.5[in] = \mathbf{6.81}[in2]$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 58000[lb/in2] * 6.81[in2] = \mathbf{118.54}[kip]$ Eq. J4-4

Block shear	[Kip]	127.49	110.00	DL	0.86	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p = (2[in] + (1 - 1) * 3[in] - (1 - 0.5) * 1.13[in]) * 0.5[in] = \mathbf{0.719}[in2]$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1) * s) * t_p = (1.75[in] + (7 - 1) * 3[in]) * 0.5[in] = \mathbf{9.88}[in2]$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p = (1.75[in] + (7 - 1) * (3[in] - 1.13[in]) - 1.13[in]/2) * 0.5[in] = \mathbf{6.22}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$
$0.5 * \min(0.6 * 58000[lb/in2] * 6.22[in2] + 1 * 58000[lb/in2] * 0.719[in2], 0.6 * 36000[lb/in2] * 9.88[in2] + 1 * 58000[lb/in2] * 0.719[in2]) = \mathbf{127.49}[kip]$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	199.54	110.00	DL	0.55	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega) * C * C_1 * D * L = 0.5 * 3.71[kip/in] * 1 * 5 * 21.5[in] = \mathbf{199.54}[kip]$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	249.75	110.00	DL	0.44	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.05[in] - 1.06[in]/2) = \mathbf{2.52}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p *$
$F_u * n_c = 0.5 * (\min(1.2 * 2.52[in], 2.4 * 1[in]) + \min(1.2 * 1.94[in], 2.4 * 1[in]) * (7 - 1)) * 0.47[in] *$
$65000[lb/in2] * 1 = \mathbf{249.75}[kip]$ Eq. J3-6

Shear yielding	[Kip]	226.54	110.00	DL	0.49	Eq. J4-3

$A_g = L_p * t_p = 24.1[in] * 0.47[in] = \mathbf{11.33}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000[lb/in2] * 11.33[in2] = \mathbf{226.54}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	290.16	61.40	DL	0.21	p. 9-5

$R_n = 0.6 * F_u * t_p = 0.6 * 65000[lb/in2] * 0.62[in] = \mathbf{24.18}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega) * C * C_1 * L) = 110[kip]/(0.5 * 3.71[kip/in] * 1 * 21.5[in]) = \mathbf{2.76}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16\ [in] = 0.6 * 70000[lb/in2] * (2)^{1/2}/2 * 2.76/16\ [in] = \mathbf{5.12}[kip/in]$ p. 9-5

Global critical strength ratio	**0.93**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 4:23 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-8**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W12x14

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	10.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.00	5.43	10.85	✔	p. 10-104
$L_{min} = T/2 = 10.85$[in]$/2 =$ **5.43**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 11.9[in] - max(0.525[in], 0[in]) - max(0.525[in], 0[in]) = **10.85**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.2[in], 12\ [in]) = \mathbf{4.8}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.19	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 8[in] - 2*1.5*0.581[in] = \mathbf{6.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (6.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.186}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	21.22	10.00	DL	0.47	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 2*10.61[kip]*1 = **21.22**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	33.85	10.00	DL	0.30	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*
0.375[in]*58000[lb/in2]*1 = **33.85**[kip] — Eq. J3-6

Shear yielding	[Kip]	32.40	10.00	DL	0.31	Eq. J4-3

$A_g = L_p*t_p$ = 6[in]*0.375[in] = **2.25**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*2.25[in2] = **32.4**[kip] — Eq. J4-3

Shear rupture	[Kip]	27.73	10.00	DL	0.36	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 6[in] - 2*0.875[in] = **4.25**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 4.25[in]*0.375[in] = **1.59**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*1.59[in2] = **27.73**[kip] — Eq. J4-4

Block shear	[Kip]	28.76	10.00	DL	0.35	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.06[in])*0.375[in] = **0.363**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (2 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.2**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*1.2[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*1.69[in2] + 1*58000[lb/in2]*0.363[in2]) = **28.76**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	44.55	10.00	DL	0.22	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*6[in] = **44.55**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	23.40	10.00	DL	0.43	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.45[in] - 0.813[in]/2) = **4.04**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*4.04[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*0.2[in]*$
$65000[lb/in2]*1 = \mathbf{23.4}[kip]$ Eq. J3-6

Shear yielding	[Kip]	47.60	10.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 11.9[in]*0.2[in] = \mathbf{2.38}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.38[in2] = \mathbf{47.6}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	20.00	DL	0.07	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.581[in] = \mathbf{22.66}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10[kip]/(0.5*3.71[kip/in]*1*6[in]) = \mathbf{0.898}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in] = 0.6*70000[lb/in2]*(2)^{1/2}/2*0.898/16\ [in] = \mathbf{1.67}[kip/in]$ p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:20 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-9**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 0[in]) - \max(0.735[in], 0[in]) =$ **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75[in]/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	3.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.19	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 8[in] - 2*1.5*0.581[in] = \mathbf{6.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (6.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.186}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] — Eq. J3-6

Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3

$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] — Eq. J4-4

Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.06[in])*0.375[in] = **0.363**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.363[in2]) = **40.91**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	20.00	DL	0.50	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3.85[in] - 0.813[in]/2) = **3.44**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.44\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*$
$0.23\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{40.37}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	63.02	20.00	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 13.7\text{[in]}*0.23\text{[in]} = \mathbf{3.15}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*3.15\text{[in2]} = \mathbf{63.02}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	26.67	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.581\text{[in]} = \mathbf{22.66}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20\text{[kip]}/(0.5*3.71\text{[kip/in]}*1*9\text{[in]}) = \mathbf{1.2}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.2/16\text{ [in]} = \mathbf{2.22}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:24 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-10**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.38	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 0[in]) - \max(0.735[in], 0[in]) =$ **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75[in]/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$ Sec. J3.3

$IsCorrosionConsidered \rightarrow \mathbf{False}$

$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$ Sec. J3.5

Beam

Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.438 = \mathbf{0.428}[in]$ p. 10-151

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

Vertical edge distance	[in]	3.85	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2

$F_{ymax} = 52\ [ksi]$ Sec. K1.2

Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2

$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$ Sec. K1.2

$(F_y/F_u)_{max} = 0.80$ Sec. K1.2

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158

$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$ Sec. B4.2

$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$ p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	20.00	DL	0.48	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/ in2]*0.398[in2]) = **41.93**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	42.82	0.38	DL	0.01	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*3 = **42.82**[kip] Eq. J3-6

Tension yielding	[Kip]	72.75	0.38	DL	0.01	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*36000[lb/in2]*3.38[in2] = **72.75**[kip] Eq. J4-1

Tension rupture	[Kip]	69.33	0.38	DL	0.01	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9[in] - 3*0.875[in])*0.375[in] = **2.39**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.38[in2], 2.39[in2]) = **2.39**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*58000[lb/in2]*2.39[in2] = **69.33**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.37	0.38	DL	0.01	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5[in] + (1 - 1)*3[in])*0.375[in] = **1.13**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5[in] + (1 - 1)*3[in] - 0.875[in]*(1 -
0.5))*0.375[in] = **0.797**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.375[in] = **1.59**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*0.797[in2] + 1*58000[lb/in2]*1.59[in2], 0.6*36000[lb/in2]*1.13[in2] + 1*58000[lb/
in2]*1.59[in2]) = **58.37**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.91	20.00	DL	0.30	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.72[kip/in]*1*4*9[in] = **66.91**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	20.00	DL	0.50	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3.85[in] - 0.813[in]/2) = **3.45**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*3.45[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.23[in]*65000[lb/in2]*1 = **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	20.00	DL	0.32	Eq. J4-3

A_g = L_p*t_p = 13.7[in]*0.23[in] = **3.15**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.15[in2] = **63.02**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	40.37	0.38	DL	0.01	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.26\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.85}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.85\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(1 - 1))*$
$0.23\text{[in]}*65000\text{[lb/in2]}*3 = \mathbf{40.37}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	194.31	0.38	DL	0.00	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*6.49\text{[in2]} = \mathbf{194.31}\text{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	147.50	0.38	DL	0.00	Eq. J4-2

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 6.49\text{[in2]} - 3*0.23\text{[in]}*0.875\text{[in]} = \mathbf{5.89}\text{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.687\text{[in]}/3\text{[in]} = \mathbf{0.771}$ Table D3.1

$A_e = U*A_n = 0.771*5.89\text{[in2]} = \mathbf{4.54}\text{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*4.54\text{[in2]} = \mathbf{147.5}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	47.37	0.38	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.26\text{[in]} + (1 - 1)*3\text{[in]})*0.23\text{[in]} = \mathbf{1.04}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.26\text{[in]} + (1 - 1)*3\text{[in]} - 0.875\text{[in]}*(1 -$
$0.5))*0.23\text{[in]} = \mathbf{0.839}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 0.875\text{[in]})*(3 - 1)*0.23\text{[in]} = \mathbf{0.978}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000\text{[lb/in2]}*0.839\text{[in2]} + 1*65000\text{[lb/in2]}*0.978\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.04\text{[in2]} + 1*$
$65000\text{[lb/in2]}*0.978\text{[in2]}) = \mathbf{47.37}\text{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	163.33	26.63	DL	0.16	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.349\text{[in]} = \mathbf{13.61}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20\text{[kip]}/(0.5*3.72\text{[kip/in]}*1*9\text{[in]}) = \mathbf{1.2}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.2/16\text{ [in]} = \mathbf{2.22}\text{[kip/in]}$ p. 9-5

Chord wall plastification	[Kip]	29.76	0.38	DL	0.01	Eq. K1-9

$U_{HSS} = \text{abs}(P_r)/(A_g*F_c) + \text{abs}(M_r)/(S*F_c) = \text{abs}(0\text{[kip]})/(7.58\text{[in2]}*30000\text{[lb/in2]}) +$
$\text{abs}(0\text{[kip*ft]})/(13.2\text{[in3]}*30000\text{[lb/in2]}) = \mathbf{0}$ Eq. K2-2

$Q_f = (1 - U_{HSS}^2)^{0.5} = (1 - 0^2)^{0.5} = \mathbf{1}$ Eq. K1-9

$(1/\Omega)R_n = (1/\Omega)*(F_y*t_p^2/(1 - t_p/B))*(2*N/B + 4*(1 - t_p/B)^{0.5}*Q_f) = 0.667*$
$(50000\text{[lb/in2]}*0.349\text{[in]}^2/(1 - 0.375\text{[in]}/6\text{[in]}))*(2*9\text{[in]}/6\text{[in]} + 4*(1 - 0.375\text{[in]}/6\text{[in]})^{0.5}*1) =$

29.76[kip] Eq. K1-9

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}:Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_c: Available stress

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}:Specified minimum yield stress of plate

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

M_r: Required flexural strength in chord

e_{dmin}: Minimum edge distance

n: Bolts rows number

N: Bearing length

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

P_r: Required axial stress

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

Q_f: Chord stress interaction parameter

R_n: Nominal strength

R_u: Required strength

S: Chord elastic section modulus

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

U_{HSS}: Utilization ratio

w_{min}: Minimum weld size required

x: Connection eccentricity

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:25 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-11**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	19.86	2.40	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 0[in]) - max(0.735[in], 0[in]) = **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	3.90	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	53.42	19.86	DL	0.37	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] — Eq. J3-6

Shear yielding	[Kip]	48.60	19.86	DL	0.41	Eq. J4-3

$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.60	19.86	DL	0.48	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] — Eq. J4-4

Block shear	[Kip]	41.93	19.86	DL	0.47	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	42.82	2.40	DL	0.06	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*3 = **42.82**[kip] — Eq. J3-6

Tension yielding	[Kip]	72.75	2.40	DL	0.03	Eq. J4-1

$A_g = L_p * t_p = 9$[in]$*0.375$[in] $=$ **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599*36000$[lb/in2]$*3.38$[in2] $=$ **72.75**[kip] Eq. J4-1

Tension rupture	[Kip]	69.33	2.40	DL	0.03	Eq. J4-2

$A_g = L_p * t_p = 9$[in]$*0.375$[in] $=$ **3.38**[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$A_n = (l - n * L_h) * t_p = (9$[in] $- 3*0.875$[in]$)*0.375$[in] $=$ **2.39**[in2] Sec. D3-2

$A_e = \min(0.85 * A_g, A_n) = \min(0.85*3.38$[in2]$, 2.39$[in2]$) =$ **2.39**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5*58000$[lb/in2]$*2.39$[in2] $=$ **69.33**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.37	2.40	DL	0.04	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5$[in] $+ (1 - 1)*3$[in]$)*0.375$[in] $=$ **1.13**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5$[in] $+ (1 - 1)*3$[in] $- 0.875$[in]$*(1 - 0.5))*0.375$[in] $=$ **0.797**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] $- 0.875$[in]$)*(3 - 1)*0.375$[in] $=$ **1.59**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*0.797$[in2]$ + 1*58000$[lb/in2]$*1.59$[in2]$, 0.6*36000$[lb/in2]$*1.13$[in2]$ + 1*58000$[lb/in2]$*1.59$[in2]$) =$ **58.37**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	68.21	20.00	DL	0.29	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega) * C * C_1 * D * L = 0.5*3.79$[kip/in]$*1*4*9$[in] $=$ **68.21**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	19.86	DL	0.49	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.9$[in] $- 0.813$[in]$/2) =$ **3.49**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.49$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$
0.23[in]$*65000$[lb/in2]$*1 =$ **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	19.86	DL	0.32	Eq. J4-3

$A_g = L_p * t_p = 13.7$[in]$*0.23$[in] $=$ **3.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.15$[in2] $=$ **63.02**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	40.37	2.40	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5$[in] $- 0.813$[in]$/2) =$ **2.09**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(1 - 1))*$

$0.23_{[in]}*65000_{[lb/in2]}*3 = \mathbf{40.37}_{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	194.31	2.40	DL	0.01	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*6.49_{[in2]} = \mathbf{194.31}_{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	147.50	2.40	DL	0.02	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 6.49_{[in2]} - 3*0.23_{[in]}*0.875_{[in]} = \mathbf{5.89}_{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.687_{[in]}/3_{[in]} = \mathbf{0.771}$ Table D3.1

$A_e = U*A_n = 0.771*5.89_{[in2]} = \mathbf{4.54}_{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000_{[lb/in2]}*4.54_{[in2]} = \mathbf{147.5}_{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	49.02	2.40	DL	0.05	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5_{[in]} + (1 - 1)*3_{[in]})*0.23_{[in]} = \mathbf{1.15}_{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5_{[in]} + (1 - 1)*3_{[in]} - 0.875_{[in]}*(1 - 0.5))*0.23_{[in]} = \mathbf{0.949}_{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3_{[in]} - 0.875_{[in]})*(3 - 1)*0.23_{[in]} = \mathbf{0.978}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000_{[lb/in2]}*0.949_{[in2]} + 1*65000_{[lb/in2]}*0.978_{[in2]}, 0.6*50000_{[lb/in2]}*1.15_{[in2]} + 1*65000_{[lb/in2]}*0.978_{[in2]}) = \mathbf{49.02}_{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	163.33	26.12	DL	0.16	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000_{[lb/in2]}*0.349_{[in]} = \mathbf{13.61}_{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20_{[kip]}/(0.5*3.79_{[kip/in]}*1*9_{[in]}) = \mathbf{1.17}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ _{[in]} = 0.6*70000_{[lb/in2]}*(2)^{1/2}/2*1.17/16\ _{[in]} = \mathbf{2.18}_{[kip/in]}$ p. 9-5

Chord wall plastification	[Kip]	29.76	2.40	DL	0.08	Eq. K1-9

$U_{HSS} = \text{abs}(P_r)/(A_g*F_c) + \text{abs}(M_r)/(S*F_c) = \text{abs}(0_{[kip]})/(7.58_{[in2]}*30000_{[lb/in2]}) + \text{abs}(0_{[kip*ft]})/(13.2_{[in3]}*30000_{[lb/in2]}) = \mathbf{0}$ Eq. K2-2

$Q_f = (1 - U_{HSS}^2)^{0.5} = (1 - 0^2)^{0.5} = \mathbf{1}$ Eq. K1-9

$(1/\Omega)R_n = (1/\Omega)*(F_y*t_p^2/(1 - t_p/B))*(2*N/B + 4*(1 - t_p/B)^{0.5}*Q_f) = 0.667*(50000_{[lb/in2]}*0.349_{[in]}^2/(1 - 0.375_{[in]}/6_{[in]}))*(2*9_{[in]}/6_{[in]} + 4*(1 - 0.375_{[in]}/6_{[in]})^{0.5}*1) = \mathbf{29.76}_{[kip]}$ Eq. K1-9

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_c: Available stress

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}:Specified minimum yield stress of plate

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

M_r: Required flexural strength in chord

e_{dmin}: Minimum edge distance

n: Bolts rows number

N: Bearing length

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

P_r: Required axial stress

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

Q_f: Chord stress interaction parameter

R_n: Nominal strength

R_u: Required strength

S: Chord elastic section modulus

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

U_{HSS}: Utilization ratio

w_{min}: Minimum weld size required

x: Connection eccentricity

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:25 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-12**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W16x26

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	24.99	0.55	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	7.10	14.21	✔	p. 10-104
$L_{min} = T/2 = 14.21[in]/2 = \mathbf{7.1}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 15.7[in] - \max(0.747[in], 0[in]) - \max(0.747[in], 0[in]) = \mathbf{14.21}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.25[in], 12\ [in]) = \mathbf{6}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	4.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	25.00	DL	0.79	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	53.42	24.99	DL	0.47	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] — Eq. J3-6

Shear yielding	[Kip]	48.60	24.99	DL	0.51	Eq. J4-3

$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.60	24.99	DL	0.60	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] — Eq. J4-4

Block shear	[Kip]	41.93	24.99	DL	0.60	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	42.82	0.55	DL	0.01	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*3 = **42.82**[kip] — Eq. J3-6

Tension yielding	[Kip]	72.75	0.55	DL	0.01	Eq. J4-1

$A_g = L_p * t_p = 9\text{[in]} * 0.375\text{[in]} = \mathbf{3.38}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 3.38\text{[in2]} = \mathbf{72.75}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	69.33	0.55	DL	0.01	Eq. J4-2

$A_g = L_p * t_p = 9\text{[in]} * 0.375\text{[in]} = \mathbf{3.38}\text{[in2]}$ Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = (l - n * L_h) * t_p = (9\text{[in]} - 3 * 0.875\text{[in]}) * 0.375\text{[in]} = \mathbf{2.39}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85 * A_g, A_n) = \min(0.85 * 3.38\text{[in2]}, 2.39\text{[in2]}) = \mathbf{2.39}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 2.39\text{[in2]} = \mathbf{69.33}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	58.37	0.55	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2 * (L + (n_c - 1) * g) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 3\text{[in]}) * 0.375\text{[in]} = \mathbf{1.13}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2 * (L + (n_c - 1) * g - dh_h * (n_c - 0.5)) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 3\text{[in]} - 0.875\text{[in]} * (1 - 0.5)) * 0.375\text{[in]} = \mathbf{0.797}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v) * (n - 1) * t_p = (3\text{[in]} - 0.875\text{[in]}) * (3 - 1) * 0.375\text{[in]} = \mathbf{1.59}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 58000\text{[lb/in2]} * 0.797\text{[in2]} + 1 * 58000\text{[lb/in2]} * 1.59\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 1.13\text{[in2]} + 1 * 58000\text{[lb/in2]} * 1.59\text{[in2]}) = \mathbf{58.37}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.93	25.00	DL	0.37	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega) * C * C_1 * D * L = 0.5 * 3.72\text{[kip/in]} * 1 * 4 * 9\text{[in]} = \mathbf{66.93}\text{[kip]}$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	43.88	24.99	DL	0.57	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.85\text{[in]} - 0.813\text{[in]}/2) = \mathbf{4.45}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 4.45\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 2.19\text{[in]}, 2.4 * 0.75\text{[in]}) * (3 - 1)) * 0.25\text{[in]} * 65000\text{[lb/in2]} * 1 = \mathbf{43.88}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	78.50	24.99	DL	0.32	Eq. J4-3

$A_g = L_p * t_p = 15.7\text{[in]} * 0.25\text{[in]} = \mathbf{3.93}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000\text{[lb/in2]} * 3.93\text{[in2]} = \mathbf{78.5}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	43.88	0.55	DL	0.01	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5\text{[in]} - 0.813\text{[in]}/2) = \mathbf{2.09}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 2.09\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 2.19\text{[in]}, 2.4 * 0.75\text{[in]}) * (1 - 1)) *$

$0.25_{[in]}*65000_{[lb/in2]}*3 = \mathbf{43.88}_{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	229.94	0.55	DL	0.00	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*7.68_{[in2]} = \mathbf{229.94}_{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	173.30	0.55	DL	0.00	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 7.68_{[in2]} - 3*0.25_{[in]}*0.875_{[in]} = \mathbf{7.02}_{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.722_{[in]}/3_{[in]} = \mathbf{0.759}$ Table D3.1

$A_e = U*A_n = 0.759*7.02_{[in2]} = \mathbf{5.33}_{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000_{[lb/in2]}*5.33_{[in2]} = \mathbf{173.3}_{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	53.28	0.55	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5_{[in]} + (1 - 1)*3_{[in]})*0.25_{[in]} = \mathbf{1.25}_{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5_{[in]} + (1 - 1)*3_{[in]} - 0.875_{[in]}*(1 - 0.5))*0.25_{[in]} = \mathbf{1.03}_{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3_{[in]} - 0.875_{[in]})*(3 - 1)*0.25_{[in]} = \mathbf{1.06}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000_{[lb/in2]}*1.03_{[in2]} + 1*65000_{[lb/in2]}*1.06_{[in2]}, 0.6*50000_{[lb/in2]}*1.25_{[in2]} + 1*65000_{[lb/in2]}*1.06_{[in2]}) = \mathbf{53.28}_{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	163.33	33.28	DL	0.20	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000_{[lb/in2]}*0.349_{[in]} = \mathbf{13.61}_{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 25_{[kip]}/(0.5*3.72_{[kip/in]}*1*9_{[in]}) = \mathbf{1.49}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ _{[in]} = 0.6*70000_{[lb/in2]}*(2)^{1/2}/2*1.49/16\ _{[in]} = \mathbf{2.77}_{[kip/in]}$ p. 9-5

Chord wall plastification	[Kip]	29.76	0.55	DL	0.02	Eq. K1-9

$U_{HSS} = \text{abs}(P_r)/(A_g*F_c) + \text{abs}(M_r)/(S*F_c) = \text{abs}(0_{[kip]})/(7.58_{[in2]}*30000_{[lb/in2]}) + \text{abs}(0_{[kip*ft]})/(13.2_{[in3]}*30000_{[lb/in2]}) = \mathbf{0}$ Eq. K2-2

$Q_f = (1 - U_{HSS}^2)^{0.5} = (1 - 0^2)^{0.5} = \mathbf{1}$ Eq. K1-9

$(1/\Omega)R_n = (1/\Omega)*(F_y*t_p^2/(1 - t_p/B))*(2*N/B + 4*(1 - t_p/B)^{0.5}*Q_f) = 0.667*(50000_{[lb/in2]}*0.349_{[in]}^2/(1 - 0.375_{[in]}/6_{[in]}))*(2*9_{[in]}/6_{[in]} + 4*(1 - 0.375_{[in]}/6_{[in]})^{0.5}*1) = \mathbf{29.76}_{[kip]}$ Eq. K1-9

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_c: Available stress

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}:Specified minimum yield stress of plate

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

M_r: Required flexural strength in chord

e_{dmin}: Minimum edge distance

n: Bolts rows number

N: Bearing length

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

P_r: Required axial stress

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

Q_f: Chord stress interaction parameter

R_n: Nominal strength

R_u: Required strength

S: Chord elastic section modulus

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

U_{HSS}: Utilization ratio

w_{min}: Minimum weld size required

x: Connection eccentricity

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:26 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-13**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W16x26

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	25.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	7.10	14.21	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 0[in]) - max(0.747[in], 0[in]) = **14.21**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.25[in], 12\ [in]) = \mathbf{6}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	4.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	25.00	DL	0.79	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	53.42	25.00	DL	0.47	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5\text{[in]} - 0.813\text{[in]}/2)$ = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]})$ = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] — Eq. J3-6

Shear yielding	[Kip]	48.60	25.00	DL	0.51	Eq. J4-3

$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.60	25.00	DL	0.60	Eq. J4-4

$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] — Eq. J4-4

Block shear	[Kip]	41.93	25.00	DL	0.60	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	25.00	DL	0.37	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	43.88	25.00	DL	0.57	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.85\text{[in]} - 0.813\text{[in]}/2)$ = **4.44**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]})$ = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*4.44[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*$
$0.25[in]*65000[lb/in2]*1 = \mathbf{43.88}[kip]$ Eq. J3-6

Shear yielding	[Kip]	78.50	25.00	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 15.7[in]*0.25[in] = \mathbf{3.93}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.93[in2] = \mathbf{78.5}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	163.33	33.33	DL	0.20	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.349[in] = \mathbf{13.61}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 25[kip]/(0.5*3.71[kip/in]*1*9[in]) = \mathbf{1.5}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*1.5/16$ [in] $= \mathbf{2.78}[kip/in]$ p. 9-5

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:27 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-14**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W16x31

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	25.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	7.11	14.22	✔	p. 10-104
$L_{min} = T/2 = 14.22[in]/2 =$ **7.11**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.9[in] - max(0.842[in], 0[in]) - max(0.842[in], 0[in]) = **14.22**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.53	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.291[in])/36000[lb/in2] = \mathbf{0.525}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.60	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.275[in], 12\ [in]) = \mathbf{6.6}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	4.95	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.29	0.15	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 6[in] - 2*1.5*0.291[in] = \mathbf{5.13}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (5.13[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.152}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	25.00	DL	0.79	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	53.42	25.00	DL	0.47	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] — Eq. J3-6

Shear yielding	[Kip]	48.60	25.00	DL	0.51	Eq. J4-3

$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.60	25.00	DL	0.60	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] — Eq. J4-4

Block shear	[Kip]	41.93	25.00	DL	0.60	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	25.00	DL	0.37	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	48.26	25.00	DL	0.52	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.95[in] - 0.813[in]/2) = **4.54**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*4.54[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*$
$0.275[in]*65000[lb/in2]*1 = \mathbf{48.26}[kip]$ Eq. J3-6

Shear yielding	[Kip]	87.45	25.00	DL	0.29	Eq. J4-3

$A_g = L_p*t_p = 15.9[in]*0.275[in] = \mathbf{4.37}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.37[in2] = \mathbf{87.45}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	136.19	33.33	DL	0.24	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.291[in] = \mathbf{11.35}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 25[kip]/(0.5*3.71[kip/in]*1*9[in]) = \mathbf{1.5}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in] = 0.6*70000[lb/in2]*(2)^{1/2}/2*1.5/16\ [in] = \mathbf{2.78}[kip/in]$ p. 9-5

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-15**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W18x35

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	45.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	8.02	16.05	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 0[in]) - max(0.827[in], 0[in]) = **16.05**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.3[in], 12\ [in]) = \mathbf{7.2}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52\ [ksi]$						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.19	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 8[in] - 2*1.5*0.581[in] = \mathbf{6.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (6.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.186}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	53.04	45.00	DL	0.85	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 5*10.61[kip]*1 = **53.04**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	92.57	45.00	DL	0.49	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*
0.375[in]*58000[lb/in2]*1 = **92.57**[kip] — Eq. J3-6

Shear yielding	[Kip]	81.00	45.00	DL	0.56	Eq. J4-3

$A_g = L_p*t_p$ = 15[in]*0.375[in] = **5.63**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*5.63[in2] = **81**[kip] — Eq. J4-3

Shear rupture	[Kip]	69.33	45.00	DL	0.65	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 15[in] - 5*0.875[in] = **10.63**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 10.63[in]*0.375[in] = **3.98**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.98[in2] = **69.33**[kip] — Eq. J4-4

Block shear	[Kip]	65.21	45.00	DL	0.69	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.06[in])*0.375[in] = **0.363**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (5 - 1)*3[in])*0.375[in] = **5.06**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (5 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **3.59**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*3.59[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*5.06[in2] + 1*58000[lb/in2]*0.363[in2]) = **65.21**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	111.37	45.00	DL	0.40	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*15[in] = **111.37**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	87.75	45.00	DL	0.51	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.85[in] - 0.813[in]/2) = **2.44**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.44[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.3[in]*$
$65000[lb/in2]*1 = \mathbf{87.75}[kip]$ Eq. J3-6

Shear yielding	[Kip]	106.20	45.00	DL	0.42	Eq. J4-3

$A_g = L_p*t_p = 17.7[in]*0.3[in] = \mathbf{5.31}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.31[in2] = \mathbf{106.2}[kip]$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	36.00	DL	0.13	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.581[in] = \mathbf{22.66}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 45[kip]/(0.5*3.71[kip/in]*1*15[in]) = \mathbf{1.62}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in] = 0.6*70000[lb/in2]*(2)^{1/2}/2*1.62/16\ [in] = \mathbf{3}[kip/in]$ p. 9-5

Global critical strength ratio **0.85**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:27 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-16**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W18x35

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.38	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	8.02	16.05	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 0[in]) - max(0.827[in], 0[in]) = **16.05**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.53	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.291[in])/36000[lb/in2] = \mathbf{0.525}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$ Sec. J3.3

$IsCorrosionConsidered \rightarrow \mathbf{False}$

$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.3[in], 12\ [in]) = \mathbf{7.2}[in]$ Sec. J3.5

Beam

Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.438 = \mathbf{0.428}[in]$ p. 10-151

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

Vertical edge distance	[in]	5.85	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2

$F_{ymax} = 52\ [ksi]$ Sec. K1.2

Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2

$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$ Sec. K1.2

$(F_y/F_u)_{max} = 0.80$ Sec. K1.2

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

Thickness	[in]	0.29	0.15	--	✔	Sec. B4.2, p. 10-158

$b = B - 2*1.5*t = 6[in] - 2*1.5*0.291[in] = \mathbf{5.13}[in]$ Sec. B4.2

$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (5.13[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.152}[in]$ p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	20.00	DL	0.48	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/ in2]*0.398[in2]) = **41.93**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	42.82	0.38	DL	0.01	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*3 = **42.82**[kip] Eq. J3-6

Tension yielding	[Kip]	72.75	0.38	DL	0.01	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*36000[lb/in2]*3.38[in2] = **72.75**[kip] Eq. J4-1

Tension rupture	[Kip]	69.33	0.38	DL	0.01	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9[in] - 3*0.875[in])*0.375[in] = **2.39**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.38[in2], 2.39[in2]) = **2.39**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*58000[lb/in2]*2.39[in2] = **69.33**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.37	0.38	DL	0.01	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5[in] + (1 - 1)*3[in])*0.375[in] = **1.13**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5[in] + (1 - 1)*3[in] - 0.875[in]*(1 -
0.5))*0.375[in] = **0.797**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.375[in] = **1.59**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*0.797[in2] + 1*58000[lb/in2]*1.59[in2], 0.6*36000[lb/in2]*1.13[in2] + 1*58000[lb/
in2]*1.59[in2]) = **58.37**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.91	20.00	DL	0.30	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.72[kip/in]*1*4*9[in] = **66.91**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	52.65	20.00	DL	0.38	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 5.85[in] - 0.813[in]/2) = **5.45**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*5.45[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.3[in]*
65000[lb/in2]*1 = **52.65**[kip] Eq. J3-6

Shear yielding	[Kip]	106.20	20.00	DL	0.19	Eq. J4-3

A_g = L_p*t_p = 17.7[in]*0.3[in] = **5.31**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.31[in2] = **106.2**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	52.65	0.38	DL	0.01	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.23\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.82}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.82\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(1 - 1))*0.3\text{[in]}*$
$65000\text{[lb/in2]}*3 = \mathbf{52.65}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	308.38	0.38	DL	0.00	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*10.3\text{[in2]} = \mathbf{308.38}\text{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	227.68	0.38	DL	0.00	Eq. J4-2

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 10.3\text{[in2]} - 3*0.3\text{[in]}*0.875\text{[in]} = \mathbf{9.51}\text{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.791\text{[in]}/3\text{[in]} = \mathbf{0.736}$ Table D3.1

$A_e = U*A_n = 0.736*9.51\text{[in2]} = \mathbf{7.01}\text{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*7.01\text{[in2]} = \mathbf{227.68}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	61.51	0.38	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.23\text{[in]} + (1 - 1)*3\text{[in]})*0.3\text{[in]} = \mathbf{1.34}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.23\text{[in]} + (1 - 1)*3\text{[in]} - 0.875\text{[in]}*(1 -$
$0.5))*0.3\text{[in]} = \mathbf{1.08}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 0.875\text{[in]})*(3 - 1)*0.3\text{[in]} = \mathbf{1.28}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000\text{[lb/in2]}*1.08\text{[in2]} + 1*65000\text{[lb/in2]}*1.28\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.34\text{[in2]} + 1*65000\text{[lb/}$
$\text{in2]}*1.28\text{[in2]}) = \mathbf{61.51}\text{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	136.19	26.63	DL	0.20	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.291\text{[in]} = \mathbf{11.35}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20\text{[kip]}/(0.5*3.72\text{[kip/in]}*1*9\text{[in]}) = \mathbf{1.2}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.2/16\text{ [in]} = \mathbf{2.22}\text{[kip/in]}$ p. 9-5

Chord wall plastification	[Kip]	20.69	0.38	DL	0.02	Eq. K1-9

$U_{HSS} = \text{abs}(P_r)/(A_g*F_c) + \text{abs}(M_r)/(S*F_c) = \text{abs}(0\text{[kip]})/(6.43\text{[in2]}*30000\text{[lb/in2]}) +$
$\text{abs}(0\text{[kip*ft]})/(11.4\text{[in3]}*30000\text{[lb/in2]}) = \mathbf{0}$ Eq. K2-2

$Q_f = (1 - U_{HSS}^2)^{0.5} = (1 - 0^2)^{0.5} = \mathbf{1}$ Eq. K1-9

$(1/\Omega)R_n = (1/\Omega)*(F_y*t_p^2/(1 - t_p/B))*(2*N/B + 4*(1 - t_p/B)^{0.5}*Q_f) = 0.667*$
$(50000\text{[lb/in2]}*0.291\text{[in]}^2/(1 - 0.375\text{[in]}/6\text{[in]}))*(2*9\text{[in]}/6\text{[in]} + 4*(1 - 0.375\text{[in]}/6\text{[in]})^{0.5}*1) =$

20.69[kip] Eq. K1-9

Global critical strength ratio	**0.63**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_c: Available stress

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}: Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

M_r: Required flexural strength in chord

e_{dmin}: Minimum edge distance

n: Bolts rows number

N: Bearing length

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

P_r: Required axial stress

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

Q_f: Chord stress interaction parameter

R_n: Nominal strength

R_u: Required strength

S: Chord elastic section modulus

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

U_{HSS}: Utilization ratio

w_{min}: Minimum weld size required

x: Connection eccentricity

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:50 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-17**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W18x35

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	8.02	16.05	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 0[in]) - max(0.827[in], 0[in]) = **16.05**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.53	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.291[in])/36000[lb/in2] = \mathbf{0.525}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$ Sec. J3.3

$IsCorrosionConsidered \rightarrow \mathbf{False}$

$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.3[in], 12\ [in]) = \mathbf{7.2}[in]$ Sec. J3.5

Beam

Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.438 = \mathbf{0.428}[in]$ p. 10-151

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

Vertical edge distance	[in]	5.85	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.73	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2

$F_{ymax} = 52\ [ksi]$ Sec. K1.2

Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2

$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$ Sec. K1.2

$(F_y/F_u)_{max} = 0.80$ Sec. K1.2

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

Thickness	[in]	0.29	0.15	--	✔	Sec. B4.2, p. 10-158

$b = B - 2*1.5*t = 6[in] - 2*1.5*0.291[in] = \mathbf{5.13}[in]$ Sec. B4.2

$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (5.13[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.152}[in]$ p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	20.00	DL	0.48	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	52.65	20.00	DL	0.38	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.85$[in] $- 0.813$[in]$/2) =$ **5.44**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*5.44$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*0.3$[in]$*$
65000[lb/in2]$*1 =$ **52.65**[kip] Eq. J3-6

Shear yielding	[Kip]	106.20	20.00	DL	0.19	Eq. J4-3

$A_g = L_p*t_p = 17.7$[in]$*0.3$[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*5.31$[in2] = **106.2**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	136.19	26.67	DL	0.20	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.291$[in] = **11.35**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **1.2** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.2/16$ [in] = **2.22**[kip/in] p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}: Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:28 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-18**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	9.40	18.80	✔	p. 10-104
$L_{min} = T/2 = 18.8$[in]$/2 =$ **9.4**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.7[in] - max(0.95[in], 0[in]) - max(0.95[in], 0[in]) = **18.8**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	8.40	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.35[in], 12\ [in]) = \mathbf{8.4}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	4.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	53.04	35.00	DL	0.66	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 5*10.61[kip]*1 = **53.04**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	92.57	35.00	DL	0.38	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5\text{[in]} - 0.813\text{[in]}/2)$ = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]})$ = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*
0.375[in]*58000[lb/in2]*1 = **92.57**[kip] — Eq. J3-6

Shear yielding	[Kip]	81.00	35.00	DL	0.43	Eq. J4-3

$A_g = L_p*t_p$ = 15[in]*0.375[in] = **5.63**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*5.63[in2] = **81**[kip] — Eq. J4-3

Shear rupture	[Kip]	69.33	35.00	DL	0.50	Eq. J4-4

$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 15[in] - 5*0.875[in] = **10.63**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 10.63[in]*0.375[in] = **3.98**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.98[in2] = **69.33**[kip] — Eq. J4-4

Block shear	[Kip]	66.23	35.00	DL	0.53	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (5 - 1)*3[in])*0.375[in] = **5.06**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (5 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **3.59**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*3.59[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*5.06[in2] + 1*58000[lb/in2]*0.398[in2]) = **66.23**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	111.37	35.00	DL	0.31	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*15[in] = **111.37**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	102.38	35.00	DL	0.34	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35\text{[in]} - 0.813\text{[in]}/2)$ = **3.94**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]})$ = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.94\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(5 - 1))*$
$0.35\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{102.38}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	144.90	35.00	DL	0.24	Eq. J4-3

$A_g = L_p*t_p = 20.7\text{[in]}*0.35\text{[in]} = \mathbf{7.25}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*7.25\text{[in2]} = \mathbf{144.9}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	163.33	28.00	DL	0.17	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.349\text{[in]} = \mathbf{13.61}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 35\text{[kip]}/(0.5*3.71\text{[kip/in]}*1*15\text{[in]}) = \mathbf{1.26}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.26/16\text{ [in]} = \mathbf{2.33}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.66**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

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Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-19**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.38	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	12.00	9.40	18.80	✔	p. 10-104
$L_{min} = T/2 = 18.8$[in]$/2 =$ **9.4**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.7[in] - max(0.95[in], 0[in]) - max(0.95[in], 0[in]) = **18.8**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	8.40	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$ Sec. J3.3

$IsCorrosionConsidered \rightarrow \mathbf{False}$

$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.35[in], 12\ [in]) = \mathbf{8.4}[in]$ Sec. J3.5

Beam

Thickness	[in]	0.35	--	0.43	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.438 = \mathbf{0.428}[in]$ p. 10-151

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

Vertical edge distance	[in]	5.85	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	2.21	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2

$F_{ymax} = 52\ [ksi]$ Sec. K1.2

Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2

$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$ Sec. K1.2

$(F_y/F_u)_{max} = 0.80$ Sec. K1.2

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158

$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$ Sec. B4.2

$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$ p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	20.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
(1/Ω)R_n = *C*(1/Ω)*R_n**BoltFactor* = 4*10.61[kip]*1 = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	20.00	DL	0.27	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))* 0.375[in]*58000[lb/in2]*1 = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	20.00	DL	0.31	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	20.00	DL	0.36	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 12[in] - 4*0.875[in] = **8.5**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 8.5[in]*0.375[in] = **3.19**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	20.00	DL	0.37	Eq. J4-5
dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/in2]*0.398[in2]) = **54.08**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	57.09	0.38	DL	0.01	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*4 = **57.09**[kip] Eq. J3-6

Tension yielding	[Kip]	97.01	0.38	DL	0.00	Eq. J4-1

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*36000[lb/in2]*4.5[in2] = **97.01**[kip] Eq. J4-1

Tension rupture	[Kip]	92.44	0.38	DL	0.00	Eq. J4-2

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (12[in] - 4*0.875[in])*0.375[in] = **3.19**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.5[in2], 3.19[in2]) = **3.19**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*58000[lb/in2]*3.19[in2] = **92.44**[kip] Eq. J4-2

Tear out under axial load	[Kip]	81.48	0.38	DL	0.00	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5[in] + (1 - 1)*3[in])*0.375[in] = **1.13**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5[in] + (1 - 1)*3[in] - 0.875[in]*(1 -
0.5))*0.375[in] = **0.797**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(4 - 1)*0.375[in] = **2.39**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*0.797[in2] + 1*58000[lb/in2]*2.39[in2], 0.6*36000[lb/in2]*1.13[in2] + 1*58000[lb/
in2]*2.39[in2]) = **81.48**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	89.21	20.00	DL	0.22	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.72[kip/in]*1*4*12[in] = **89.21**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	81.90	20.00	DL	0.24	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 5.85[in] - 0.813[in]/2) = **5.45**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*5.45[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*
0.35[in]*65000[lb/in2]*1 = **81.9**[kip] Eq. J3-6

Shear yielding	[Kip]	144.90	20.00	DL	0.14	Eq. J4-3

A_g = L_p*t_p = 20.7[in]*0.35[in] = **7.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.25[in2] = **144.9**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	81.90	0.38	DL	0.00	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.21[in] - 0.813[in]/2) = **1.8**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.8[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.35[in]*
65000[lb/in2]*4 = **81.9**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	389.22	0.38	DL	0.00	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*13[in2] = **389.22**[kip] Eq. D2-1

Tension rupture	[Kip]	281.75	0.38	DL	0.00	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 13[in2] - 4*0.35[in]*0.875[in] = **11.78**[in2] Sec. D3-2

U = 1 - x/l = 1 - 0.791[in]/3[in] = **0.736** Table D3.1

A_e = U*A_n = 0.736*11.78[in2] = **8.67**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*8.67[in2] = **281.75**[kip] Eq. J4-2

Tear out under axial load	[Kip]	95.70	0.38	DL	0.00	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.21[in] + (1 - 1)*3[in])*0.35[in] = **1.55**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.21[in] + (1 - 1)*3[in] - 0.875[in]*(1 -
0.5))*0.35[in] = **1.24**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(4 - 1)*0.35[in] = **2.23**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.24[in2] + 1*65000[lb/in2]*2.23[in2], 0.6*50000[lb/in2]*1.55[in2] + 1*65000[lb/
in2]*2.23[in2]) = **95.7**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	163.33	19.97	DL	0.12	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.349[in] = **13.61**[kip/in] p. 9-5

D_{min} = P/(($1/\Omega$)*C*C_1*L) = 20[kip]/(0.5*3.72[kip/in]*1*12[in]) = **0.897** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*(2)$^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.897/16 [in] = **1.66**[kip/in] p. 9-5

Chord wall plastification	[Kip]	34.10	0.38	DL	0.01	Eq. K1-9

U_{HSS} = abs(P_r)/(A_g*F_c) + abs(M_r)/(S*F_c) = abs(0[kip])/(7.58[in2]*30000[lb/in2]) +
abs(0[kip*ft])/(13.2[in3]*30000[lb/in2]) = **0** Eq. K2-2

Q_f = (1 - U_{HSS}^2)$^{0.5}$ = (1 - 0^2)$^{0.5}$ = **1** Eq. K1-9

$(1/\Omega)R_n$ = $(1/\Omega)$*(F_y*t_p^2/(1 - t_p/B))*(2*N/B + 4*(1 - t_p/B)$^{0.5}$*Q_f) = 0.667*
(50000[lb/in2]*0.349[in]^2/(1 - 0.375[in]/6[in]))*(2*12[in]/6[in] + 4*(1 - 0.375[in]/6[in])$^{0.5}$*1) =

34.1[kip] Eq. K1-9

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}:Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_c: Available stress

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}:Specified minimum yield stress of plate

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

M_r: Required flexural strength in chord

e_{dmin}: Minimum edge distance

n: Bolts rows number

N: Bearing length

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

P_r: Required axial stress

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

Q_f: Chord stress interaction parameter

R_n: Nominal strength

R_u: Required strength

S: Chord elastic section modulus

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

U_{HSS}: Utilization ratio

w_{min}: Minimum weld size required

x: Connection eccentricity

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:29 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-20**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W21x50

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	30.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	12.00	9.36	18.72	✔	p. 10-104
$L_{min} = T/2 = 18.72$[in]$/2 =$ **9.36**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.8[in] - max(1.04[in], 0[in]) - max(1.04[in], 0[in]) = **18.72**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	0.63	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.349[in])/36000[lb/in2] = \mathbf{0.63}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.375[in], 12\ [in]) = \mathbf{9}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	5.90	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.35	0.15	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 6[in] - 2*1.5*0.349[in] = \mathbf{4.95}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (4.95[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.147}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 4*10.61[kip]*1 = **42.43**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	73.00	30.00	DL	0.41	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*
0.375[in]*58000[lb/in2]*1 = **73**[kip] — Eq. J3-6

Shear yielding	[Kip]	64.80	30.00	DL	0.46	Eq. J4-3

$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip] — Eq. J4-3

Shear rupture	[Kip]	55.46	30.00	DL	0.54	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 12[in] - 4*0.875[in] = **8.5**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 8.5[in]*0.375[in] = **3.19**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip] — Eq. J4-4

Block shear	[Kip]	54.08	30.00	DL	0.55	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **2.79**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/in2]*0.398[in2]) = **54.08**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	89.10	30.00	DL	0.34	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*12[in] = **89.1**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	88.92	30.00	DL	0.34	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 5.9[in] - 0.813[in]/2) = **5.49**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*5.49\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(4 - 1))*$
$0.38\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{88.92}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	158.08	30.00	DL	0.19	Eq. J4-3

$A_g = L_p*t_p = 20.8\text{[in]}*0.38\text{[in]} = \mathbf{7.9}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*7.9\text{[in2]} = \mathbf{158.08}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	163.33	30.00	DL	0.18	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.349\text{[in]} = \mathbf{13.61}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 30\text{[kip]}/(0.5*3.71\text{[kip/in]}*1*12\text{[in]}) = \mathbf{1.35}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.35/16\text{ [in]} = \mathbf{2.5}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:30 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-21**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W24x55

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	34.99	0.73	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	10.79	21.58	✔	p. 10-104
$L_{min} = T/2 = 21.58[in]/2 =$ **10.79**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 23.6[in] - max(1.01[in], 0[in]) - max(1.01[in], 0[in]) = **21.58**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.375[in], 12\ [in]) = \mathbf{9}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	5.80	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.19	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 8[in] - 2*1.5*0.581[in] = \mathbf{6.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (6.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.186}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	53.04	35.00	DL	0.66	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 5*10.61[kip]*1 = **53.04**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	92.57	34.99	DL	0.38	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*
0.375[in]*58000[lb/in2]*1 = **92.57**[kip] — Eq. J3-6

Shear yielding	[Kip]	81.00	34.99	DL	0.43	Eq. J4-3

$A_g = L_p*t_p$ = 15[in]*0.375[in] = **5.63**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*5.63[in2] = **81**[kip] — Eq. J4-3

Shear rupture	[Kip]	69.33	34.99	DL	0.50	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 15[in] - 5*0.875[in] = **10.63**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 10.63[in]*0.375[in] = **3.98**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.98[in2] = **69.33**[kip] — Eq. J4-4

Block shear	[Kip]	66.23	34.99	DL	0.53	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (5 - 1)*3[in])*0.375[in] = **5.06**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (5 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **3.59**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*3.59[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*5.06[in2] + 1*58000[lb/in2]*0.398[in2]) = **66.23**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	71.37	0.73	DL	0.01	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*5 = **71.37**[kip] — Eq. J3-6

Tension yielding	[Kip]	121.26	0.73	DL	0.01	Eq. J4-1

$A_g = L_p * t_p = 15\text{[in]} * 0.375\text{[in]} = \mathbf{5.63}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 5.63\text{[in2]} = \mathbf{121.26}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	115.55	0.73	DL	0.01	Eq. J4-2

$A_g = L_p * t_p = 15\text{[in]} * 0.375\text{[in]} = \mathbf{5.63}\text{[in2]}$ Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = (l - n * L_h) * t_p = (15\text{[in]} - 5 * 0.875\text{[in]}) * 0.375\text{[in]} = \mathbf{3.98}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85 * A_g, A_n) = \min(0.85 * 5.63\text{[in2]}, 3.98\text{[in2]}) = \mathbf{3.98}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 3.98\text{[in2]} = \mathbf{115.55}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	104.59	0.73	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2 * (L + (n_c - 1) * g) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 3\text{[in]}) * 0.375\text{[in]} = \mathbf{1.13}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2 * (L + (n_c - 1) * g - dh_h * (n_c - 0.5)) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 3\text{[in]} - 0.875\text{[in]} * (1 - 0.5)) * 0.375\text{[in]} = \mathbf{0.797}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v) * (n - 1) * t_p = (3\text{[in]} - 0.875\text{[in]}) * (5 - 1) * 0.375\text{[in]} = \mathbf{3.19}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 58000\text{[lb/in2]} * 0.797\text{[in2]} + 1 * 58000\text{[lb/in2]} * 3.19\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 1.13\text{[in2]} + 1 * 58000\text{[lb/in2]} * 3.19\text{[in2]}) = \mathbf{104.59}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	111.54	35.00	DL	0.31	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega) * C * C_1 * D * L = 0.5 * 3.72\text{[kip/in]} * 1 * 4 * 15\text{[in]} = \mathbf{111.54}\text{[kip]}$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	115.54	34.99	DL	0.30	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.8\text{[in]} - 0.813\text{[in]}/2) = \mathbf{5.4}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 5.4\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 2.19\text{[in]}, 2.4 * 0.75\text{[in]}) * (5 - 1)) * 0.395\text{[in]} * 65000\text{[lb/in2]} * 1 = \mathbf{115.54}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	186.44	34.99	DL	0.19	Eq. J4-3

$A_g = L_p * t_p = 23.6\text{[in]} * 0.395\text{[in]} = \mathbf{9.32}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000\text{[lb/in2]} * 9.32\text{[in2]} = \mathbf{186.44}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	115.54	0.73	DL	0.01	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5\text{[in]} - 0.813\text{[in]}/2) = \mathbf{2.09}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 2.09\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 2.19\text{[in]}, 2.4 * 0.75\text{[in]}) * (1 - 1)) *$

$0.395_{[in]}*65000_{[lb/in2]}*5 = \mathbf{115.54}_{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	485.03	0.73	DL	0.00	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*16.2_{[in2]} = \mathbf{485.03}_{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	340.15	0.73	DL	0.00	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 16.2_{[in2]} - 5*0.395_{[in]}*0.875_{[in]} = \mathbf{14.47}_{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.83_{[in]}/3_{[in]} = \mathbf{0.723}$ Table D3.1

$A_e = U*A_n = 0.723*14.47_{[in2]} = \mathbf{10.47}_{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000_{[lb/in2]}*10.47_{[in2]} = \mathbf{340.15}_{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	138.74	0.73	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5_{[in]} + (1 - 1)*3_{[in]})*0.395_{[in]} = \mathbf{1.98}_{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5_{[in]} + (1 - 1)*3_{[in]} - 0.875_{[in]}*(1 - 0.5))*0.395_{[in]} = \mathbf{1.63}_{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3_{[in]} - 0.875_{[in]})*(5 - 1)*0.395_{[in]} = \mathbf{3.36}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000_{[lb/in2]}*1.63_{[in2]} + 1*65000_{[lb/in2]}*3.36_{[in2]}, 0.6*50000_{[lb/in2]}*1.98_{[in2]} + 1*65000_{[lb/in2]}*3.36_{[in2]}) = \mathbf{138.74}_{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	271.91	27.96	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000_{[lb/in2]}*0.581_{[in]} = \mathbf{22.66}_{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 35_{[kip]}/(0.5*3.72_{[kip/in]}*1*15_{[in]}) = \mathbf{1.26}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ _{[in]} = 0.6*70000_{[lb/in2]}*(2)^{1/2}/2*1.26/16\ _{[in]} = \mathbf{2.33}_{[kip/in]}$ p. 9-5

Chord wall plastification	[Kip]	90.37	0.73	DL	0.01	Eq. K1-9

$U_{HSS} = \text{abs}(P_r)/(A_g*F_c) + \text{abs}(M_r)/(S*F_c) = \text{abs}(0_{[kip]})/(18.7_{[in2]}*30000_{[lb/in2]}) + \text{abs}(0_{[kip*ft]})/(50.5_{[in3]}*30000_{[lb/in2]}) = \mathbf{0}$ Eq. K2-2

$Q_f = (1 - U_{HSS}^2)^{0.5} = (1 - 0^2)^{0.5} = \mathbf{1}$ Eq. K1-9

$(1/\Omega)R_n = (1/\Omega)*(F_y*t_p^2/(1 - t_p/B))*(2*N/B + 4*(1 - t_p/B)^{0.5}*Q_f) = 0.667*(50000_{[lb/in2]}*0.581_{[in]}^2/(1 - 0.375_{[in]}/8_{[in]}))*(2*15_{[in]}/8_{[in]} + 4*(1 - 0.375_{[in]}/8_{[in]})^{0.5}*1) = \mathbf{90.37}_{[kip]}$ Eq. K1-9

Global critical strength ratio **0.66**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_c: Available stress

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}:Specified minimum yield stress of plate

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

M_r: Required flexural strength in chord

e_{dmin}: Minimum edge distance

n: Bolts rows number

N: Bearing length

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

P_r: Required axial stress

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

Q_f: Chord stress interaction parameter

R_n: Nominal strength

R_u: Required strength

S: Chord elastic section modulus

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

U_{HSS}: Utilization ratio

w_{min}: Minimum weld size required

x: Connection eccentricity

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:22 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-22**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W24x62

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	70.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	21.50	10.76	21.52	✔	p. 10-104
$L_{min} = T/2 = 21.52$[in]$/2 =$ **10.76**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 23.7[in] - max(1.09[in], 0[in]) - max(1.09[in], 0[in]) = **21.52**[in]						p. 10-49
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = \mathbf{1.75}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.375[in], 12\ [in]) = \mathbf{9}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = \mathbf{1.75}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.19	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 8[in] - 2*1.5*0.581[in] = \mathbf{6.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (6.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.186}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	164.85	70.00	DL	0.42	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 7*23.55[kip]*1 = **164.85**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	167.61	70.00	DL	0.42	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(7 - 1))*0.375[in]*
58000[lb/in2]*1 = **167.61**[kip] — Eq. J3-6

Shear yielding	[Kip]	116.10	70.00	DL	0.60	Eq. J4-3

$A_g = L_p*t_p$ = 21.5[in]*0.375[in] = **8.06**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*8.06[in2] = **116.1**[kip] — Eq. J4-3

Shear rupture	[Kip]	88.90	70.00	DL	0.79	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 21.5[in] - 7*1.13[in] = **13.63**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 13.63[in]*0.375[in] = **5.11**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*5.11[in2] = **88.9**[kip] — Eq. J4-4

Block shear	[Kip]	94.26	70.00	DL	0.74	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.31[in] + 1/16 [in] = **1.38**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.38[in])*0.375[in] = **0.492**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (7 - 1)*3[in])*0.375[in] = **7.41**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (7 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **4.66**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*4.66[in2] + 1*58000[lb/in2]*0.492[in2], 0.6*36000[lb/in2]*7.41[in2] + 1*58000[lb/
in2]*0.492[in2]) = **94.26**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	159.63	70.00	DL	0.44	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*21.5[in] = **159.63**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	228.49	70.00	DL	0.31	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.85[in] - 1.06[in]/2) = **2.32**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.32[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(7 - 1))*0.43[in]*$
$65000[lb/in2]*1 =$ **228.49**[kip] Eq. J3-6

Shear yielding	[Kip]	203.82	70.00	DL	0.34	Eq. J4-3

$A_g = L_p*t_p = 23.7[in]*0.43[in] =$ **10.19**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*10.19[in2] =$ **203.82**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	39.07	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.581[in] =$ **22.66**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 70[kip]/(0.5*3.71[kip/in]*1*21.5[in]) =$ **1.75** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*1.75/16$ [in] = **3.26**[kip/in] p. 9-5

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:31 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-23**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W24x68

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	65.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	21.00	10.76	21.52	✔	p. 10-104
$L_{min} = T/2 = 21.52$[in]$/2 =$ **10.76**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 23.7[in] - max(1.09[in], 0[in]) - max(1.09[in], 0[in]) = **21.52**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.375[in], 12\ [in]) = \mathbf{9}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52$ [ksi]						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.19	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 8[in] - 2*1.5*0.581[in] = \mathbf{6.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (6.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.186}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	74.26	65.00	DL	0.88	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 7*10.61[kip]*1 = **74.26**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	131.72	65.00	DL	0.49	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*$(min($k_1*L_{c\text{-}end}$, k_2*d) + min($k_1*L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(7 - 1))*
0.375[in]*58000[lb/in2]*1 = **131.72**[kip] — Eq. J3-6

Shear yielding	[Kip]	113.40	65.00	DL	0.57	Eq. J4-3

$A_g = L_p*t_p$ = 21[in]*0.375[in] = **7.88**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*7.88[in2] = **113.4**[kip] — Eq. J4-3

Shear rupture	[Kip]	97.06	65.00	DL	0.67	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h$ = 21[in] - 7*0.875[in] = **14.88**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 14.88[in]*0.375[in] = **5.58**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*5.58[in2] = **97.06**[kip] — Eq. J4-4

Block shear	[Kip]	89.51	65.00	DL	0.73	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] — Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.06[in])*0.375[in] = **0.363**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (7 - 1)*3[in])*0.375[in] = **7.31**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (7 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **5.18**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*$min(0.6*$F_u*A_{nv}$ + $U_{bs}*F_u*A_{nt}$, 0.6*F_y*A_{gv} + $U_{bs}*F_u*A_{nt}$) =
0.5*min(0.6*58000[lb/in2]*5.18[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*7.31[in2] + 1*58000[lb/in2]*0.363[in2]) = **89.51**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	155.92	65.00	DL	0.42	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*21[in] = **155.92**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	169.94	65.00	DL	0.38	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.85[in] - 0.813[in]/2) = **2.44**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.44\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(7 - 1))*$
$0.415\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{169.94}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	196.71	65.00	DL	0.33	Eq. J4-3

$A_g = L_p*t_p = 23.7\text{[in]}*0.415\text{[in]} = \mathbf{9.84}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*9.84\text{[in2]} = \mathbf{196.71}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	37.14	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.581\text{[in]} = \mathbf{22.66}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 65\text{[kip]}/(0.5*3.71\text{[kip/in]}*1*21\text{[in]}) = \mathbf{1.67}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.67/16\text{ [in]} = \mathbf{3.1}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.88**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}:Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 4:31 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-24**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W12x14

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.00	5.43	10.85	✔	p. 10-104
$L_{min} = T/2 = 10.85$[in]$/2 =$ **5.43**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 11.9[in] - max(0.525[in], 0[in]) - max(0.525[in], 0[in]) = **10.85**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in] — p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.2$[in], 12 [in]$) =$ **4.8**[in] — Sec. J3.5

Beam

Thickness	[in]	0.20	--	0.44	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.105 =$ **1.79**[in] — p. 10-151

$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in] — p. 10-102

$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in] — p. 10-102

Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.46	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in] — p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** — p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1 =$ **21.22**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in] $- 0.813$[in]$/2) =$ **1.09**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.09\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(2 - 1))*$
$0.375\text{[in]}*58000\text{[lb/in2]}*1 = \mathbf{33.85}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3

$A_g = L_p*t_p = 6\text{[in]}*0.375\text{[in]} = \mathbf{2.25}\text{[in2]}$ Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000\text{[lb/in2]}*2.25\text{[in2]} = \mathbf{32.4}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2
$L_e = L - n*L_h = 6\text{[in]} - 2*0.875\text{[in]} = \mathbf{4.25}\text{[in]}$ DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25\text{[in]}*0.375\text{[in]} = \mathbf{1.59}\text{[in2]}$ Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000\text{[lb/in2]}*1.59\text{[in2]} = \mathbf{27.73}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	29.78	15.00	DL	0.50	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2
$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*$
$0.875\text{[in]})*0.375\text{[in]} = \mathbf{0.398}\text{[in2]}$ Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5\text{[in]} + (2 - 1)*3\text{[in]})*0.375\text{[in]} = \mathbf{1.69}\text{[in2]}$ Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5\text{[in]} + (2 - 1)*(3\text{[in]} - 0.875\text{[in]}) -$
$0.875\text{[in]}/2)*0.375\text{[in]} = \mathbf{1.2}\text{[in2]}$ Sec. J4-3
$IsStressUniform \rightarrow \mathbf{True}$
$U_{bs} = 1$ Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000\text{[lb/in2]}*1.2\text{[in2]} + 1*58000\text{[lb/in2]}*0.398\text{[in2]}, 0.6*36000\text{[lb/in2]}*1.69\text{[in2]} + 1*58000\text{[lb/in2]}*0.398\text{[in2]}) = \mathbf{29.78}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71\text{[kip/in]}*1*4*6\text{[in]} = \mathbf{44.55}\text{[kip]}$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	23.40	15.00	DL	0.64	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45\text{[in]} - 0.813\text{[in]}/2) = \mathbf{4.04}\text{[in]}$ Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*4.04\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(2 - 1))*0.2\text{[in]}*$
$65000\text{[lb/in2]}*1 = \mathbf{23.4}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	47.60	15.00	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 11.9\text{[in]}*0.2\text{[in]} = \mathbf{2.38}\text{[in2]}$ Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*2.38\text{[in2]} = \mathbf{47.6}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	299.52	30.00	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.64$[in] = **24.96**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15$[kip]$/(0.5*3.71$[kip/in]$*1*6$[in]$) =$ **1.35** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.35/16$ [in] = **2.5**[kip/in] p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 4:32 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-25**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.29	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 0[in]) - \max(0.735[in], 0[in]) =$ **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75[in]/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23$[in]$, 12$ [in]$) =$ **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	3.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1 =$ **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] Eq. J3-6

Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] Eq. J4-3

Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*0.875[in] = **6.38**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.38[in]*0.375[in] = **2.39**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] Eq. J4-4

Block shear	[Kip]	41.93	15.00	DL	0.36	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.82	0.29	DL	0.01	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*
0.375[in]*58000[lb/in2]*3 = **42.82**[kip] Eq. J3-6

Tension yielding	[Kip]	72.75	0.29	DL	0.00	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*36000[lb/in2]*3.38[in2] = **72.75**[kip] Eq. J4-1

Tension rupture	[Kip]	69.33	0.29	DL	0.00	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9[in] - 3*0.875[in])*0.375[in] = **2.39**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.38[in2], 2.39[in2]) = **2.39**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*2.39$[in2]$ =$ **69.33**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.37	0.29	DL	0.00	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5$[in] $+ (1 - 1)*3$[in]$)*0.375$[in] $=$ **1.13**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5$[in] $+ (1 - 1)*3$[in] $- 0.875$[in]$*(1 - 0.5))*0.375$[in] $=$ **0.797**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] $- 0.875$[in]$)*(3 - 1)*0.375$[in] $=$ **1.59**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*0.797$[in2]$ + 1*58000$[lb/in2]$*1.59$[in2]$, 0.6*36000$[lb/in2]$*1.13$[in2]$ + 1*58000$[lb/in2]$*1.59$[in2]$) =$ **58.37**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.91	15.00	DL	0.22	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.72$[kip/in]$*1*4*9$[in] $=$ **66.91**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	15.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.85$[in] $- 0.813$[in]$/2) =$ **3.45**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.45$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$
0.23[in]$*65000$[lb/in2]$*1 =$ **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	15.00	DL	0.24	Eq. J4-3

$A_g = L_p*t_p = 13.7$[in]$*0.23$[in] $=$ **3.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.15$[in2] $=$ **63.02**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	40.37	0.29	DL	0.01	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.26$[in] $- 0.813$[in]$/2) =$ **1.85**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.85$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(1 - 1))*$
0.23[in]$*65000$[lb/in2]$*3 =$ **40.37**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	194.31	0.29	DL	0.00	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*6.49$[in2] $=$ **194.31**[kip] Eq. D2-1

Tension rupture	[Kip]	147.50	0.29	DL	0.00	Eq. J4-2

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 6.49$[in2]$ - 3*0.23$[in]$*0.875$[in] $=$ **5.89**[in2] Sec. D3-2

$U = 1 - x/l = 1 - 0.687\text{[in]}/3\text{[in]} = \mathbf{0.771}$ Table D3.1

$A_e = U*A_n = 0.771*5.89\text{[in2]} = \mathbf{4.54}\text{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*4.54\text{[in2]} = \mathbf{147.5}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	47.37	0.29	DL	0.01	Eq. J4-5

$dh_h = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.26\text{[in]} + (1 - 1)*3\text{[in]})*0.23\text{[in]} = \mathbf{1.04}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.26\text{[in]} + (1 - 1)*3\text{[in]} - 0.875\text{[in]}*(1 - 0.5))*0.23\text{[in]} = \mathbf{0.839}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 0.875\text{[in]})*(3 - 1)*0.23\text{[in]} = \mathbf{0.978}\text{[in2]}$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000\text{[lb/in2]}*0.839\text{[in2]} + 1*65000\text{[lb/in2]}*0.978\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.04\text{[in2]} + 1*65000\text{[lb/in2]}*0.978\text{[in2]}) = \mathbf{47.37}\text{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	283.14	19.97	DL	0.07	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.605\text{[in]} = \mathbf{23.6}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15\text{[kip]}/(0.5*3.72\text{[kip/in]}*1*9\text{[in]}) = \mathbf{0.897}$ tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ \text{[in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.897/16\ \text{[in]} = \mathbf{1.66}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

g: Transversal gage between bolts

HasWeldsOnBothSides: Has welds on both sides

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

n_h: Holes number

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U: Shear lag factor

U_{bs}: Stress index

w_{min}: Minimum weld size required

x: Connection eccentricity

Current Date: 2016-05-25 4:33 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C WEB22.cnx\

Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-03-26**

Family: Beam - Column web (BCW)
Type: Single plate
Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 0[in]) - max(0.735[in], 0[in]) = **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23$[in], 12 [in]$) =$ **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.44	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.105 =$ **1.79**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	3.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.45	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1 =$ **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] Eq. J3-6

Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] Eq. J4-3

Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*0.875[in] = **6.38**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.38[in]*0.375[in] = **2.39**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] Eq. J4-4

Block shear	[Kip]	41.93	15.00	DL	0.36	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	15.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3.85[in] - 0.813[in]/2) = **3.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*3.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.23[in]*65000[lb/in2]*1 = **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	15.00	DL	0.24	Eq. J4-3

A_g = L_p*t_p = 13.7[in]*0.23[in] = **3.15**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.15[in2] = **63.02**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	135.72	20.00	DL	0.15	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.29$[in] = **11.31**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **0.898** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.898/16$ [in] = **1.67**[kip/in] p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}:Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 4:37 PM

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\B2C Flange1.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-27**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W16x26

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	7.10	14.21	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 0[in]) - max(0.747[in], 0[in]) = **14.21**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25$[in]$, 12$ [in]$) =$ **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.44	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.105 =$ **1.79**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	4.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.45	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1 =$ **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] Eq. J3-6

Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] Eq. J4-3

Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*0.875[in] = **6.38**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.38[in]*0.375[in] = **2.39**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] Eq. J4-4

Block shear	[Kip]	40.91	15.00	DL	0.37	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.06[in])*0.375[in] = **0.363**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.363[in2]) = **40.91**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	43.88	15.00	DL	0.34	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.85[in] - 0.813[in]/2) = **4.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*4.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.25[in]*65000[lb/in2]*1 = **43.88**[kip] Eq. J3-6

Shear yielding	[Kip]	78.50	15.00	DL	0.19	Eq. J4-3

A_g = L_p*t_p = 15.7[in]*0.25[in] = **3.93**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.93[in2] = **78.5**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	299.52	20.00	DL	0.07	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.64$[in] = **24.96**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **0.898** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.898/16$ [in] = **1.67**[kip/in] p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}:Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

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Steel connections

Results

Connection name : **SP BCW**
Connection ID : **SC-03-28**

Family: Beam - Column web (BCW)

Type: Single plate

Description: W16x26

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	7.10	14.21	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 0[in]) - max(0.747[in], 0[in]) = **14.21**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25$[in]$, 12$ [in]$) =$ **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.44	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.105 =$ **1.79**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	4.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.45	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1 =$ **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.375[in]*58000[lb/in2]*1 = **53.42**[kip] Eq. J3-6

Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip] Eq. J4-3

Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*0.875[in] = **6.38**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.38[in]*0.375[in] = **2.39**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip] Eq. J4-4

Block shear	[Kip]	41.93	20.00	DL	0.48	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **1.99**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	43.88	20.00	DL	0.46	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.85[in] - 0.813[in]/2) = **4.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*4.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*
0.25[in]*65000[lb/in2]*1 = **43.88**[kip] Eq. J3-6

Shear yielding	[Kip]	78.50	20.00	DL	0.25	Eq. J4-3

A_g = L_p*t_p = 15.7[in]*0.25[in] = **3.93**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.93[in2] = **78.5**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	159.12	26.67	DL	0.17	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.34$[in] = **13.26**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **1.2** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.2/16$ [in] = **2.22**[kip/in] p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}:Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 3:59 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\L3 W36 beams connection.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-29**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W 36X150

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	77.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	30.50	16.26	32.52	✔	p. 10-104
$L_{min} = T/2 = 32.52$[in]$/2 =$ **16.26**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 35.9[in] - max(1.69[in], 0[in]) - max(1.69[in], 0[in]) = **32.52**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4,

						J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in], 12 [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.45	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	143.43	77.00	DL	0.54	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (10>=10) and (10<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*0.85*64$[kip]$*1*1 =$ **14.34**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 10*14.34$[kip]$*1 =$ **143.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	363.80	77.00	DL	0.21	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) =$ **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(10 - 1))*0.5$[in]$*$ 65000[lb/in2]$*1 =$ **363.8**[kip]						Eq. J3-6

Shear yielding	[Kip]	305.00	77.00	DL	0.25	Eq. J4-3
$A_g = L_p*t_p$ = 30.5[in]*0.5[in] = **15.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*15.25[in2] = **305**[kip]						Eq. J4-3
Shear rupture	[Kip]	187.69	77.00	DL	0.41	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 30.5[in] - 10*1.13[in] = **19.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 19.25[in]*0.5[in] = **9.63**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*9.63[in2] = **187.69**[kip]						Eq. J4-4
Block shear	[Kip]	197.44	77.00	DL	0.39	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.31[in] + 1/16 [in] = **1.38**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.38[in])*0.5[in] = **0.656**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (10 - 1)*3[in])*0.5[in] = **14.38**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (10 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **9.03**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*9.03[in2] + 1*65000[lb/in2]*0.656[in2], 0.6*50000[lb/in2]*14.38[in2] + 1* 65000[lb/in2]*0.656[in2]) = **197.44**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	283.06	77.00	DL	0.27	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*5*30.5[in] = **283.06**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	473.79	77.00	DL	0.16	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 4.45[in] - 1.06[in]/2) = **3.92**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*3.92[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(10 - 1))*0.625[in]* 65000[lb/in2]*1 = **473.79**[kip]						Eq. J3-6
Shear yielding	[Kip]	448.75	77.00	DL	0.17	Eq. J4-3
$A_g = L_p*t_p$ = 35.9[in]*0.625[in] = **22.44**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*22.44[in2] = **448.75**[kip]						Eq. J4-3

Support

Welds rupture	[Kip/ft]	332.28	30.30	DL	0.09	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 77[kip]/(0.5*3.71[kip/in]*1*30.5[in]) = **1.36**						tables 8-4..11
HasWeldsOnBothSides → **False**						

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.36/16 [in] = **2.52**[kip/in] p. 9-5

Global critical strength ratio **0.54**

NOTATION

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

h_{sc}: Hole factor

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

k_s: Slip resistance factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 4:00 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\L3 W36 beams connection.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-30**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W 36X170

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	160.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	30.50	16.25	32.50	✔	p. 10-104
$L_{min} = T/2 = 32.5[in]/2 = \mathbf{16.25}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 36.2[in] - \max(1.85[in], 0[in]) - \max(1.85[in], 0[in]) = \mathbf{32.5}[in]$						p. 10-49
Thickness	[in]	0.50	--	1.08	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*142.85[in] = \mathbf{700.88}[kip*ft]$						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*700.88[kip*ft])/(50000[lb/in2]*30.5[in]^2) = \mathbf{1.08}[in]$						p. 10-103

Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in], 12 [in]$) =$ **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in], 12 [in]$) =$ **12**[in]						Sec. J3.5
Eccentricity	[in]	5.00	4.50	--	✔	
Min. eb=4.5 [in]						
Beam						
Vertical edge distance	[in]	4.60	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	237.08	160.00	DL	0.67	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (10>=10) and (10<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5

$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*0.85*64$[kip]$*1*1 =$
14.34[kip] Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 16.53*14.34$[kip]$*1 =$ **237.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	601.32	160.00	DL	0.27	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) =$ **1.22**[in] Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(16.53/(2*10))*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*$
1[in]$)*(10 - 1))*0.5$[in]$*65000$[lb/in2]$*2 =$ **601.32**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	305.00	160.00	DL	0.52	Eq. J4-3

$A_g = L_p*t_p = 30.5$[in]$*0.5$[in]$ =$ **15.25**[in2] Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*15.25$[in2]$ =$ **305**[kip] Eq. J4-3

Shear rupture	[Kip]	187.69	160.00	DL	0.85	Eq. J4-4

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ =$ **1.13**[in] Sec. D3-2
$L_e = L - n*L_h = 30.5$[in]$ - 10*1.13$[in]$ =$ **19.25**[in] DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 19.25$[in]$*0.5$[in]$ =$ **9.63**[in2] Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*9.63$[in2]$ =$ **187.69**[kip] Eq. J4-4

Block shear	[Kip]	199.98	160.00	DL	0.80	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1.31$[in]$ + 1/16$ [in]$ =$ **1.38**[in] Sec. D3-2
$dh_v = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ =$ **1.13**[in] Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*$
1.38[in]$)*0.5$[in]$ =$ **1.47**[in2] Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in]$ + (10 - 1)*3$[in]$)*0.5$[in]$ =$ **14.38**[in2] Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75$[in]$ + (10 - 1)*(3$[in]$ - 1.13$[in]$) -$
1.13[in]$/2)*0.5$[in]$ =$ **9.03**[in2] Sec. J4-3
IsStressUniform → **False**
$U_{bs} = 0.5$ Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*9.03$[in2]$ + 0.5*65000$[lb/in2]$*1.47$[in2]$, 0.6*50000$[lb/in2]$*14.38$[in2]$ + 0.5*$
65000[lb/in2]$*1.47$[in2]$) =$ **199.98**[kip] Eq. J4-5

Flexural rupture	[Kip]	814.67	160.00	DL	0.20	p. 9-6

$L_h = d_h + 1/16$ [in]$ = 1.06$[in]$ + 1/16$ [in]$ =$ **1.13**[in] Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5$[in]$/4*(30.5$[in]$^2 - 3$[in]$^2*10*(10^2 -$
$1)*1.13$[in]$/30.5$[in]$) =$ **75.2**[in3] 4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*75.2$[in3]$/3$[in]$ =$ **814.67**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	283.06	160.00	DL	0.57	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*5*30.5$[in]$ =$ **283.06**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	230.57	40.00	DL	0.17	p. 10-103

$A_g = L_p * t_p = 30.5\text{[in]} * 0.5\text{[in]} = \mathbf{15.25}\text{[in2]}$ Sec. D3-1

$f_v = V/A_g = 160\text{[kip]}/15.25\text{[in2]} = \mathbf{10491.8}\text{[lb/in2]}$ p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000\text{[lb/in2]})^2 - 3*10491.8\text{[lb/in2]}^2))^{1/2} = \mathbf{23794.47}\text{[lb/in2]}$ p. 10-103

$Z_x = t_p * L^2/4 = 0.5\text{[in]} * 30.5\text{[in]}^2/4 = \mathbf{116.28}\text{[in3]}$ T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr} * Z = 23794.47\text{[lb/in2]} * 116.28\text{[in3]} = \mathbf{230.57}\text{[kip*ft]}$ p. 10-103

Beam

Bolt bearing under shear load	[Kip]	852.04	160.00	DL	0.19	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.6\text{[in]} - 1.06\text{[in]}/2) = \mathbf{4.07}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(16.53/(2*10))*(\min(1.2*4.07\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(10 - 1))*0.68\text{[in]}*65000\text{[lb/in2]}*2 = \mathbf{852.04}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	492.32	160.00	DL	0.32	Eq. J4-3

$A_g = L_p * t_p = 36.2\text{[in]} * 0.68\text{[in]} = \mathbf{24.62}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*24.62\text{[in2]} = \mathbf{492.32}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	332.28	62.95	DL	0.19	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.71\text{[in]} = \mathbf{27.69}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 160\text{[kip]}/(0.5*3.71\text{[kip/in]}*1*30.5\text{[in]}) = \mathbf{2.83}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*2.83/16\text{ [in]} = \mathbf{5.25}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.85**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_y: Specified minimum yield stress

h_o: Reduced beam depth

h_{sc}: Hole factor

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

k_s: Slip resistance factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L: Length of weld

λ: Slenderness

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t_{max}: Maximum thickness

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 4:01 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\L3 W36 beams connection.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-31**

Family: Beam - Column flange (BCF)

Type: Single plate

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	75.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	29.50	16.25	32.50	✔	p. 10-104
$L_{min} = T/2 = 32.5$[in]$/2 =$ **16.25**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 36.2[in] - max(1.85[in], 0[in]) - max(1.85[in], 0[in]) = **32.5**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.25	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in] — p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in], 12 [in]$) =$ **9**[in] — Sec. J3.5

Beam

Vertical edge distance	[in]	4.60	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in] — p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** — p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	106.08	75.00	DL	0.71	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (10>=10) and (10<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 10*10.61$[kip]$*1 =$ **106.08**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	187.19	75.00	DL	0.40	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

$F_u*n_c = 0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4*0.75[in]$)*(10 - 1))*$

0.375[in]$*58000$[lb/in2]$*1 =$ **187.19**[kip] — Eq. J3-6

Shear yielding	[Kip]	159.30	75.00	DL	0.47	Eq. J4-3

$A_g = L_p*t_p = 29.5$[in]$*0.375$[in] = **11.06**[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*11.06$[in2] = **159.3**[kip] Eq. J4-3

Shear rupture	[Kip]	135.39	75.00	DL	0.55	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$L_e = L - n*L_h = 29.5$[in] $- 10*0.875$[in] $=$ **20.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 20.75$[in]$*0.375$[in] $=$ **7.78**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*7.78$[in2] = **135.39**[kip] Eq. J4-4

Block shear	[Kip]	124.95	75.00	DL	0.60	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] $=$ **1.06**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 1.06[in]$)*0.375$[in] $=$ **0.363**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (10 - 1)*3$[in]$)*0.375$[in] $=$ **10.59**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (10 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] $=$ **7.48**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*7.48$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*10.59$[in2] $+ 1*$ 58000[lb/in2]$*0.363$[in2]$) =$ **124.95**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	219.03	75.00	DL	0.34	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*29.5$[in] $=$ **219.03**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	397.80	75.00	DL	0.19	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.6$[in] $- 0.813$[in]$/2) =$ **4.19**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*4.19$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(10 - 1))*$ 0.68[in]$*65000$[lb/in2]$*1 =$ **397.8**[kip] Eq. J3-6

Shear yielding	[Kip]	492.32	75.00	DL	0.15	Eq. J4-3

$A_g = L_p*t_p = 36.2$[in]$*0.68$[in] $=$ **24.62**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*24.62$[in2] = **492.32**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	343.98	30.51	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.735$[in] $=$ **28.67**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 75$[kip]$/(0.5*3.71$[kip/in]$*1*29.5$[in]$) =$ **1.37** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.37/16$ [in] $=$ **2.54**[kip/in] p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

Current Date: 2016-05-25 4:02 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-03 Beam to HSS_PIPE_W Column Shear Tab Design\L3 W36 beams connection.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-03-32**

Family: Beam - Column flange (BCF)

Type: Single plate

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	30.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	11.50	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 0[in]) - max(0.735[in], 0[in]) = **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.25	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in] — p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23$[in], 12 [in]$) =$ **5.52**[in] — Sec. J3.5

Beam

Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in] — p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** — p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1 =$ **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	69.74	30.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*0.844$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1 =$ **69.74**[kip]						Eq. J3-6
Shear yielding	[Kip]	62.10	30.00	DL	0.48	Eq. J4-3
$A_g = L_p*t_p = 11.5$[in]$*0.375$[in] = **4.31**[in2]						Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.31$[in2] = **62.1**[kip] Eq. J4-3

Shear rupture	[Kip]	52.20	30.00	DL	0.57	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h = 11.5$[in] $- 4*0.875$[in] = **8**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8$[in]$*0.375$[in] = **3**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3$[in2] = **52.2**[kip] Eq. J4-4

Block shear	[Kip]	53.07	30.00	DL	0.57	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.398**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (4 - 1)*3$[in]$)*0.375$[in] = **3.84**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (4 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.7**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*58000$[lb/in2]$*2.7$[in2] $+ 1*58000$[lb/in2]$*0.398$[in2]$, 0.6*36000$[lb/in2]$*3.84$[in2] $+ 1*58000$[lb/in2]$*0.398$[in2]$) =$ **53.07**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	85.38	30.00	DL	0.35	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*11.5$[in] = **85.38**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	53.82	30.00	DL	0.56	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2) =$ **1.94**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1 =$ **53.82**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	30.00	DL	0.48	Eq. J4-3

$A_g = L_p*t_p = 13.7$[in]$*0.23$[in] = **3.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.15$[in2] = **63.02**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	343.98	31.30	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.735$[in] = **28.67**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 30$[kip]$/(0.5*3.71$[kip/in]$*1*11.5$[in]$) =$ **1.41** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.41/16$ [in] = **2.61**[kip/in] p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

SC-04 BEAM TO EMBED. PLATE DOUBLE ANGLE CONNECTION (Weld to Support, Bolted to Beam)

Connection ID	Beam Size	Design Reaction (kip) "R"	Double Angle Size**	Min No Of Bolts	3/4" Dia. A325N Bolt Rows	Bolt Spacing (inch) "Spa."	Beam Side Bolt Edge Distance (inch)		Weld Size to Embed Plate* (inch) "w"
							Vertical "Lev"	Horizontal "Leh"	
SC-04-1	W8x18	15	(2)L4x4x1/2	2	2	3	1.25	1.25	5/16"
SC-04-2	W10x17	15	(2)L4x4x5/16	2	3	3	1.25	1.25	1/4"
SC-04-3	W12x19	10	(2)L4x4x5/16	3	3	3	1.25	1.25	1/4"
SC-04-4	W12x26	30	(2)L4x4x5/16	3	3	3	1.25	1.25	1/4"
SC-04-5	W14x22	10	(2)L4x4x5/16	3	3	3	1.25	1.25	1/4"
SC-04-6	W14x22	30	(2)L4x4x5/16	3	4	3	1.25	1.25	1/4"
SC-04-7	W16x26	30	(2)L4x4x5/16	4	4	3	1.25	1.25	1/4"
SC-04-8	W16x31	25	(2)L4x4x5/16	4	4	3	1.25	1.25	1/4"
SC-04-9	W18x35	35	(2)L4x4x5/16	5	4	3	1.25	1.25	1/4"
SC-04-10	W18x40	45	(2)L4x4x5/16	5	5	3	1.25	1.25	1/4"
SC-04-11	W18x65	85	(2)L4x4x1/2	5	5	3	1.25	1.25	5/16"
SC-04-12	W21x44	45	(2)L4x4x5/16	6	5	3	1.25	1.25	1/4"
SC-04-13	W24x55	50	(2)L4x4x5/16	7	6	3	1.25	1.25	1/4"
SC-04-14	W18x60	85	(2)L4x4x1/2	5	5	3	1.25	1.25	5/16"

Short Slotted Hole on web angles against beam web.

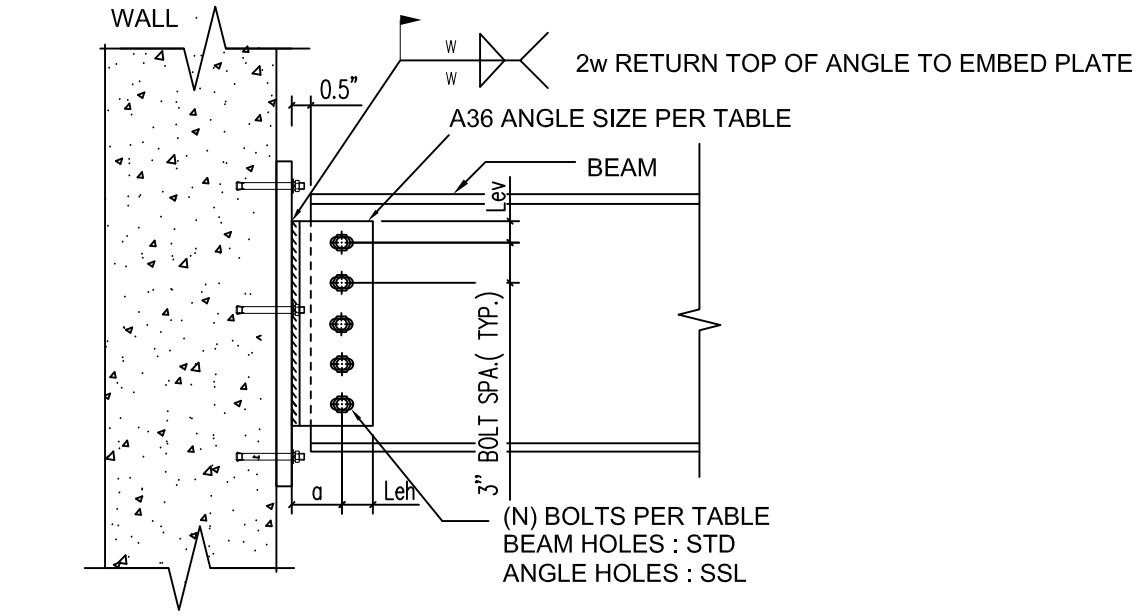
*Weld turn to top of angle (length= 2w)

SC-04a BEAM TO EMBED. PLATE Via SHEAR TAB CONNECTION

Connection ID	Beam Size	Design Reaction (kip) "R"	SKEW (Degree) "β"	Single Plate (A36 Steel)				Bolt Size and Grade	Bolt Row x Col.	Bolt Spacing (inch) "Spa."	Distance between Weld to Bolts (inch) "a"
				Plate Size (inch) "t_p"	Plate weld size to support Column (inch) "w"	Bolt edge distance					
						Vertical "L_{ev}" (inch)	Horizontal "L_{eh}" (inch)				
SC-04-15	W14X22	⩽15	6	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-04-16	W16X26	⩽35	26	3/8"	1/4"	1.5	1.5	3/4" A325N	4x1	3	3
SC-04-17	W16X31	⩽20	1.6	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3
SC-04-18	W12X19	⩽10	38	3/8"	1/4"	1.5	1.5	3/4" A325N	3x1	3	3

*Short Slotted Hole on Shear Tab

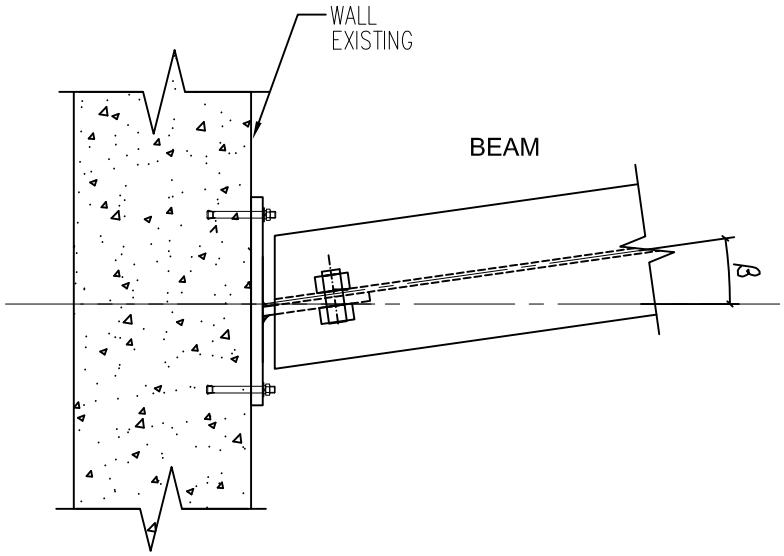
SC-04 Beam to Embed. Plate Double Angle Shear Connection



Wall and embedded plate for illustration ONLY

SC-04a

Beam to Embed. Plate via Shear Tab w. Skewed Angle



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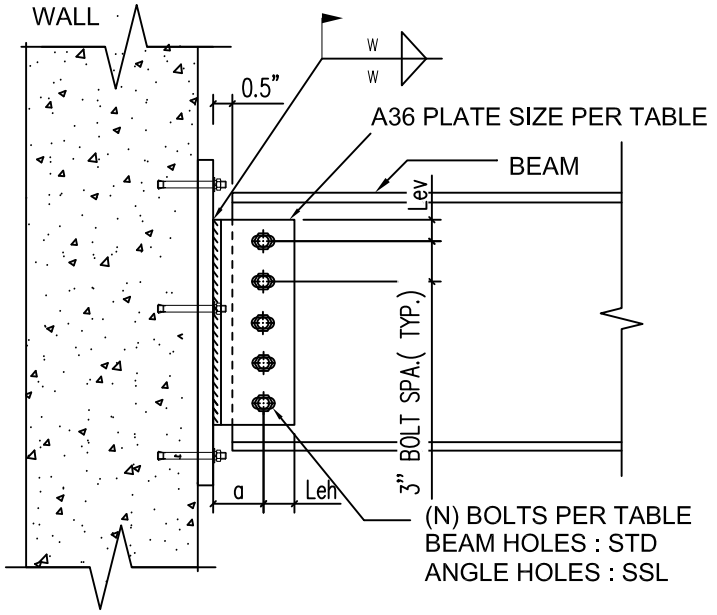


Wall and embedded plate for illustration ONLY

A—A

Current Date: 2016-05-25 3:03 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-04 Beam to Embed Plate Double Angle Weld_Bolt Shear Connection\B2W2.cnx\

Steel connections

Results

Connection name : **DA BCF Weld support Bolt beam**
Connection ID : **SC-04-14**

Family: Beam - Column flange (BCF)

Type: Angle(s)

Description: W18x60

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	85.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	8.00	16.00	✔	p. 10-8
$L_{min} = T/2 = 16[in]/2 = \mathbf{8}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18.2[in] - \max(1.1[in], 0[in]) - \max(1.1[in], 0[in]) = \mathbf{16}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.96	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]) = min(24*0.415[in], 12 [in]) = **9.96**[in]						Sec. J3.5
Thickness	[in]	0.50	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Weld size	[1/16in]	5	3	7	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} =$ **0.0156**						table J2.4
t_p<1/4 [in] → 0.5[in]<1/4 [in] → **False**						
$w_{max} = t_p$ - 1/16 [in] = 0.5[in] - 1/16 [in] = **0.0365**						Sec. J2.2b
Beam						
Horizontal edge distance	[in]	2.37	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	85.00	DL	0.80	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]) = **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	238.16	85.00	DL	0.36	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(5 - 1))*0.5[in]*58000[lb/in2]*1) = **238.16**[kip]						Eq. J3-6
Shear yielding	[Kip]	208.80	85.00	DL	0.41	Eq. J4-3

$A_g = L_p * t_p = 14.5\text{[in]} * 0.5\text{[in]} = \mathbf{7.25}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_y * A_g) = 2 * (0.667 * 0.60 * 36000\text{[lb/in2]} * 7.25\text{[in2]}) = \mathbf{208.8}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	176.18	85.00	DL	0.48	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n * L_h = 14.5\text{[in]} - 5 * 0.875\text{[in]} = \mathbf{10.13}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 10.13\text{[in]} * 0.5\text{[in]} = \mathbf{5.06}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5 * 0.60 * 58000\text{[lb/in2]} * 5.06\text{[in2]}) = \mathbf{176.18}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	160.46	85.00	DL	0.53	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1\text{[in]} + 1/16\text{ [in]} = \mathbf{1.06}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p = (1.13\text{[in]} + (1 - 1) * 3\text{[in]} - (1 - 0.5) * 1.06\text{[in]}) * 0.5\text{[in]} = \mathbf{0.299}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1) * s) * t_p = (1.25\text{[in]} + (5 - 1) * 3\text{[in]}) * 0.5\text{[in]} = \mathbf{6.63}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p = (1.25\text{[in]} + (5 - 1) * (3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2) * 0.5\text{[in]} = \mathbf{4.66}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})) = 2 * (0.5 * \min(0.6 * 58000\text{[lb/in2]} * 4.66\text{[in2]} + 1 * 58000\text{[lb/in2]} * 0.299\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 6.63\text{[in2]} + 1 * 58000\text{[lb/in2]} * 0.299\text{[in2]})) = \mathbf{160.46}\text{[kip]}$ Eq. J4-5

Angle (Support side)

Weld capacity	[Kip]	95.48	85.00	DL	0.89	p. 10-11

$(1/\Omega)R_n = (1/\Omega) * 2 * 0.6 * F_{EXX} * (2)^{1/2}/2 * D/16\text{ [in]} * L/(1 + 12.96 * e^2/L^2)^{1/2} = 0.5 * 2 * 0.6 * 70000\text{[lb/in2]} * (2)^{1/2}/2 * 5/16\text{ [in]} * 14.5\text{[in]}/(1 + 12.96 * 4\text{[in]}^2/14.5\text{[in]}^2)^{1/2} = \mathbf{95.48}\text{[kip]}$ p. 10-11

Shear yielding	[Kip]	208.80	85.00	DL	0.41	Eq. J4-3

$A_g = L_p * t_p = 14.5\text{[in]} * 0.5\text{[in]} = \mathbf{7.25}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_y * A_g) = 2 * (0.667 * 0.60 * 36000\text{[lb/in2]} * 7.25\text{[in2]}) = \mathbf{208.8}\text{[kip]}$ Eq. J4-3

Beam

Bolt bearing under shear load	[Kip]	121.39	85.00	DL	0.70	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.1\text{[in]} - 0.813\text{[in]}/2) = \mathbf{2.69}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 2.69\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 2.19\text{[in]}, 2.4 * 0.75\text{[in]}) * (5 - 1)) * 0.415\text{[in]} * 65000\text{[lb/in2]} * 1 = \mathbf{121.39}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	151.06	85.00	DL	0.56	Eq. J4-3

$A_g = L_p * t_p = 18.2\text{[in]} * 0.415\text{[in]} = \mathbf{7.55}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000\text{[lb/in2]} * 7.55\text{[in2]} = \mathbf{151.06}\text{[kip]}$ Eq. J4-3

Support

Welds rupture	[Kip/ft]	136.19	99.14	DL	0.73	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.291$[in] = **11.35**[kip/in] p. 9-5

$D_{min} = P*(1 + 12.96*e^2/L^2)^{1/2}*16/(1$ [in]$)/((1/\Omega)*2*0.6*F_{EXX}*(2)^{1/2}/2*L) = 85$[kip]$*(1 +$
$12.96*4$[in]$^2/14.5$[in]$^2)^{1/2}*16/(1$ [in]$)/(0.5*2*0.6*70000$[lb/in2]$*(2)^{1/2}/2*14.5$[in]$) =$ **4.45** p. 10-11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*4.45/16$ [in] = **8.26**[kip/in] p. 9-5

Global critical strength ratio **0.89**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C: Bolt group coefficient

C_2: Edge distance increment

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D: Uniform force method factor

ΔV: Arbitrary shear

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Width of the leg of the connection angle attached to the support

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

K: Uniform force method factor

K': Uniform force method factor

L: Length

L: Angle length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

$tan\theta$: Tangent of the brace with the vertical angle

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{max}: Maximum weld size required

w_{min}: Minimum weld size required

Current Date: 2016-05-25 3:06 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-04 Beam to Embed Plate Double Angle Weld_Bolt Shear Connection\B2W SP.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-04-15**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W14x22

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 0[in]) - \max(0.735[in], 0[in]) =$ **12.23**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75[in]/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$ Sec. J3.3

$IsCorrosionConsidered \rightarrow \mathbf{False}$

$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$ Sec. J3.5

Beam

Thickness	[in]	0.23	--	0.44	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.105 = \mathbf{1.79}[in]$ p. 10-151

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

Vertical edge distance	[in]	3.85	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	2.45	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2

$F_{ymax} = 52\ [ksi]$ Sec. K1.2

Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2

$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$ Sec. K1.2

$(F_y/F_u)_{max} = 0.80$ Sec. K1.2

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

Thickness	[in]	0.58	0.24	--	✔	Sec. B4.2, p. 10-158

$b = B - 2*1.5*t = 10[in] - 2*1.5*0.581[in] = \mathbf{8.26}[in]$ Sec. B4.2

$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (8.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.245}[in]$ p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	15.00	DL	0.36	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	15.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.85$[in] $- 0.813$[in]$/2) =$ **3.44**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

$F_u*n_c = 0.5*(\min(1.2*3.44$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$

0.23[in]$*65000$[lb/in2]$*1 =$ **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	15.00	DL	0.24	Eq. J4-3

$A_g = L_p*t_p = 13.7$[in]$*0.23$[in] = **3.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.15$[in2] = **63.02**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	20.00	DL	0.07	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.581$[in] = **22.66**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **0.898** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.898/16$ [in] = **1.67**[kip/in] p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}: Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 3:08 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-04 Beam to Embed Plate Double Angle Weld_Bolt Shear Connection\B2W SP.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-04-16**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W16x26

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	12.00	7.10	14.21	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 0[in]) - max(0.747[in], 0[in]) = **14.21**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.25[in], 12\ [in]) = \mathbf{6}[in]$						Sec. J3.5

Beam

Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.438 = \mathbf{0.428}[in]$						p. 10-151
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	3.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52\ [ksi]$						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.24	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 10[in] - 2*1.5*0.581[in] = \mathbf{8.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (8.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.245}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	35.00	DL	0.82	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 4*10.61[kip]*1 = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	35.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))* 0.375[in]*58000[lb/in2]*1 = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	35.00	DL	0.54	Eq. J4-3
$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	35.00	DL	0.63	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12[in] - 4*0.875[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.5[in]*0.375[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	35.00	DL	0.65	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/in2]*0.398[in2]) = **54.08**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	35.00	DL	0.39	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	58.50	35.00	DL	0.60	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.35$[in] $- 0.813$[in]$/2) =$ **2.94**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

$F_u*n_c = 0.5*(\min(1.2*2.94$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$

0.25[in]$*65000$[lb/in2]$*1 =$ **58.5**[kip] Eq. J3-6

Shear yielding	[Kip]	78.50	35.00	DL	0.45	Eq. J4-3

$A_g = L_p*t_p = 15.7$[in]$*0.25$[in] = **3.93**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.93$[in2] = **78.5**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	35.00	DL	0.13	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.581$[in] = **22.66**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 35$[kip]$/(0.5*3.71$[kip/in]$*1*12$[in]$) =$ **1.57** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.57/16$ [in] = **2.92**[kip/in] p. 9-5

Global critical strength ratio **0.82**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}: Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 3:07 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-04 Beam to Embed Plate Double Angle Weld_Bolt Shear Connection\B2W SP.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-04-17**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W16x31

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	7.11	14.22	✔	p. 10-104
$L_{min} = T/2 = 14.22[in]/2 =$ **7.11**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.9[in] - max(0.842[in], 0[in]) - max(0.842[in], 0[in]) = **14.22**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.60	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.275[in], 12\ [in]) = \mathbf{6.6}[in]$						Sec. J3.5

Beam

Thickness	[in]	0.28	--	0.44	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.0279 = \mathbf{6.72}[in]$						p. 10-151
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	4.95	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.49	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2
$F_{ymax} = 52\ [ksi]$						Sec. K1.2
Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2
$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$						Sec. K1.2
$(F_y/F_u)_{max} = 0.80$						Sec. K1.2
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101
Thickness	[in]	0.58	0.24	--	✔	Sec. B4.2, p. 10-158
$b = B - 2*1.5*t = 10[in] - 2*1.5*0.581[in] = \mathbf{8.26}[in]$						Sec. B4.2
$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (8.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.245}[in]$						p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	20.00	DL	0.48	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	48.26	20.00	DL	0.41	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.95\text{[in]} - 0.813\text{[in]}/2) = \mathbf{4.54}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*4.54\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*$
0.275[in]$*65000$[lb/in2]$*1 =$ **48.26**[kip] Eq. J3-6

Shear yielding	[Kip]	87.45	20.00	DL	0.23	Eq. J4-3

$A_g = L_p*t_p = 15.9$[in]$*0.275$[in] = **4.37**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*4.37$[in2] = **87.45**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	26.67	DL	0.10	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.581$[in] = **22.66**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **1.2** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.2/16$ [in] = **2.22**[kip/in] p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}: Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

Current Date: 2016-05-25 3:08 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\SC-04 Beam to Embed Plate Double Angle Weld_Bolt Shear Connection\B2W SP.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **SC-04-18**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W12x19

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	10.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	5.45	10.90	✔	p. 10-104
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 0[in]) - max(0.65[in], 0[in]) = **10.9**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Thickness, precludes a punching failure of the HSS...	[in]	0.38	--	1.05	✔	Eq. K1-10

$t_{pmax} = (F_{uc}*t)/F_{yp} = (65000[lb/in2]*0.581[in])/36000[lb/in2] = \mathbf{1.05}[in]$ Eq. K1-10

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$ Sec. J3.3

$IsCorrosionConsidered \rightarrow \mathbf{False}$

$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.235[in], 12\ [in]) = \mathbf{5.64}[in]$ Sec. J3.5

Beam

Thickness	[in]	0.24	--	0.30	✔	p. 10-151, p. 10-102

$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.616 = \mathbf{0.305}[in]$ p. 10-151

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$ p. 10-102

Vertical edge distance	[in]	3.10	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$ Tables J3.4, J3.5

Horizontal edge distance	[in]	2.11	1.50	--	✔	p. 10-102

$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$ p. 10-102

Support

Maximum value of the specified yield stress	[Lb/ft2]	7200000.00	--	7488000.00	✔	Sec. K1.2

$F_{ymax} = 52\ [ksi]$ Sec. K1.2

Yield stress to tensile stress ratio		0.77	--	0.80	✔	Sec. K1.2

$F_y/F_u = F_y/F_u = 50000[lb/in2]/65000[lb/in2] = \mathbf{0.769}$ Sec. K1.2

$(F_y/F_u)_{max} = 0.80$ Sec. K1.2

Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

Thickness	[in]	0.58	0.24	--	✔	Sec. B4.2, p. 10-158

$b = B - 2*1.5*t = 10[in] - 2*1.5*0.581[in] = \mathbf{8.26}[in]$ Sec. B4.2

$t_{max} = (b/1.40)*(F_y/E)^{0.5} = (8.26[in]/1.40)*(50000[lb/in2]/2.90E+07[lb/in2])^{0.5} = \mathbf{0.245}[in]$ p. 10-158

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	10.00	DL	0.31	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	10.00	DL	0.19	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	10.00	DL	0.21	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	10.00	DL	0.24	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	10.00	DL	0.24	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.363[in2]) = **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	10.00	DL	0.15	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	41.24	10.00	DL	0.24	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.1$[in]$ - 0.813$[in]$/2) =$ **2.69**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.69$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$
0.235[in]$*65000$[lb/in2]$*1 =$ **41.24**[kip] Eq. J3-6

Shear yielding	[Kip]	57.34	10.00	DL	0.17	Eq. J4-3

$A_g = L_p*t_p = 12.2$[in]$*0.235$[in]$ =$ **2.87**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.87$[in2] = **57.34**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	271.91	13.33	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.581$[in]$ =$ **22.66**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **0.599** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.599/16$ [in] $=$ **1.11**[kip/in] p. 9-5

Global critical strength ratio **0.31**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

B: Width of a rectangular HSS

b: Clear distance between the webs less the inside corner radius on each side

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

F_{uc}: Specified minimum tensile strength of the support

F_y: Specified minimum yield stress

F_{yp}: Specified minimum yield stress of plate

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t: The weld effective throat

t_{max}: Limit wall thickness for the HSS support

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

U_{bs}: Stress index

w_{min}: Minimum weld size required

F_{ymax}: Maximum value of the specified yield stress

F_y/F_u: Yield stress to tensile stress ratio

$(F_y/F_u)_{max}$: Yield stress to tensile stress limiting ratio

SC-05 Beam to Column Shear Connection with Axial Load

Location	Connection ID	Beam Size	Beam Web Thickness (inch)	Column Size		Design Reaction (kip)		Double Angle Size*	3/4" Dia. A325N Bolt Rows	Bolt Spacing (inch) "Spa."	Feature***	Bolt Gage on Column Flange** (inch) "Ga."	Beam Side Bolt Edge Distance (inch)		Column Side Bolt Edge Distance (inch)	
						Shear	Axial						Vertical "L_{evb}"	Horizontal "L_{ehb}"	Vertical "L_{evc}"	Horizontal "L_{ehc}"
B.3-2.6	SC-05-01	W12X14	3/16	W12X53	Flange	⩽10	±10	L4x4x3/8	3	3	DA	6	1.25	1.25	1.25	
D-7	SC-05-02	W12X14	3/16	W12X79	Web	⩽10	±20	L4x4x3/8	2	3	EST	-	1.25	1.25	1.25	
D-6	SC-05-03	W12X14	3/16	W12X87	Flange	⩽10	±26	L4x4x3/8	3	3	DA	6.125	1.25	1.25	1.25	
F.5-6	SC-05-04	W14X22	1/4	W10X49	Flange	≤12	±8	L4x4x5/16	3	3	DA	6	1.25	1.25	1.25	
B.3-2	SC-05-05	W16X26	1/4	W14X90	Web	⩽10	±10	L4x4x5/16	4	3	EST	-	1.25	1.25	1.25	
C-5	SC-05-06	W18x35	5/16	W12X72	Flange	⩽25	±15	L4x4x3/8	4	3	DA	6.125	1.25	1.25	1.25	
B.3-2	SC-05-07	W18X35	5/16	W14X90	Flange	⩽25	±20	L4x4x3/8	5	3	DA	6.125	1.25	1.25	1.25	≥1.125
D-7	SC-05-08	W18X35	5/16	W12X79	Web	⩽10	±20	L4x4x3/8	5	3	EST	-	1.25	1.25	1.25	
D-6	SC-05-09	W18X40	5/16	W12X87	Flange	⩽20	±26	L4x4x3/8	4	3	DA	6.125	1.25	1.25	1.25	
F-8	SC-05-10	W21X44	3/8	W12X65	Flange	⩽45	±7	L4x4x5/16	5	3	DA	6.125	1.25	1.25	1.25	
D-8	SC-05-11	W21X44	3/8	W12X65	Flange	⩽45	±15	L4x4x5/16	5	3	DA	6.125	1.25	1.25	1.25	
E-8	SC-05-12	W24X68	7/16	W12X87	Flange	⩽30	±15	L4x4x5/16	5	3	DA	6.25	1.25	1.25	1.25	
D-8	SC-05-13	W24X68	7/16	W12X65	Flange	⩽30	±15	L4x4x5/16	5	3	DA	6.25	1.25	1.25	1.25	

*Horizontal Short Slotted Hole on Angle Outstanding Legs against Support Column.

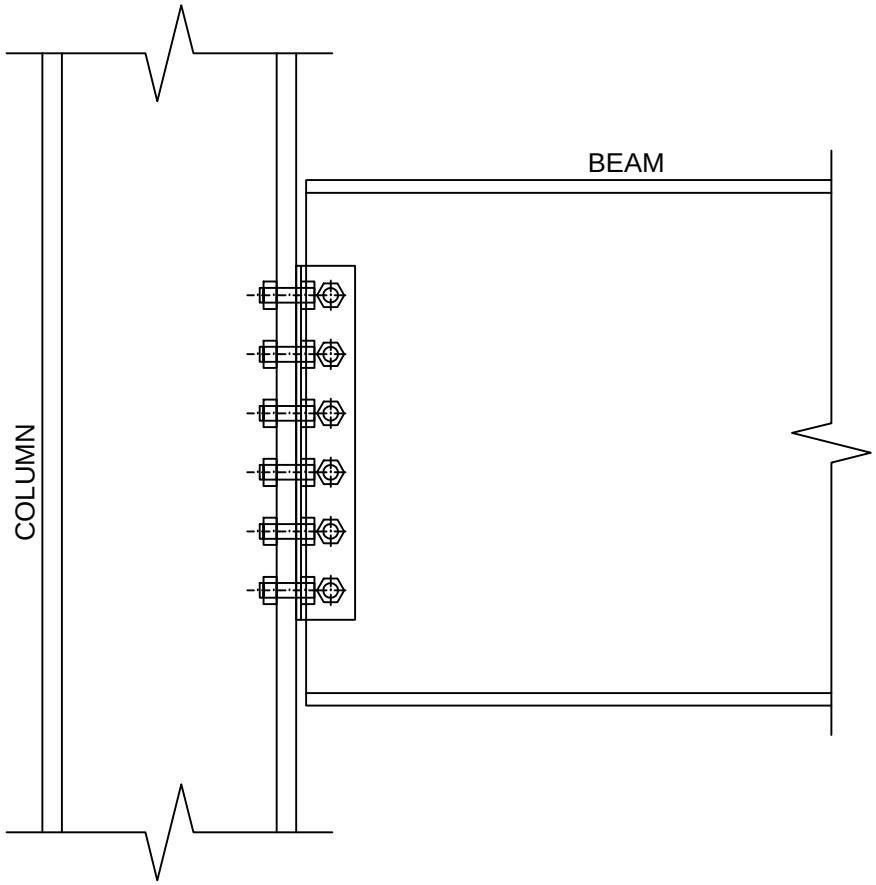
**Use L4X3 1/2x5/16 for column W10x33,W10x39,W10x45, and W12x40. Short angle legs against Column Flange. Bolt Gage =5". Use stagger bolt pattern P=1.75 inch. See SC-03 shear tab connection for connection detail if beam is not deep enough for stagger pattern.

Horizontal SSL on supporting angles against column flanges

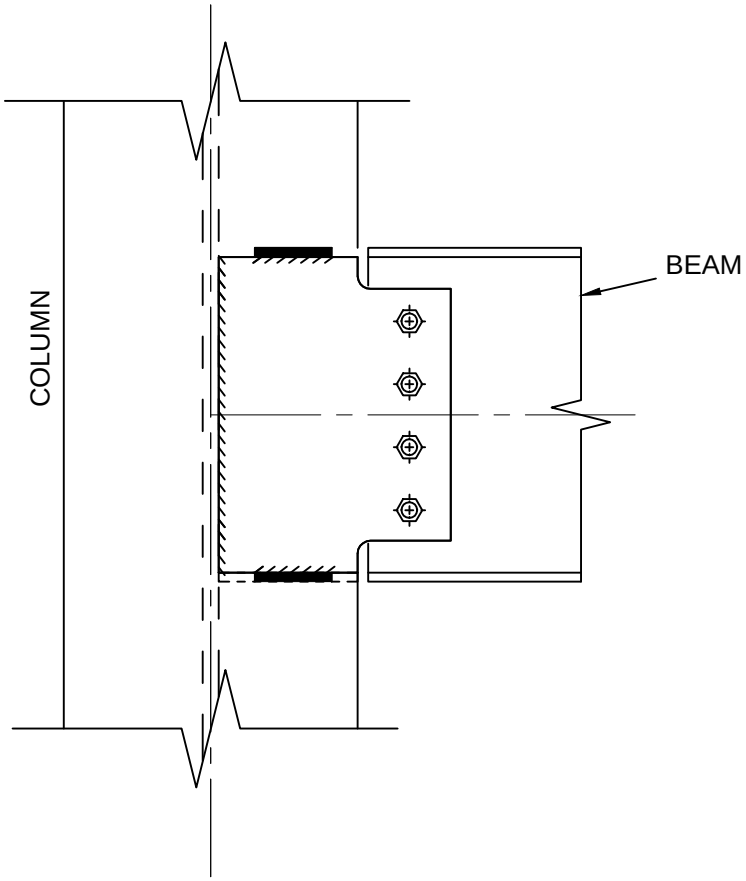
Location per structural drawings S400 & S401

***DA:Duble Angle; EST: Extended Shear Tab (per SC-02)

SC-05 Beam to Column Shear Connection with Axial Load



CONNECTION TO COLUMN FLANGE
(Refer to SC-01F)



CONNECTION TO COLUMN WEB
(Refer to SC-02)

Current Date: 2016-05-25 5:24 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA_BCF_
Connection ID : SC-05-01

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W12X14

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	10.00	Design
DL2	10.00	-10.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	5.43	10.85	✔	p. 10-8
$L_{min} = T/2 = 10.85$[in]$/2 =$ **5.43**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 11.9[in] - max(0.525[in], 0[in]) - max(0.525[in], 0[in]) = **10.85**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.2[in], 12 [in]) = **4.8**[in]						Sec. J3.5
Thickness	[in]	0.63	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	12.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.575$[in], 12 [in]$) =$ **12**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	14.14	DL	0.22	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	167.20	10.00	DL	0.06	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*$ 0.75[in]$)*(3 - 1))*0.625$[in]$*58000$[lb/in2]$*1) =$ **167.2**[kip]						Eq. J3-6
Shear yielding	[Kip]	153.00	10.00	DL	0.07	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.625$[in] = **5.31**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*5.31$[in2]$) =$ **153**[kip]						Eq. J4-3
Shear rupture	[Kip]	127.78	10.00	DL	0.08	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in] $- 3*0.875$[in] = **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.625$[in] = **3.67**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.67$[in2]$) =$ **127.78**[kip]						Eq. J4-4
Block shear	[Kip]	127.33	10.00	DL	0.08	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*5.5$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.625$[in] = **0.508**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (3 - 1)*3$[in]$)*0.625$[in] = **4.53**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (3 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.625$[in] = **3.16**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*3.16$[in2] $+ 1*58000$[lb/in2]$*0.508$[in2], $0.6*36000$[lb/in2]$*$ 4.53[in2] $+ 1*58000$[lb/in2]$*0.508$[in2]$)) =$ **127.33**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	110.11	10.00	DL	0.09	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*4.69[in], 2.4* 0.75[in])*(1 - 1))*0.625[in]*58000[lb/in2]*3) = **110.11**[kip] Eq. J3-6

Tear out under axial load	[Kip]	187.81	10.00	DL	0.05	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*5.5[in])*0.625[in] = **1.56**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*5.5[in] - 0.875[in]* (1 - 0.5))*0.625[in] = **1.02**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.625[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.02[in2] + 1*58000[lb/in2]*2.66[in2], 0.6*36000[lb/in2]* 1.56[in2] + 1*58000[lb/in2]*2.66[in2])) = **187.81**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	229.04	10.00	DL	0.04	Eq. J4-1

A_g = L_p*t_p = 8.5[in]*0.625[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*5.31[in2]) = **229.04**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	212.97	10.00	DL	0.05	Eq. J4-2

A_g = L_p*t_p = 8.5[in]*0.625[in] = **5.31**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (8.5[in] - 3*0.875[in])*0.625[in] = **3.67**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.31[in2], 3.67[in2]) = **3.67**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3.67[in2]) = **212.97**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	63.65	10.00	DL	0.16	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	167.20	10.00	DL	0.06	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2* d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(3 - 1))*0.625[in]*58000[lb/in2]*1) = **167.2**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	153.00	10.00	DL	0.07	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.625[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.31[in2]) = **153**[kip] Eq. J4-3

Shear rupture	[Kip]	127.78	10.00	DL	0.08	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.625[in] = **3.67**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.67[in2]) = **127.78**[kip] Eq. J4-4

Block shear	[Kip]	119.40	10.00	DL	0.08	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.625[in] = **0.371**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.625[in] = **4.53**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) -

$0.875_{[in]}/2)*0.625_{[in]} = \mathbf{3.16}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000_{[lb/in2]}*3.16_{[in2]} + 1*58000_{[lb/in2]}*0.371_{[in2]}, 0.6*36000_{[lb/in2]}*4.53_{[in2]} + 1*58000_{[lb/in2]}*0.371_{[in2]})) = \mathbf{119.4}_{[kip]}$ Eq. J4-5

Resulting tension capacity due prying action	[Kip]	45.29	10.00	DL	0.22	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts}) = 10_{[kip]}/(0.442_{[in2]}*6) = \mathbf{3770.74}_{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000_{[lb/in2]} - 90000_{[lb/in2]}*3770.74_{[lb/in2]}/(0.5*48000_{[lb/in2]}), 0.0), 90000_{[lb/in2]}) = \mathbf{90000}_{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*90000_{[lb/in2]}*0.442_{[in2]} = \mathbf{19.89}_{[kip]}$ Eq. J3-2

$f_v = F/(A_b*N_{bolts}) = 10_{[kip]}/(0.442_{[in2]}*6) = \mathbf{3770.74}_{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000_{[lb/in2]} - 90000_{[lb/in2]}*3770.74_{[lb/in2]}/(0.5*48000_{[lb/in2]}), 0.0), 90000_{[lb/in2]}) = \mathbf{90000}_{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*90000_{[lb/in2]}*0.442_{[in2]} = \mathbf{19.89}_{[kip]}$ Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13_{[in]} + 0.75_{[in]}/2, 1.25*2.56_{[in]} + 0.75_{[in]}/2) = \mathbf{1.5}_{[in]}$ p. 9-12

$b' = b - d/2 = 2.56_{[in]} - 0.75_{[in]}/2 = \mathbf{2.19}_{[in]}$ p. 9-12

$\rho = b'/a' = 2.19_{[in]}/1.5_{[in]} = \mathbf{1.46}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813_{[in]}/3_{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.89_{[kip]}*2.19_{[in]})/(0.5*3_{[in]}*58000_{[lb/in2]}))^{0.5} = \mathbf{1.29}_{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.46)))*((1.29_{[in]}/0.625_{[in]})^2 - 1) = \mathbf{1.82}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.625_{[in]}/1.29_{[in]})^2*(1 + 0.729) = \mathbf{0.406}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13_{[in]} + 0.75_{[in]}/2, 1.25*2.56_{[in]} + 0.75_{[in]}/2) = \mathbf{1.5}_{[in]}$ p. 9-12

$b' = b - d/2 = 2.56_{[in]} - 0.75_{[in]}/2 = \mathbf{2.19}_{[in]}$ p. 9-12

$\rho = b'/a' = 2.19_{[in]}/1.5_{[in]} = \mathbf{1.46}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813_{[in]}/2.75_{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.89_{[kip]}*2.19_{[in]})/(0.5*2.75_{[in]}*58000_{[lb/in2]}))^{0.5} = \mathbf{1.35}_{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.46)))*((1.35_{[in]}/0.625_{[in]})^2 - 1) = \mathbf{2.11}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.625_{[in]}/1.35_{[in]})^2*(1 + 0.705) = \mathbf{0.366}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.366 + (3 - 2)*0.406)/3 = \mathbf{0.38}$ p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (19.89_{[kip]}*0.38) = \mathbf{45.29}_{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	35.10	10.00	DL	0.28	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.95_{[in]} - 0.813_{[in]}/2) = \mathbf{2.54}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 0.813_{[in]}) = \mathbf{2.19}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*2.54_{[in]}, 2.4*0.75_{[in]}) + \min(1.2*2.19_{[in]}, 2.4*0.75_{[in]})*(3 - 1))*0.2_{[in]}*65000_{[lb/in2]}*1 = \mathbf{35.1}_{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	47.60	10.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 11.9_{[in]}*0.2_{[in]} = \mathbf{2.38}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*2.38_{[in2]} = \mathbf{47.6}_{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	35.10	10.00	DL	0.28	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25_{[in]} - 0.813_{[in]}/2) = \mathbf{1.84}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 5.5_{[in]} - 0.813_{[in]}) = \mathbf{4.69}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*1.84_{[in]}, 2.4*0.75_{[in]}) + \min(1.2*4.69_{[in]}, 2.4*0.75_{[in]})*(1 - 1))*0.2_{[in]}*65000_{[lb/in2]}*3 = \mathbf{35.1}_{[kip]}$ Eq. J3-6

Tear out under axial load	[Kip]	41.13	10.00	DL	0.24	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*5.5[in])*0.2[in] =$ **0.9**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*5.5[in] - 0.875[in]*$
$(1 - 0.5))*0.2[in] =$ **0.725**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.2[in] =$ **0.85**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*0.725[in2] + 1*65000[lb/in2]*0.85[in2], 0.6*50000[lb/in2]*0.9[in2] + 1*65000[lb/in2]*0.85[in2]) =$ **41.13**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	201.83	10.00	DL	0.05	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(3 - 1))*0.575[in]*65000[lb/in2]*1) =$ **201.83**[kip] Eq. J3-6

Web crippling	[Kip]	176.35	10.00	DL2	0.06	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.345[in]^2*(1 + 3*(12[in]/12.1[in])*(0.345[in]/0.575[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.575[in]/0.345[in])^{1/2} =$ **176.35**[kip] Eq. J10-4

Global critical strength ratio **0.28**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:27 PM
Units system: English
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Steel connections

Results

Connection name : SP BCW
Connection ID : SC-05-02

Family: Beam - Column web (BCW)
Type: Single plate
Description: W12X14

Design code: AISC 360-05 ASD

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	10.00	20.00	0.00	0.00	0.00	Design
DL2	10.00	-20.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.2[in], 12\ [in]) = \mathbf{4.8}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.2[in], 12\ [in]) = \mathbf{4.8}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.95	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	29.04	22.36	DL2	0.77	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2.74*10.61$[kip]$*1 =$ **29.04**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	13.25	8.18	DL	0.62	p. 10-103
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$f_v = V/A_g = 10$[kip]$/3.38$[in2] = **2962.96**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*36000$[lb/in2]$)^2 - 3*2962.96$[lb/in2]$^2))^{1/2} =$ **20937.09**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4 = 0.375$[in]$*9$[in]$^2/4 =$ **7.59**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 20937.09$[lb/in2]$*7.59$[in3] = **13.25**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	39.07	10.00	DL2	0.26	Eq. J3-6, p. 7-18
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.09$[in]$*0.375$[in]$*58000$[lb/in2], $2.4*0.75$[in]$*0.375$[in]$*58000$[lb/in2]$) =$ **28.55**[kip]						Eq. J3-6
$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.19$[in]$*0.375$[in]$*58000$[lb/in2], $2.4*0.75$[in]$*0.375$[in]$*58000$[lb/in2]$) =$ **39.15**[kip]						Eq. J3-6
$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*2.74*\min(28.55$[kip], 39.15[kip]$) =$ **39.07**[kip]						p. 7-18
Shear yielding	[Kip]	48.60	10.00	DL	0.21	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	10.00	DL	0.24	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	47.71	10.00	DL	0.21	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$ - (2 - 0.5)*0.875$[in]$)*0.375$[in]$ =$ **1.2**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) - 0.875$[in]$/2)*0.375$[in]$ =$ **1.99**[in2]						Sec. J4-3
IsStressUniform → **False**						
$U_{bs} = 0.5$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2]$ + 0.5*58000$[lb/in2]$*1.2$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 0.5*58000$[lb/in2]$*1.2$[in2]$) =$ **47.71**[kip]						Eq. J4-5
Flexural rupture	[Kip]	19.62	10.00	DL	0.51	p. 9-6
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375$[in]$/4*(9$[in]$^2 - 3$[in]$^2*3*(3^2 - 1)*0.875$[in]$/9$[in]$) =$ **5.63**[in3]						4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*5.63$[in3]$/8.32$[in] $= \mathbf{19.62}$[kip] p. 9-6

Bolt bearing under axial load	[Kip]	39.07	20.00	DL	0.51	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in] $- 0.813$[in]$/2) = \mathbf{1.09}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) = \mathbf{2.19}$[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.09$[in]$*0.375$[in]$*58000$[lb/in2], $2.4*0.75$[in]$*0.375$[in]$*58000$[lb/in2]$) = \mathbf{28.55}$[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.19$[in]$*0.375$[in]$*58000$[lb/in2], $2.4*0.75$[in]$*0.375$[in]$*58000$[lb/in2]$) = \mathbf{39.15}$[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*2.74*\min(28.55$[kip]$, 39.15$[kip]$) = \mathbf{39.07}$[kip] p. 7-18

Tension yielding	[Kip]	72.75	20.00	DL	0.27	Eq. J4-1

$A_g = L_p*t_p = 9$[in]$*0.375$[in] $= \mathbf{3.38}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*36000$[lb/in2]$*3.38$[in2] $= \mathbf{72.75}$[kip] Eq. J4-1

Tension rupture	[Kip]	69.33	20.00	DL	0.29	Eq. J4-2

$A_g = L_p*t_p = 9$[in]$*0.375$[in] $= \mathbf{3.38}$[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (9$[in]$ - 3*0.875$[in]$)*0.375$[in] $= \mathbf{2.39}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*3.38$[in2]$, 2.39$[in2]$) = \mathbf{2.39}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*2.39$[in2] $= \mathbf{69.33}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	82.67	20.00	DL	0.24	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] $= \mathbf{3.38}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5$[in]$ + (2 - 1)*3$[in]$ - 0.875$[in]$*(2 - 0.5))*0.375$[in] $= \mathbf{2.39}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in]$ - 0.875$[in]$)*(3 - 1)*0.375$[in] $= \mathbf{1.59}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000$[lb/in2]$*2.39$[in2]$ + 1*58000$[lb/in2]$*1.59$[in2]$, 0.6*36000$[lb/in2]$*3.38$[in2]$ + 1*58000$[lb/in2]$*1.59$[in2]$) = \mathbf{82.67}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	120.97	22.36	DL	0.18	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.64$[kip/in]$*1*4*11.45$[in]$) = \mathbf{120.97}$[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	32.03	10.00	DL2	0.31	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.95$[in]$ - 0.813$[in]$/2) = \mathbf{2.54}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) = \mathbf{2.19}$[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.54$[in]$*0.2$[in]$*65000$[lb/in2], $2.4*0.75$[in]$*0.2$[in]$*65000$[lb/in2]$) = \mathbf{23.4}$[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.19$[in]$*0.2$[in]$*65000$[lb/in2], $2.4*0.75$[in]$*0.2$[in]$*65000$[lb/in2]$) = \mathbf{23.4}$[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*2.74*\min(23.4$[kip]$, 23.4$[kip]$) = \mathbf{32.03}$[kip] p. 7-18

Shear yielding	[Kip]	47.60	10.00	DL	0.21	Eq. J4-3

$A_g = L_p*t_p = 11.9$[in]$*0.2$[in] $= \mathbf{2.38}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.38$[in2] $= \mathbf{47.6}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	70.20	20.00	DL	0.28	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in]$ - 0.813$[in]$/2) = \mathbf{1.59}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) = \mathbf{2.19}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.59[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*0.2[in]* 65000[lb/in2]*3 = **70.2**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	124.55	20.00	DL	0.16	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.16[in2] = **124.55**[kip] Eq. D2-1

Tension rupture	[Kip]	109.02	20.00	DL	0.18	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 4.16[in2] - 3*0.2[in]*0.875[in] = **3.64**[in2] Sec. D3-2

$U = 1 - x/l$ = 1 - 0.463[in]/6[in] = **0.923** Table D3.1

$A_e = U*A_n$ = 0.923*3.64[in2] = **3.35**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.35[in2] = **109.02**[kip] Eq. J4-2

Tear out under axial load	[Kip]	56.39	20.00	DL	0.35	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 3>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (2 - 1)*3[in])*0.2[in] = **2**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (2 - 1)*3[in] - 0.875[in]*(2 - 0.5))*0.2[in] = **1.48**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 0.875[in])*(3 - 1)*0.2[in] = **0.85**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.48[in2] + 1*65000[lb/in2]*0.85[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*0.85[in2]) = **56.39**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	219.96	16.47	DL	0.07	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.47[in] = **18.33**[kip/in] p. 9-5

e = 0 p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 11.18[kip]/(0.5*2.64[kip/in]*1*11.45[in]) = **0.739** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.739/16 [in] = **1.37**[kip/in] p. 9-5

Global critical strength ratio **0.77**

NOTATION

A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
g: Transversal gage between bolts

h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBoltedConnection: Is bolted connection
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_p: Plate length
L: Length of weld
λ: Slenderness
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
n_h: Holes number
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling
$(1/\Omega)M_n$: Design or allowable strength
$(1/\Omega)R_n$: Design or allowable strength
r_{n1}: Nominal strength of one bolt
r_{n2}: Nominal strength of one bolt
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
t_p: Plate thickness
t_w: Web thickness
U: Shear lag factor
U_{bs}: Stress index
V: Shear load
w_{min}: Minimum weld size required
x: Connection eccentricity
Z: Plastic modulus
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:21 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA_BCF
Connection ID : SC-05-03

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W12X14

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	20.00	Design
DL2	10.00	-20.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	5.43	10.85	✔	p. 10-8
$L_{min} = T/2 = 10.85$[in]$/2 =$ **5.43**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 11.9[in] - max(0.525[in], 0[in]) - max(0.525[in], 0[in]) = **10.85**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.2[in], 12 [in]) = **4.8**[in]						Sec. J3.5
Thickness	[in]	0.63	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	12.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.625$[in], 12 [in]$) =$ **12**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	22.36	DL	0.35	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	167.20	10.00	DL	0.06	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*$ 0.75[in]$)*(3 - 1))*0.625$[in]$*58000$[lb/in2]$*1) =$ **167.2**[kip]						Eq. J3-6
Shear yielding	[Kip]	153.00	10.00	DL	0.07	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.625$[in] = **5.31**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*5.31$[in2]$) =$ **153**[kip]						Eq. J4-3
Shear rupture	[Kip]	127.78	10.00	DL	0.08	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in] $- 3*0.875$[in] = **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.625$[in] = **3.67**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.67$[in2]$) =$ **127.78**[kip]						Eq. J4-4
Block shear	[Kip]	127.33	10.00	DL	0.08	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*5.5$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.625$[in] = **0.508**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (3 - 1)*3$[in]$)*0.625$[in] = **4.53**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (3 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.625$[in] = **3.16**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*3.16$[in2] $+ 1*58000$[lb/in2]$*0.508$[in2], $0.6*36000$[lb/in2]$*$ 4.53[in2] $+ 1*58000$[lb/in2]$*0.508$[in2]$)) =$ **127.33**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	110.11	20.00	DL	0.18	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*4.69[in], 2.4* 0.75[in])*(1 - 1))*0.625[in]*58000[lb/in2]*3) = **110.11**[kip] Eq. J3-6

Tear out under axial load	[Kip]	187.81	20.00	DL	0.11	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*5.5[in])*0.625[in] = **1.56**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*5.5[in] - 0.875[in]* (1 - 0.5))*0.625[in] = **1.02**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.625[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.02[in2] + 1*58000[lb/in2]*2.66[in2], 0.6*36000[lb/in2]* 1.56[in2] + 1*58000[lb/in2]*2.66[in2])) = **187.81**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	229.04	20.00	DL	0.09	Eq. J4-1

A_g = L_p*t_p = 8.5[in]*0.625[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*5.31[in2]) = **229.04**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	212.97	20.00	DL	0.09	Eq. J4-2

A_g = L_p*t_p = 8.5[in]*0.625[in] = **5.31**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (8.5[in] - 3*0.875[in])*0.625[in] = **3.67**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.31[in2], 3.67[in2]) = **3.67**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3.67[in2]) = **212.97**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	63.65	10.00	DL	0.16	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	167.20	10.00	DL	0.06	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2* d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(3 - 1))*0.625[in]*58000[lb/in2]*1) = **167.2**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	153.00	10.00	DL	0.07	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.625[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.31[in2]) = **153**[kip] Eq. J4-3

Shear rupture	[Kip]	127.78	10.00	DL	0.08	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.625[in] = **3.67**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.67[in2]) = **127.78**[kip] Eq. J4-4

Block shear	[Kip]	119.40	10.00	DL	0.08	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.625[in] = **0.371**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.625[in] = **4.53**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.625[in] = **3.16**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.16[in2] + 1*58000[lb/in2]*0.371[in2], 0.6*36000[lb/in2]*4.53[in2] + 1*58000[lb/in2]*0.371[in2])) = **119.4**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	45.29	20.00	DL	0.44	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 10[kip]/(0.442[in2]*6) = **3770.74**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*3770.74[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 10[kip]/(0.442[in2]*6) = **3770.74**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*3770.74[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.56[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.56[in] - 0.75[in]/2 = **2.19**[in] p. 9-12

ρ = b'/a' = 2.19[in]/1.5[in] = **1.46** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.19[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.29**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.46)))*((1.29[in]/0.625[in])^2 - 1) = **1.82** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.625[in]/1.29[in])^2*(1 + 0.729) = **0.406** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.56[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.56[in] - 0.75[in]/2 = **2.19**[in] p. 9-12

ρ = b'/a' = 2.19[in]/1.5[in] = **1.46** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.19[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.35**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.46)))*((1.35[in]/0.625[in])^2 - 1) = **2.11** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.625[in]/1.35[in])^2*(1 + 0.705) = **0.366** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.366 + (3 - 2)*0.406)/3 = **0.38** p. 9-13

T_{avail} = 6 * (B*Q) = 6 * (19.89[kip]*0.38) = **45.29**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	35.10	10.00	DL	0.28	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.95[in] - 0.813[in]/2) = **2.54**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.54[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.2[in]*65000[lb/in2]*1 = **35.1**[kip] Eq. J3-6

Shear yielding	[Kip]	47.60	10.00	DL	0.21	Eq. J4-3

A_g = L_p*t_p = 11.9[in]*0.2[in] = **2.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.38[in2] = **47.6**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	35.10	20.00	DL	0.57	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*4.69[in], 2.4*0.75[in])*(1 - 1))*0.2[in]*65000[lb/in2]*3 = **35.1**[kip] Eq. J3-6

Tear out under axial load	[Kip]	41.13	20.00	DL	0.49	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*5.5[in])*0.2[in] =$ **0.9**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*5.5[in] - 0.875[in]*$
$(1 - 0.5))*0.2[in] =$ **0.725**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.2[in] =$ **0.85**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*0.725[in2] + 1*65000[lb/in2]*0.85[in2], 0.6*50000[lb/in2]*0.9[in2] + 1*65000[lb/in2]*0.85[in2]) =$ **41.13**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	284.31	10.00	DL	0.04	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(3 - 1))*0.81[in]*65000[lb/in2]*1) =$ **284.31**[kip] Eq. J3-6

Web crippling	[Kip]	394.14	20.00	DL2	0.05	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515[in]^2*(1 + 3*(12[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.81[in]/0.515[in])^{1/2} =$ **394.14**[kip] Eq. J10-4

Global critical strength ratio **0.57**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:22 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-04

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	12.00	8.00	Design
DL2	12.00	-8.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	6.11	12.23	✔	p. 10-8
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 0[in]) - \max(0.735[in], 0[in]) = \mathbf{12.23}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00		7.50	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00		--	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00		--	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Angle (Beam side)

Bolts shear	[Kip]	63.65	14.42	DL	0.23	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]*0.442[in2] = **10.61**[kip] — Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]) = **63.65**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	12.00	DL	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] - 0.813[in]/2) = **0.844**[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*
0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] — Eq. J3-6

Shear yielding	[Kip]	76.50	12.00	DL	0.16	Eq. J4-3

$A_g = L_p*t_p = 8.5$[in]*0.313[in] = **2.66**[in2] — Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]*2.66[in2]) = **76.5**[kip] — Eq. J4-3

Shear rupture	[Kip]	63.89	12.00	DL	0.19	Eq. J4-4

$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$L_e = L - n*L_h = 8.5$[in] - 3*0.875[in] = **5.88**[in] — DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 5.88$[in]*0.313[in] = **1.84**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]*1.84[in2]) = **63.89**[kip] — Eq. J4-4

Block shear	[Kip]	63.66	12.00	DL	0.19	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.313[in] = **0.254**[in2] — Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] — Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.313[in] = **1.58**[in2] — Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ — Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$
$A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*
2.27[in2] + 1*58000[lb/in2]*0.254[in2])) = **63.66**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	55.05	8.00	DL	0.15	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] - 0.813[in]/2) = **0.844**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(1 - 1))*0.313[in]*58000[lb/in2]*3) = **55.05**[kip] Eq. J3-6

Tear out under axial load	[Kip]	93.91	8.00	DL	0.09	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*3[in])*0.313[in] = **0.781**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.313[in] = **0.508**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.313[in] = **1.33**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.508[in2] + 1*58000[lb/in2]*1.33[in2], 0.6*36000[lb/in2]* 0.781[in2] + 1*58000[lb/in2]*1.33[in2])) = **93.91**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	114.52	8.00	DL	0.07	Eq. J4-1

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*2.66[in2]) = **114.52**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	106.48	8.00	DL	0.08	Eq. J4-2

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (8.5[in] - 3*0.875[in])*0.313[in] = **1.84**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*2.66[in2], 1.84[in2]) = **1.84**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*1.84[in2]) = **106.48**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	63.65	12.00	DL	0.19	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	12.00	DL	0.14	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	12.00	DL	0.16	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	12.00	DL	0.19	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	59.70	12.00	DL	0.20	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.186[in2])) = **59.7**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	10.57	8.00	DL	0.76	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 12[kip]/(0.442[in2]*6) = **4524.89**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*4524.89[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 12[kip]/(0.442[in2]*6) = **4524.89**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*4524.89[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.34**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.34[in]/0.313[in])^2 - 1) = **9.24** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.34[in])^2*(1 + 0.729) = **0.0946** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.4**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.4[in]/0.313[in])^2 - 1) = **10.49** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.4[in])^2*(1 + 0.705) = **0.0855** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0855 + (3 - 2)*0.0946)/3 = **0.0886** p. 9-13

T_{avail} = 6 * (B*Q) = 6 * (19.89[kip]*0.0886) = **10.57**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	40.37	12.00	DL	0.30	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 3.85[in] - 0.813[in]/2) = **3.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*3.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.23[in]*65000[lb/in2]*1 = **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	63.02	12.00	DL	0.19	Eq. J4-3

A_g = L_p*t_p = 13.7[in]*0.23[in] = **3.15**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.15[in2] = **63.02**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	40.37	8.00	DL	0.20	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.23[in]*65000[lb/in2]*3 = **40.37**[kip] Eq. J3-6

Tear out under axial load	[Kip]	47.29	8.00	DL	0.17	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.23[in] =$ **1.04**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.23[in] =$ **0.834**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.23[in] =$ **0.978**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*0.834[in2] + 1*65000[lb/in2]*0.978[in2], 0.6*50000[lb/in2]*1.04[in2] + 1*65000[lb/in2]*0.978[in2]) =$ **47.29**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	196.56	12.00	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.56[in]*65000[lb/in2]*1) =$ **196.56**[kip] Eq. J3-6

Web crippling	[Kip]	193.16	8.00	DL2	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.34[in]^2*(1 + 3*(12[in]/10[in])*(0.34[in]/0.56[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.56[in]/0.34[in])^{1/2} =$ **193.16**[kip] Eq. J10-4

Global critical strength ratio **0.76**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:24 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : SP BCW
Connection ID : SC-05-05

Family: Beam - Column web (BCW)
Type: Single plate
Description: W16X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	10.00	10.00	0.00	0.00	0.00	Design
DL2	10.00	-10.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.25[in], 12\ [in]) = \mathbf{6}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	15.12	14.14	DL2	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 1.43*10.61[kip]*1 = **15.12**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	23.86	7.94	DL	0.33	p. 10-103
$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$f_v = V/A_g$ = 10[kip]/4.5[in2] = **2222.22**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr}$ = (max(0, $((1/\Omega)*F_y)^2$ - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*2222.22[lb/in2]^2))$^{1/2}$ = **21210.48**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.375[in]*12[in]^2/4 = **13.5**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 21210.48[lb/in2]*13.5[in3] = **23.86**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	20.34	10.00	DL2	0.49	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
r_{n1} = min($k_1*L_{c\text{-}end}*t_p*F_u$, $k_2*d*t_p*F_u$) = min(1.2*1.09[in]*0.375[in]*58000[lb/in2], 2.4*0.75[in]*0.375[in]*58000[lb/in2]) = **28.55**[kip]						Eq. J3-6
r_{n2} = min($k_1*L_{c\text{-}spa}*t_p*F_u$, $k_2*d*t_p*F_u$) = min(1.2*2.19[in]*0.375[in]*58000[lb/in2], 2.4*0.75[in]*0.375[in]*58000[lb/in2]) = **39.15**[kip]						Eq. J3-6
$(1/\Omega)R_n = (1/\Omega)*C*$min($r_{n1}$, r_{n2}) = 0.5*1.43*min(28.55[kip], 39.15[kip]) = **20.34**[kip]						p. 7-18
Shear yielding	[Kip]	64.80	10.00	DL	0.15	Eq. J4-3
$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	10.00	DL	0.18	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12[in] - 4*0.875[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.5[in]*0.375[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	10.00	DL	0.18	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*$min($0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}$, $0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/in2]*0.398[in2]) = **54.08**[kip]						Eq. J4-5
Flexural rupture	[Kip]	29.85	10.00	DL	0.34	p. 9-6
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(12[in]^2 - 3[in]^2*4*(4^2 - 1)*0.875[in]/12[in]) = **9.81**[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*58000[lb/in2]*9.81[in3]/9.53[in] = **29.85**[kip]						p. 9-6
Bolt bearing under axial load	[Kip]	20.34	10.00	DL	0.49	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10

$r_{n1} = \min(k_1 * L_{c\text{-}end} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 1.09\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}) = \mathbf{28.55}\text{[kip]}$ Eq. J3-6

$r_{n2} = \min(k_1 * L_{c\text{-}spa} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 2.19\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}) = \mathbf{39.15}\text{[kip]}$ Eq. J3-6

$(1/\Omega)R_n = (1/\Omega) * C * \min(r_{n1}, r_{n2}) = 0.5 * 1.43 * \min(28.55\text{[kip]}, 39.15\text{[kip]}) = \mathbf{20.34}\text{[kip]}$ p. 7-18

Tension yielding	[Kip]	97.01	10.00	DL	0.10	Eq. J4-1

$A_g = L_p * t_p = 12\text{[in]} * 0.375\text{[in]} = \mathbf{4.5}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 4.5\text{[in2]} = \mathbf{97.01}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	92.44	10.00	DL	0.11	Eq. J4-2

$A_g = L_p * t_p = 12\text{[in]} * 0.375\text{[in]} = \mathbf{4.5}\text{[in2]}$ Sec. D3-1

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = (l - n * L_h) * t_p = (12\text{[in]} - 4 * 0.875\text{[in]}) * 0.375\text{[in]} = \mathbf{3.19}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85 * A_g, A_n) = \min(0.85 * 4.5\text{[in2]}, 3.19\text{[in2]}) = \mathbf{3.19}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 3.19\text{[in2]} = \mathbf{92.44}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	81.48	10.00	DL	0.12	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow \mathbf{True}$

$A_{gv} = 2 * (L + (n_c - 1) * g) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 3\text{[in]}) * 0.375\text{[in]} = \mathbf{1.13}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2 * (L + (n_c - 1) * g - dh_h * (n_c - 0.5)) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 3\text{[in]} - 0.875\text{[in]} * (1 - 0.5)) * 0.375\text{[in]} = \mathbf{0.797}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v) * (n - 1) * t_p = (3\text{[in]} - 0.875\text{[in]}) * (4 - 1) * 0.375\text{[in]} = \mathbf{2.39}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 58000\text{[lb/in2]} * 0.797\text{[in2]} + 1 * 58000\text{[lb/in2]} * 2.39\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 1.13\text{[in2]} + 1 * 58000\text{[lb/in2]} * 2.39\text{[in2]}) = \mathbf{81.48}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	144.58	14.14	DL	0.10	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega) * C * C_1 * D * L) = 2 * (0.5 * 2.41\text{[kip/in]} * 1 * 4 * 15.01\text{[in]}) = \mathbf{144.58}\text{[kip]}$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	20.84	10.00	DL2	0.48	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.35\text{[in]} - 0.813\text{[in]}/2) = \mathbf{2.94}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$r_{n1} = \min(k_1 * L_{c\text{-}end} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 2.94\text{[in]} * 0.25\text{[in]} * 65000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.25\text{[in]} * 65000\text{[lb/in2]}) = \mathbf{29.25}\text{[kip]}$ Eq. J3-6

$r_{n2} = \min(k_1 * L_{c\text{-}spa} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 2.19\text{[in]} * 0.25\text{[in]} * 65000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.25\text{[in]} * 65000\text{[lb/in2]}) = \mathbf{29.25}\text{[kip]}$ Eq. J3-6

$(1/\Omega)R_n = (1/\Omega) * C * \min(r_{n1}, r_{n2}) = 0.5 * 1.43 * \min(29.25\text{[kip]}, 29.25\text{[kip]}) = \mathbf{20.84}\text{[kip]}$ p. 7-18

Shear yielding	[Kip]	78.50	10.00	DL	0.13	Eq. J4-3

$A_g = L_p * t_p = 15.7\text{[in]} * 0.25\text{[in]} = \mathbf{3.93}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000\text{[lb/in2]} * 3.93\text{[in2]} = \mathbf{78.5}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	58.50	10.00	DL	0.17	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.59}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 1.59\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 2.19\text{[in]}, 2.4 * 0.75\text{[in]}) * (1 - 1)) * 0.25\text{[in]} * 65000\text{[lb/in2]} * 4 = \mathbf{58.5}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	229.94	10.00	DL	0.04	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 50000\text{[lb/in2]} * 7.68\text{[in2]} = \mathbf{229.94}\text{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	167.90	10.00	DL	0.06	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 7.68[in2] - 4*0.25[in]*0.875[in] = **6.81**[in2] — Sec. D3-2

$U = 1 - x/l$ = 1 - 0.722[in]/3[in] = **0.759** — Table D3.1

$A_e = U*A_n$ = 0.759*6.81[in2] = **5.17**[in2] — Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*5.17[in2] = **167.9**[kip] — Eq. J4-2

Tear out under axial load	[Kip]	66.80	10.00	DL	0.15	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (1 - 1)*3[in])*0.25[in] = **1**[in2] — Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.25[in] = **0.781**[in2] — Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 0.875[in])*(4 - 1)*0.25[in] = **1.59**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*0.781[in2] + 1*65000[lb/in2]*1.59[in2], 0.6*50000[lb/in2]*1[in2] + 1*65000[lb/in2]*1.59[in2]) = **66.8**[kip] — Eq. J4-5

Support

Welds rupture	[Kip/ft]	205.92	8.72	DL	0.04	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.44[in] = **17.16**[kip/in] — p. 9-5

e = 0 — p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 7.07[kip]/(0.5*2.41[kip/in]*1*15.01[in]) = **0.391** — tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.391/16 [in] = **0.726**[kip/in] — p. 9-5

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
g: Transversal gage between bolts
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBoltedConnection: Is bolted connection
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor

l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_p: Plate length
L: Length of weld
λ: Slenderness
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
n_h: Holes number
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling
$(1/\Omega)M_n$: Design or allowable strength
$(1/\Omega)R_n$: Design or allowable strength
r_{n1}: Nominal strength of one bolt
r_{n2}: Nominal strength of one bolt
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
t_p: Plate thickness
t_w: Web thickness
U: Shear lag factor
U_{bs}: Stress index
V: Shear load
w_{min}: Minimum weld size required
x: Connection eccentricity
Z: Plastic modulus
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:14 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA_BCF
Connection ID : SC-05-06

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	15.00	Design
DL2	25.00	-15.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	11.50	8.02	16.05	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 0[in]) - max(0.827[in], 0[in]) = **16.05**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Thickness	[in]	0.38	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in], 12 [in]$) =$ **9**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	84.86	29.15	DL	0.34	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (4*10.61$[kip]$) =$ **84.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	139.47	25.00	DL	0.18	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*$ 0.75[in]$)*(4 - 1))*0.375$[in]$*58000$[lb/in2]$*1) =$ **139.47**[kip]						Eq. J3-6
Shear yielding	[Kip]	124.20	25.00	DL	0.20	Eq. J4-3
$A_g = L_p*t_p = 11.5$[in]$*0.375$[in] = **4.31**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.31$[in2]$) =$ **124.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	104.40	25.00	DL	0.24	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 11.5$[in] $- 4*0.875$[in] $=$ **8**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8$[in]$*0.375$[in] = **3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3$[in2]$) =$ **104.4**[kip]						Eq. J4-4
Block shear	[Kip]	100.70	25.00	DL	0.25	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*5.5$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.305**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (4 - 1)*3$[in]$)*0.375$[in] = **3.84**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (4 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.7**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.7$[in2] $+ 1*58000$[lb/in2]$*0.305$[in2], $0.6*36000$[lb/in2]$*$ 3.84[in2] $+ 1*58000$[lb/in2]$*0.305$[in2]$)) =$ **100.7**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	88.09	15.00	DL	0.17	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*4.69[in], 2.4* 0.75[in])*(1 - 1))*0.375[in]*58000[lb/in2]*4) = **88.09**[kip] Eq. J3-6

Tear out under axial load	[Kip]	158.91	15.00	DL	0.09	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*5.5[in])*0.375[in] = **0.938**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*5.5[in] - 0.875[in]* (1 - 0.5))*0.375[in] = **0.609**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(4 - 1)*0.375[in] = **2.39**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.609[in2] + 1*58000[lb/in2]*2.39[in2], 0.6*36000[lb/in2]* 0.938[in2] + 1*58000[lb/in2]*2.39[in2])) = **158.91**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	185.93	15.00	DL	0.08	Eq. J4-1

A_g = L_p*t_p = 11.5[in]*0.375[in] = **4.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*4.31[in2]) = **185.93**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	174.00	15.00	DL	0.09	Eq. J4-2

A_g = L_p*t_p = 11.5[in]*0.375[in] = **4.31**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (11.5[in] - 4*0.875[in])*0.375[in] = **3**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.31[in2], 3[in2]) = **3**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3[in2]) = **174**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	84.86	25.00	DL	0.29	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (4*10.61[kip]) = **84.86**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	139.47	25.00	DL	0.18	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2* d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(4/(1*4))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(4 - 1))*0.375[in]*58000[lb/in2]*1) = **139.47**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	124.20	25.00	DL	0.20	Eq. J4-3

A_g = L_p*t_p = 11.5[in]*0.375[in] = **4.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.31[in2]) = **124.2**[kip] Eq. J4-3

Shear rupture	[Kip]	104.40	25.00	DL	0.24	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 11.5[in] - 4*0.875[in] = **8**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.375[in] = **3**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3[in2]) = **104.4**[kip] Eq. J4-4

Block shear	[Kip]	95.94	25.00	DL	0.26	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.223**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (4 - 1)*3[in])*0.375[in] = **3.84**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (4 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.375[in] = **2.7**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.7[in2] + 1*58000[lb/in2]*0.223[in2], 0.6*36000[lb/in2]*3.84[in2] + 1*58000[lb/in2]*0.223[in2])) = **95.94**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	20.92	15.00	DL	0.72	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 25[kip]/(0.442[in2]*8) = **7070.14**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*7070.14[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 25[kip]/(0.442[in2]*8) = **7070.14**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*7070.14[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.69[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.69[in] - 0.75[in]/2 = **2.31**[in] p. 9-12

ρ = b'/a' = 2.31[in]/1.5[in] = **1.54** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.31[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.33**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.54)))*((1.33[in]/0.375[in])^2 - 1) = **6.22** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.375[in]/1.33[in])^2*(1 + 0.729) = **0.138** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.69[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.69[in] - 0.75[in]/2 = **2.31**[in] p. 9-12

ρ = b'/a' = 2.31[in]/1.5[in] = **1.54** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.31[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.39**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.54)))*((1.39[in]/0.375[in])^2 - 1) = **7.07** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.375[in]/1.39[in])^2*(1 + 0.705) = **0.125** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.125 + (4 - 2)*0.138)/4 = **0.131** p. 9-13

T_{avail} = 8 * (B*Q) = 8 * (19.89[kip]*0.131) = **20.92**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	70.20	25.00	DL	0.36	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 4.35[in] - 0.813[in]/2) = **3.94**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*3.94[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.3[in]*65000[lb/in2]*1 = **70.2**[kip] Eq. J3-6

Shear yielding	[Kip]	106.20	25.00	DL	0.24	Eq. J4-3

A_g = L_p*t_p = 17.7[in]*0.3[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.31[in2] = **106.2**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	70.20	15.00	DL	0.21	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*4.69[in], 2.4*0.75[in])*(1 - 1))*0.3[in]*65000[lb/in2]*4 = **70.2**[kip] Eq. J3-6

Tear out under axial load	[Kip]	82.41	15.00	DL	0.18	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*5.5[in])*0.3[in] =$ **1.35**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*5.5[in] - 0.875[in]*$
$(1 - 0.5))*0.3[in] =$ **1.09**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(4 - 1)*0.3[in] =$ **1.91**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.09[in2] + 1*65000[lb/in2]*1.91[in2], 0.6*50000[lb/in2]*1.35[in2] + 1*65000[lb/in2]*1.91[in2]) =$ **82.41**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	313.56	25.00	DL	0.08	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(4 - 1))*0.67[in]*65000[lb/in2]*1) =$ **313.56**[kip] Eq. J3-6

Web crippling	[Kip]	362.11	15.00	DL2	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **18**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43[in]^2*(1 + 3*(18[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.67[in]/0.43[in])^{1/2} =$ **362.11**[kip] Eq. J10-4

Global critical strength ratio **0.72**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:25 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-07

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	20.00	Design
DL2	25.00	-20.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	8.02	16.05	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 0[in]) - max(0.827[in], 0[in]) = **16.05**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Thickness	[in]	0.38	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in], 12 [in]$) =$ **9**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	32.02	DL	0.30	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	178.62	25.00	DL	0.14	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*$ 0.75[in]$)*(5 - 1))*0.375$[in]$*58000$[lb/in2]$*1) =$ **178.62**[kip]						Eq. J3-6
Shear yielding	[Kip]	156.60	25.00	DL	0.16	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.375$[in] = **5.44**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*5.44$[in2]$) =$ **156.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	132.13	25.00	DL	0.19	Eq. J4-4
$L_h = d_h +$ 1/16 [in] $= 0.813$[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in] $- 5*0.875$[in] = **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.375$[in] = **3.8**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.8$[in2]$) =$ **132.13**[kip]						Eq. J4-4
Block shear	[Kip]	125.00	25.00	DL	0.20	Eq. J4-5
$dh_h = d_h +$ 1/16 [in] $= 0.813$[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h +$ 1/16 [in] $= 0.813$[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.305**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (5 - 1)*3$[in]$)*0.375$[in] = **4.97**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (5 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **3.49**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*3.49$[in2]$ + 1*58000$[lb/in2]$*0.305$[in2], $0.6*36000$[lb/in2]$*$ 4.97[in2]$ + 1*58000$[lb/in2]$*0.305$[in2]$)) =$ **125**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	110.11	20.00	DL	0.18	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(1 - 1))*0.375[in]*58000[lb/in2]*5) = **110.11**[kip] Eq. J3-6

Tear out under axial load	[Kip]	205.13	20.00	DL	0.10	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*3[in])*0.375[in] = **0.938**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.375[in] = **0.609**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.375[in] = **3.19**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.609[in2] + 1*58000[lb/in2]*3.19[in2], 0.6*36000[lb/in2]* 0.938[in2] + 1*58000[lb/in2]*3.19[in2])) = **205.13**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	234.43	20.00	DL	0.09	Eq. J4-1

A_g = L_p*t_p = 14.5[in]*0.375[in] = **5.44**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*5.44[in2]) = **234.43**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	220.22	20.00	DL	0.09	Eq. J4-2

A_g = L_p*t_p = 14.5[in]*0.375[in] = **5.44**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (14.5[in] - 5*0.875[in])*0.375[in] = **3.8**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.44[in2], 3.8[in2]) = **3.8**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3.8[in2]) = **220.22**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	106.08	25.00	DL	0.24	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (5*10.61[kip]) = **106.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	178.62	25.00	DL	0.14	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(5 - 1))*0.375[in]*58000[lb/in2]*1) = **178.62**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	156.60	25.00	DL	0.16	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.375[in] = **5.44**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.44[in2]) = **156.6**[kip] Eq. J4-3

Shear rupture	[Kip]	132.13	25.00	DL	0.19	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.375[in] = **3.8**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.8[in2]) = **132.13**[kip] Eq. J4-4

Block shear	[Kip]	120.24	25.00	DL	0.21	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.223**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.375[in] = **4.97**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.375[in] = **3.49**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.49[in2] + 1*58000[lb/in2]*0.223[in2], 0.6*36000[lb/in2]*4.97[in2] + 1*58000[lb/in2]*0.223[in2])) = **120.24**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	26.41	20.00	DL	0.76	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 25[kip]/(0.442[in2]*10) = **5656.11**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*5656.11[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 25[kip]/(0.442[in2]*10) = **5656.11**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*5656.11[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.69[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.69[in] - 0.75[in]/2 = **2.31**[in] p. 9-12

ρ = b'/a' = 2.31[in]/1.5[in] = **1.54** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.31[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.33**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.54)))*((1.33[in]/0.375[in])^2 - 1) = **6.22** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.375[in]/1.33[in])^2*(1 + 0.729) = **0.138** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.69[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.69[in] - 0.75[in]/2 = **2.31**[in] p. 9-12

ρ = b'/a' = 2.31[in]/1.5[in] = **1.54** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.31[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.39**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.54)))*((1.39[in]/0.375[in])^2 - 1) = **7.07** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.375[in]/1.39[in])^2*(1 + 0.705) = **0.125** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.125 + (5 - 2)*0.138)/5 = **0.133** p. 9-13

T_{avail} = 10 * (B*Q) = 10 * (19.89[kip]*0.133) = **26.41**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	87.75	25.00	DL	0.28	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.85[in] - 0.813[in]/2) = **2.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.3[in]*65000[lb/in2]*1 = **87.75**[kip] Eq. J3-6

Shear yielding	[Kip]	106.20	25.00	DL	0.24	Eq. J4-3

A_g = L_p*t_p = 17.7[in]*0.3[in] = **5.31**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.31[in2] = **106.2**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	87.75	20.00	DL	0.23	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.3[in]*65000[lb/in2]*5 = **87.75**[kip] Eq. J3-6

Tear out under axial load	[Kip]	103.13	20.00	DL	0.19	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.3[in] =$ **1.35**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.3[in] =$ **1.09**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.3[in] =$ **2.55**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.09[in2] + 1*65000[lb/in2]*2.55[in2], 0.6*50000[lb/in2]*1.35[in2] + 1*65000[lb/in2]*2.55[in2]) =$ **103.13**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	415.35	25.00	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(5 - 1))*0.71[in]*65000[lb/in2]*1) =$ **415.35**[kip] Eq. J3-6

Web crippling	[Kip]	415.65	20.00	DL2	0.05	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **24**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.44[in]^2*(1 + 3*(24[in]/14[in])*(0.44[in]/0.71[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.71[in]/0.44[in])^{1/2} =$ **415.65**[kip] Eq. J10-4

Global critical strength ratio **0.76**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:29 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : SP_BCW_
Connection ID : SC-05-08

Family: Beam - Column web (BCW)
Type: Single plate
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	12.00	20.00	0.00	0.00	0.00	Design
DL2	12.00	-20.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.3[in], 12\ [in]) = \mathbf{7.2}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	29.07	23.32	DL	0.80	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 2.74*10.61[kip]*1 = **29.07**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	37.33	8.32	DL	0.22	p. 10-103
$A_g = L_p*t_p$ = 15[in]*0.375[in] = **5.63**[in2]						Sec. D3-1
$f_v = V/A_g$ = 12[kip]/5.63[in2] = **2133.33**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr}$ = (max(0, $((1/\Omega)*F_y)^2$ - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*2133.33[lb/in2]^2))$^{1/2}$ = **21237.84**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.375[in]*15[in]^2/4 = **21.09**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 21237.84[lb/in2]*21.09[in3] = **37.33**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	39.12	12.00	DL	0.31	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
r_{n1} = min($k_1*L_{c\text{-}end}*t_p*F_u$, $k_2*d*t_p*F_u$) = min(1.2*1.09[in]*0.375[in]*58000[lb/in2], 2.4*0.75[in]*0.375[in]*58000[lb/in2]) = **28.55**[kip]						Eq. J3-6
r_{n2} = min($k_1*L_{c\text{-}spa}*t_p*F_u$, $k_2*d*t_p*F_u$) = min(1.2*2.19[in]*0.375[in]*58000[lb/in2], 2.4*0.75[in]*0.375[in]*58000[lb/in2]) = **39.15**[kip]						Eq. J3-6
$(1/\Omega)R_n = (1/\Omega)*C*$min($r_{n1}$, r_{n2}) = 0.5*2.74*min(28.55[kip], 39.15[kip]) = **39.12**[kip]						p. 7-18
Shear yielding	[Kip]	81.00	12.00	DL	0.15	Eq. J4-3
$A_g = L_p*t_p$ = 15[in]*0.375[in] = **5.63**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*5.63[in2] = **81**[kip]						Eq. J4-3
Shear rupture	[Kip]	69.33	12.00	DL	0.17	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 15[in] - 5*0.875[in] = **10.63**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 10.63[in]*0.375[in] = **3.98**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.98[in2] = **69.33**[kip]						Eq. J4-4
Block shear	[Kip]	66.23	12.00	DL	0.18	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)*0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (5 - 1)*3[in])*0.375[in] = **5.06**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **3.59**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*$min($0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}$, $0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*58000[lb/in2]*3.59[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*5.06[in2] + 1*58000[lb/in2]*0.398[in2]) = **66.23**[kip]						Eq. J4-5
Flexural rupture	[Kip]	52.97	12.00	DL	0.23	p. 9-6
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(15[in]^2 - 3[in]^2*5*(5^2 - 1)*0.875[in]/15[in]) = **15.19**[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*58000[lb/in2]*15.19[in3]/8.32[in] = **52.97**[kip]						p. 9-6
Bolt bearing under axial load	[Kip]	39.12	20.00	DL	0.51	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in]						Sec. J4.10

$r_{n1} = \min(k_1 * L_{c\text{-}end} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 1.09\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}) = \mathbf{28.55}\text{[kip]}$ Eq. J3-6

$r_{n2} = \min(k_1 * L_{c\text{-}spa} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 4.69\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.375\text{[in]} * 58000\text{[lb/in2]}) = \mathbf{39.15}\text{[kip]}$ Eq. J3-6

$(1/\Omega)R_n = (1/\Omega) * C * \min(r_{n1}, r_{n2}) = 0.5 * 2.74 * \min(28.55\text{[kip]}, 39.15\text{[kip]}) = \mathbf{39.12}\text{[kip]}$ p. 7-18

Tension yielding	[Kip]	121.26	20.00	DL	0.16	Eq. J4-1

$A_g = L_p * t_p = 15\text{[in]} * 0.375\text{[in]} = \mathbf{5.63}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 5.63\text{[in2]} = \mathbf{121.26}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	115.55	20.00	DL	0.17	Eq. J4-2

$A_g = L_p * t_p = 15\text{[in]} * 0.375\text{[in]} = \mathbf{5.63}\text{[in2]}$ Sec. D3-1

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = (l - n * L_h) * t_p = (15\text{[in]} - 5 * 0.875\text{[in]}) * 0.375\text{[in]} = \mathbf{3.98}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85 * A_g, A_n) = \min(0.85 * 5.63\text{[in2]}, 3.98\text{[in2]}) = \mathbf{3.98}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 3.98\text{[in2]} = \mathbf{115.55}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	104.59	20.00	DL	0.19	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow \mathbf{True}$

$A_{gv} = 2 * (L + (n_c - 1) * g) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 5.5\text{[in]}) * 0.375\text{[in]} = \mathbf{1.13}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2 * (L + (n_c - 1) * g - dh_h * (n_c - 0.5)) * t_p = 2 * (1.5\text{[in]} + (1 - 1) * 5.5\text{[in]} - 0.875\text{[in]} * (1 - 0.5)) * 0.375\text{[in]} = \mathbf{0.797}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v) * (n - 1) * t_p = (3\text{[in]} - 0.875\text{[in]}) * (5 - 1) * 0.375\text{[in]} = \mathbf{3.19}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 58000\text{[lb/in2]} * 0.797\text{[in2]} + 1 * 58000\text{[lb/in2]} * 3.19\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 1.13\text{[in2]} + 1 * 58000\text{[lb/in2]} * 3.19\text{[in2]}) = \mathbf{104.59}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	174.77	23.32	DL	0.13	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n = 2 * ((1/\Omega) * C * C_1 * D * L) = 2 * (0.5 * 2.59\text{[kip/in]} * 1 * 4 * 16.85\text{[in]}) = \mathbf{174.77}\text{[kip]}$ Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	48.10	12.00	DL	0.25	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85\text{[in]} - 0.813\text{[in]}/2) = \mathbf{2.44}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$r_{n1} = \min(k_1 * L_{c\text{-}end} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 2.44\text{[in]} * 0.3\text{[in]} * 65000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.3\text{[in]} * 65000\text{[lb/in2]}) = \mathbf{35.1}\text{[kip]}$ Eq. J3-6

$r_{n2} = \min(k_1 * L_{c\text{-}spa} * t_p * F_u, k_2 * d * t_p * F_u) = \min(1.2 * 2.19\text{[in]} * 0.3\text{[in]} * 65000\text{[lb/in2]}, 2.4 * 0.75\text{[in]} * 0.3\text{[in]} * 65000\text{[lb/in2]}) = \mathbf{35.1}\text{[kip]}$ Eq. J3-6

$(1/\Omega)R_n = (1/\Omega) * C * \min(r_{n1}, r_{n2}) = 0.5 * 2.74 * \min(35.1\text{[kip]}, 35.1\text{[kip]}) = \mathbf{48.1}\text{[kip]}$ p. 7-18

Shear yielding	[Kip]	106.20	12.00	DL	0.11	Eq. J4-3

$A_g = L_p * t_p = 17.7\text{[in]} * 0.3\text{[in]} = \mathbf{5.31}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000\text{[lb/in2]} * 5.31\text{[in2]} = \mathbf{106.2}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	87.75	20.00	DL	0.23	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.59}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 5.5\text{[in]} - 0.813\text{[in]}) = \mathbf{4.69}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 1.59\text{[in]}, 2.4 * 0.75\text{[in]}) + \min(1.2 * 4.69\text{[in]}, 2.4 * 0.75\text{[in]}) * (1 - 1)) * 0.3\text{[in]} * 65000\text{[lb/in2]} * 5 = \mathbf{87.75}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	308.38	20.00	DL	0.06	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 50000\text{[lb/in2]} * 10.3\text{[in2]} = \mathbf{308.38}\text{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	215.11	20.00	DL	0.09	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 10.3[in2] - 5*0.3[in]*0.875[in] = **8.99**[in2] — Sec. D3-2

$U = 1 - x/l$ = 1 - 0.791[in]/3[in] = **0.736** — Table D3.1

$A_e = U*A_n$ = 0.736*8.99[in2] = **6.62**[in2] — Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*6.62[in2] = **215.11**[kip] — Eq. J4-2

Tear out under axial load	[Kip]	100.88	20.00	DL	0.20	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (1 - 1)*5.5[in])*0.3[in] = **1.2**[in2] — Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (1 - 1)*5.5[in] - 0.875[in]*(1 - 0.5))*0.3[in] = **0.938**[in2] — Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 0.875[in])*(5 - 1)*0.3[in] = **2.55**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*0.938[in2] + 1*65000[lb/in2]*2.55[in2], 0.6*50000[lb/in2]*1.2[in2] + 1*65000[lb/in2]*2.55[in2]) = **100.88**[kip] — Eq. J4-5

Support

Welds rupture	[Kip/ft]	219.96	11.89	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.47[in] = **18.33**[kip/in] — p. 9-5

e = 0 — p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 11.66[kip]/(0.5*2.59[kip/in]*1*16.85[in]) = **0.534** — tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)^1/2/2*0.534/16 [in] = **0.991**[kip/in] — p. 9-5

Global critical strength ratio **0.80**

NOTATION

A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
g: Transversal gage between bolts
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBoltedConnection: Is bolted connection
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor

l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_p: Plate length
L: Length of weld
λ: Slenderness
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
n_h: Holes number
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling
$(1/\Omega)M_n$: Design or allowable strength
$(1/\Omega)R_n$: Design or allowable strength
r_{n1}: Nominal strength of one bolt
r_{n2}: Nominal strength of one bolt
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
t_p: Plate thickness
t_w: Web thickness
U: Shear lag factor
U_{bs}: Stress index
V: Shear load
w_{min}: Minimum weld size required
x: Connection eccentricity
Z: Plastic modulus
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:18 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-09

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W18X40

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	26.00	Design
DL2	20.00	-26.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	11.50	8.02	16.05	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.9[in] - max(0.927[in], 0[in]) - max(0.927[in], 0[in]) = **16.05**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.315[in], 12 [in]) = **7.56**[in]						Sec. J3.5
Thickness	[in]	0.63	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0.125$[in] $=$ **1.13**[in]						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.625[in], 12 [in]) = **12**[in]						Sec. J3.5
Beam						
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Support						
Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	84.86	32.80	DL	0.39	Tables (7-1..14)
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (4*10.61[kip]) = **84.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	232.45	20.00	DL	0.09	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(4 - 1))*0.625[in]*58000[lb/in2]*1) = **232.45**[kip]						Eq. J3-6
Shear yielding	[Kip]	207.00	20.00	DL	0.10	Eq. J4-3
A_g = L_p*t_p = 11.5[in]*0.625[in] = **7.19**[in2]						Sec. D3-1
(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*7.19[in2]) = **207**[kip]						Eq. J4-3
Shear rupture	[Kip]	174.00	20.00	DL	0.11	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 11.5[in] - 4*0.875[in] = **8**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 8[in]*0.625[in] = **5**[in2]						Sec. J4-2
(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*5[in2]) = **174**[kip]						Eq. J4-4
Block shear	[Kip]	167.83	20.00	DL	0.12	Eq. J4-5
dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.625[in] = **0.508**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (4 - 1)*3[in])*0.625[in] = **6.41**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.625[in] = **4.49**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
(1/Ω)R_n = 2 * (*(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.49[in2] + 1*58000[lb/in2]*0.508[in2], 0.6*36000[lb/in2]* 6.41[in2] + 1*58000[lb/in2]*0.508[in2])) = **167.83**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	146.81	26.00	DL	0.18	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(1 - 1))*0.625[in]*58000[lb/in2]*4) = \mathbf{146.81}$[kip] Eq. J3-6

Tear out under axial load	[Kip]	264.84	26.00	DL	0.10	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*3[in])*0.625[in] = \mathbf{1.56}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.625[in] = \mathbf{1.02}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(4 - 1)*0.625[in] = \mathbf{3.98}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000[lb/in2]*1.02[in2] + 1*58000[lb/in2]*3.98[in2], 0.6*36000[lb/in2]*1.56[in2] + 1*58000[lb/in2]*3.98[in2])) = \mathbf{264.84}$[kip] Eq. J4-5

Leg tensile yielding	[Kip]	309.88	26.00	DL	0.08	Eq. J4-1

$A_g = L_p*t_p = 11.5$[in]$*0.625$[in] $= \mathbf{7.19}$[in2] Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_y*A_g) = 2 * (0.599*36000[lb/in2]*7.19[in2]) = \mathbf{309.88}$[kip] Eq. J4-1

Leg tensile rupture	[Kip]	290.00	26.00	DL	0.09	Eq. J4-2

$A_g = L_p*t_p = 11.5$[in]$*0.625$[in] $= \mathbf{7.19}$[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (11.5[in] - 4*0.875[in])*0.625[in] = \mathbf{5}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*7.19[in2], 5[in2]) = \mathbf{5}$[in2] Sec. J4-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_u*A_e) = 2 * (0.5*58000[lb/in2]*5[in2]) = \mathbf{290}$[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	84.86	20.00	DL	0.24	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = \mathbf{10.61}$[kip] Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (4*10.61[kip]) = \mathbf{84.86}$[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	232.45	20.00	DL	0.09	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \max(0.0, L_e - d_h/2) = \max(0.0, 1.25[in] - 0.813[in]/2) = \mathbf{0.844}$[in] Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - d_h) = \max(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}$[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(4/(1*4))*(\min(1.2*0.844[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.625[in]*58000[lb/in2]*1) = \mathbf{232.45}$[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	207.00	20.00	DL	0.10	Eq. J4-3

$A_g = L_p*t_p = 11.5$[in]$*0.625$[in] $= \mathbf{7.19}$[in2] Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*7.19[in2]) = \mathbf{207}$[kip] Eq. J4-3

Shear rupture	[Kip]	174.00	20.00	DL	0.11	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$L_e = L - n*L_h = 11.5$[in] $- 4*0.875$[in] $= \mathbf{8}$[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8$[in]$*0.625$[in] $= \mathbf{5}$[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*5[in2]) = \mathbf{174}$[kip] Eq. J4-4

Block shear	[Kip]	159.90	20.00	DL	0.13	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] $= \mathbf{1.06}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.625[in] = \mathbf{0.371}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (4 - 1)*3[in])*0.625[in] = \mathbf{6.41}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.625[in] = \mathbf{4.49}$[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*4.49[in2] + 1*58000[lb/in2]*0.371[in2], 0.6*36000[lb/in2]*6.41[in2] + 1*58000[lb/in2]*0.371[in2])) = **159.9**[kip] — Eq. J4-5

Resulting tension capacity due prying action	[Kip]	61.43	26.00	DL	0.42	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 20[kip]/(0.442[in2]*8) = **5656.11**[lb/in2] — Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)*F_{nv})$, 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*5656.11[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] — Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] — Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 20[kip]/(0.442[in2]*8) = **5656.11**[lb/in2] — Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)*F_{nv})$, 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*5656.11[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] — Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] — Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.56[in] + 0.75[in]/2) = **1.5**[in] — p. 9-12

b' = b - $d/2$ = 2.56[in] - 0.75[in]/2 = **2.19**[in] — p. 9-12

ρ = b'/a' = 2.19[in]/1.5[in] = **1.46** — p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** — p. 9-11

t_c = ((3.33*B*b')/$((1/\Omega)*p*F_u)$)$^{0.5}$ = ((3.33*19.89[kip]*2.19[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.29**[in] — p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.46)))*((1.29[in]/0.625[in])^2 - 1) = **1.82** — p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.625[in]/1.29[in])^2*(1 + 0.729) = **0.406** — p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.56[in] + 0.75[in]/2) = **1.5**[in] — p. 9-12

b' = b - $d/2$ = 2.56[in] - 0.75[in]/2 = **2.19**[in] — p. 9-12

ρ = b'/a' = 2.19[in]/1.5[in] = **1.46** — p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** — p. 9-11

t_c = ((3.33*B*b')/$((1/\Omega)*p*F_u)$)$^{0.5}$ = ((3.33*19.89[kip]*2.19[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.35**[in] — p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.46)))*((1.35[in]/0.625[in])^2 - 1) = **2.11** — p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.625[in]/1.35[in])^2*(1 + 0.705) = **0.366** — p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.366 + (4 - 2)*0.406)/4 = **0.386** — p. 9-13

T_{avail} = 8 * (B*Q) = 8 * (19.89[kip]*0.386) = **61.43**[kip] — p. 9-10

Beam

Bolt bearing under shear load	[Kip]	73.71	20.00	DL	0.27	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 4.45[in] - 0.813[in]/2) = **4.04**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*4.04[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.315[in]*65000[lb/in2]*1 = **73.71**[kip] — Eq. J3-6

Shear yielding	[Kip]	112.77	20.00	DL	0.18	Eq. J4-3

A_g = L_p*t_p = 17.9[in]*0.315[in] = **5.64**[in2] — Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.64[in2] = **112.77**[kip] — Eq. J4-3

Bolt bearing under axial load	[Kip]	73.71	26.00	DL	0.35	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] — Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.315[in]*65000[lb/in2]*4 = **73.71**[kip] — Eq. J3-6

Tear out under axial load	[Kip]	86.53	26.00	DL	0.30	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] — Sec. D3-2

n>1 → 4>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.315[in] = \mathbf{1.42}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.315[in] = \mathbf{1.14}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(4 - 1)*0.315[in] = \mathbf{2.01}[in2]$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*1.14[in2] + 1*65000[lb/in2]*2.01[in2], 0.6*50000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*2.01[in2]) = \mathbf{86.53}[kip]$ Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	379.08	20.00	DL	0.05	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) = \mathbf{1.20E+31}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))*0.81[in]*65000[lb/in2]*1) = \mathbf{379.08}[kip]$ Eq. J3-6

Web crippling	[Kip]	511.10	26.00	DL2	0.05	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{18}[in]$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.515[in]^2*(1 + 3*(18[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])^{1/2} = \mathbf{511.1}[kip]$ Eq. J10-4

Global critical strength ratio **0.42**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection
IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:26 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-10

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W21X44

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	45.00	15.00	Design
DL2	45.00	-15.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	9.40	18.80	✔	p. 10-8
$L_{min} = T/2 = 18.8$[in]$/2 =$ **9.4**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.7[in] - max(0.95[in], 0[in]) - max(0.95[in], 0[in]) = **18.8**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	47.43	DL	0.45	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	45.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4* 0.75[in]$)*(5 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	45.00	DL	0.34	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.313$[in] = **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.53$[in2]$) =$ **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	45.00	DL	0.41	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in] $- 5*0.875$[in] $=$ **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.313$[in] = **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.16$[in2]$) =$ **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	45.00	DL	0.43	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.313$[in] = **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (5 - 1)*3$[in]$)*0.313$[in] = **4.14**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (5 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in] = **2.91**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.91$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 4.14[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **104.16**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	91.76	15.00	DL	0.16	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(1 - 1))*0.313[in]*58000[lb/in2]*5) = **91.76**[kip] Eq. J3-6

Tear out under axial load	[Kip]	170.94	15.00	DL	0.09	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*3[in])*0.313[in] = **0.781**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.313[in] = **0.508**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.313[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.508[in2] + 1*58000[lb/in2]*2.66[in2], 0.6*36000[lb/in2]* 0.781[in2] + 1*58000[lb/in2]*2.66[in2])) = **170.94**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	195.36	15.00	DL	0.08	Eq. J4-1

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*4.53[in2]) = **195.36**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	183.52	15.00	DL	0.08	Eq. J4-2

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (14.5[in] - 5*0.875[in])*0.313[in] = **3.16**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.53[in2], 3.16[in2]) = **3.16**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3.16[in2]) = **183.52**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	106.08	45.00	DL	0.42	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (5*10.61[kip]) = **106.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	148.85	45.00	DL	0.30	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	45.00	DL	0.34	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	45.00	DL	0.41	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.20	45.00	DL	0.45	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.186[in2])) = **100.2**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.10	15.00	DL	0.83	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 45[kip]/(0.442[in2]*10) = **10181**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)*F_{nv})$, 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*10181[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **78821.27**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)*F'_{nt}*A_b$ = 0.5*78821.27[lb/in2]*0.442[in2] = **17.42**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 45[kip]/(0.442[in2]*10) = **10181**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*$f_v/((1/\Omega)*F_{nv})$, 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*10181[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **78821.27**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)*F'_{nt}*A_b$ = 0.5*78821.27[lb/in2]*0.442[in2] = **17.42**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - d/2 = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/$((1/\Omega)*p*F_u)$)$^{0.5}$ = ((3.33*17.42[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.25**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.25[in]/0.313[in])^2 - 1) = **8.03** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.25[in])^2*(1 + 0.729) = **0.108** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - d/2 = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/$((1/\Omega)*p*F_u)$)$^{0.5}$ = ((3.33*17.42[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.31**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.31[in]/0.313[in])^2 - 1) = **9.12** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.31[in])^2*(1 + 0.705) = **0.0976** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0976 + (5 - 2)*0.108)/5 = **0.104** p. 9-13

T_{avail} = 10 * (B*Q) = 10 * (17.42[kip]*0.104) = **18.1**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	102.38	45.00	DL	0.44	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.35[in] - 0.813[in]/2) = **3.94**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*3.94[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.35[in]*65000[lb/in2]*1 = **102.38**[kip] Eq. J3-6

Shear yielding	[Kip]	144.90	45.00	DL	0.31	Eq. J4-3

A_g = L_p*t_p = 20.7[in]*0.35[in] = **7.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.25[in2] = **144.9**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	102.38	15.00	DL	0.15	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.35[in]*65000[lb/in2]*5 = **102.38**[kip] Eq. J3-6

Tear out under axial load	[Kip]	120.31	15.00	DL	0.12	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.35[in] =$ **1.58**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.35[in] =$ **1.27**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.35[in] =$ **2.98**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.27[in2] + 1*65000[lb/in2]*2.98[in2], 0.6*50000[lb/in2]*1.58[in2] + 1*65000[lb/in2]*2.98[in2]) =$ **120.31**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	353.93	45.00	DL	0.13	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(5 - 1))*0.605[in]*65000[lb/in2]*1) =$ **353.93**[kip] Eq. J3-6

Web crippling	[Kip]	372.26	15.00	DL2	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **24**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.39[in]^2*(1 + 3*(24[in]/12.1[in])*(0.39[in]/0.605[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.605[in]/0.39[in])^{1/2} =$ **372.26**[kip] Eq. J10-4

Global critical strength ratio **0.83**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:17 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-11

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W21X44

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	45.00	7.00	Design
DL2	45.00	-7.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	9.40	18.80	✔	p. 10-8
$L_{min} = T/2 = 18.8[in]/2 = \mathbf{9.4}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 20.7[in] - \max(0.95[in], 0[in]) - \max(0.95[in], 0[in]) = \mathbf{18.8}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.313[in], 12\ [in]) = \mathbf{7.5}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Beam						
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Support						
Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	45.54	DL	0.43	Tables (7-1..14)
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (5*10.61[kip]) = **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	45.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
(1/Ω)R_n = 2 * ((1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	45.00	DL	0.34	Eq. J4-3
A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2]						Sec. D3-1
(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	45.00	DL	0.41	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2]						Sec. J4-2
(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	45.00	DL	0.43	Eq. J4-5
dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.313[in] = **0.254**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **2.91**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]* 4.14[in2] + 1*58000[lb/in2]*0.254[in2])) = **104.16**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	91.76	7.00	DL	0.08	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*$
$0.75\text{[in]})*(1 - 1))*0.313\text{[in]}*58000\text{[lb/in2]}*5) = \mathbf{91.76}\text{[kip]}$ Eq. J3-6

Tear out under axial load [Kip] 170.94 7.00 DL 0.04 Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25\text{[in]} + (1 - 1)*3\text{[in]})*0.313\text{[in]} = \mathbf{0.781}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25\text{[in]} + (1 - 1)*3\text{[in]} - 0.875\text{[in]}*(1 -$
$0.5))*0.313\text{[in]} = \mathbf{0.508}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 0.875\text{[in]})*(5 - 1)*0.313\text{[in]} = \mathbf{2.66}\text{[in2]}$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$
$A_{nt})) = 2 * (0.5*\min(0.6*58000\text{[lb/in2]}*0.508\text{[in2]} + 1*58000\text{[lb/in2]}*2.66\text{[in2]}, 0.6*36000\text{[lb/in2]}*$
$0.781\text{[in2]} + 1*58000\text{[lb/in2]}*2.66\text{[in2]})) = \mathbf{170.94}\text{[kip]}$ Eq. J4-5

Leg tensile yielding [Kip] 195.36 7.00 DL 0.04 Eq. J4-1

$A_g = L_p*t_p = 14.5\text{[in]}*0.313\text{[in]} = \mathbf{4.53}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_y*A_g) = 2 * (0.599*36000\text{[lb/in2]}*4.53\text{[in2]}) = \mathbf{195.36}\text{[kip]}$ Eq. J4-1

Leg tensile rupture [Kip] 183.52 7.00 DL 0.04 Eq. J4-2

$A_g = L_p*t_p = 14.5\text{[in]}*0.313\text{[in]} = \mathbf{4.53}\text{[in2]}$ Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_n = (l - n*L_h)*t_p = (14.5\text{[in]} - 5*0.875\text{[in]})*0.313\text{[in]} = \mathbf{3.16}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*4.53\text{[in2]}, 3.16\text{[in2]}) = \mathbf{3.16}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_u*A_e) = 2 * (0.5*58000\text{[lb/in2]}*3.16\text{[in2]}) = \mathbf{183.52}\text{[kip]}$ Eq. J4-2

Angle (Support side)

Bolts shear [Kip] 106.08 45.00 DL 0.42 Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000\text{[lb/in2]}*0.442\text{[in2]} = \mathbf{10.61}\text{[kip]}$ Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61\text{[kip]}) = \mathbf{106.08}\text{[kip]}$ Tables (7-1..14)

Bolt bearing under shear load [Kip] 148.85 45.00 DL 0.30 p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25\text{[in]} - 0.813\text{[in]}/2) = \mathbf{0.844}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*$
$d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(\min(1.2*0.844\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*$
$2.19\text{[in]}, 2.4*0.75\text{[in]})*(5 - 1))*0.313\text{[in]}*58000\text{[lb/in2]}*1) = \mathbf{148.85}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding [Kip] 130.50 45.00 DL 0.34 Eq. J4-3

$A_g = L_p*t_p = 14.5\text{[in]}*0.313\text{[in]} = \mathbf{4.53}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000\text{[lb/in2]}*4.53\text{[in2]}) = \mathbf{130.5}\text{[kip]}$ Eq. J4-3

Shear rupture [Kip] 110.11 45.00 DL 0.41 Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 14.5\text{[in]} - 5*0.875\text{[in]} = \mathbf{10.13}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 10.13\text{[in]}*0.313\text{[in]} = \mathbf{3.16}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000\text{[lb/in2]}*3.16\text{[in2]}) = \mathbf{110.11}\text{[kip]}$ Eq. J4-4

Block shear [Kip] 100.20 45.00 DL 0.45 Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1\text{[in]} + 1/16\text{ [in]} = \mathbf{1.06}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13\text{[in]} + (1 - 1)*5.5\text{[in]} - (1 - 0.5)*$
$1.06\text{[in]})*0.313\text{[in]} = \mathbf{0.186}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25\text{[in]} + (5 - 1)*3\text{[in]})*0.313\text{[in]} = \mathbf{4.14}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25\text{[in]} + (5 - 1)*(3\text{[in]} - 0.875\text{[in]}) -$
$0.875\text{[in]}/2)*0.313\text{[in]} = \mathbf{2.91}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.186[in2])) = **100.2**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.10	7.00	DL	0.39	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 45[kip]/(0.442[in2]*10) = **10181**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*10181[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **78821.27**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*78821.27[lb/in2]*0.442[in2] = **17.42**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 45[kip]/(0.442[in2]*10) = **10181**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*10181[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **78821.27**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*78821.27[lb/in2]*0.442[in2] = **17.42**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*17.42[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.25**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.25[in]/0.313[in])^2 - 1) = **8.03** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.25[in])^2*(1 + 0.729) = **0.108** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*17.42[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.31**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.31[in]/0.313[in])^2 - 1) = **9.12** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.31[in])^2*(1 + 0.705) = **0.0976** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0976 + (5 - 2)*0.108)/5 = **0.104** p. 9-13

T_{avail} = 10 * (B*Q) = 10 * (17.42[kip]*0.104) = **18.1**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	102.38	45.00	DL	0.44	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 4.35[in] - 0.813[in]/2) = **3.94**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*3.94[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.35[in]*65000[lb/in2]*1 = **102.38**[kip] Eq. J3-6

Shear yielding	[Kip]	144.90	45.00	DL	0.31	Eq. J4-3

A_g = L_p*t_p = 20.7[in]*0.35[in] = **7.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.25[in2] = **144.9**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	102.38	7.00	DL	0.07	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.35[in]*65000[lb/in2]*5 = **102.38**[kip] Eq. J3-6

Tear out under axial load	[Kip]	120.31	7.00	DL	0.06	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 5>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.35[in] = \mathbf{1.58}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.35[in] = \mathbf{1.27}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.35[in] = \mathbf{2.98}[in2]$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*1.27[in2] + 1*65000[lb/in2]*2.98[in2], 0.6*50000[lb/in2]*1.58[in2] + 1*65000[lb/in2]*2.98[in2]) = \mathbf{120.31}[kip]$ Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	353.93	45.00	DL	0.13	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) = \mathbf{1.20E+31}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.605[in]*65000[lb/in2]*1) = \mathbf{353.93}[kip]$ Eq. J3-6

Web crippling	[Kip]	372.26	7.00	DL2	0.02	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{24}[in]$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.39[in]^2*(1 + 3*(24[in]/12.1[in])*(0.39[in]/0.605[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.605[in]/0.39[in])^{1/2} = \mathbf{372.26}[kip]$ Eq. J10-4

Global critical strength ratio **0.45**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection
IsCorrosionConsidered: Is corrosion considered

IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:16 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-12

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W24X68

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	15.00	Design
DL2	30.00	-15.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	10.76	21.52	✔	p. 10-8
$L_{min} = T/2 = 21.52[in]/2 = \mathbf{10.76}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.7[in] - \max(1.09[in], 0[in]) - \max(1.09[in], 0[in]) = \mathbf{21.52}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.313[in], 12\ [in]) = \mathbf{7.5}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	33.54	DL	0.32	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	30.00	DL	0.20	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4* 0.75[in]$)*(5 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	30.00	DL	0.23	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.313$[in] = **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.53$[in2]$) =$ **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	30.00	DL	0.27	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in] $- 5*0.875$[in] $=$ **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.313$[in] = **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.16$[in2]$) =$ **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	30.00	DL	0.29	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.313$[in] = **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (5 - 1)*3$[in]$)*0.313$[in] = **4.14**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (5 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in] = **2.91**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.91$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 4.14[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **104.16**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	91.76	15.00	DL	0.16	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(1 - 1))*0.313[in]*58000[lb/in2]*5) = **91.76**[kip] Eq. J3-6

Tear out under axial load	[Kip]	170.94	15.00	DL	0.09	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*3[in])*0.313[in] = **0.781**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.313[in] = **0.508**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.313[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.508[in2] + 1*58000[lb/in2]*2.66[in2], 0.6*36000[lb/in2]* 0.781[in2] + 1*58000[lb/in2]*2.66[in2])) = **170.94**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	195.36	15.00	DL	0.08	Eq. J4-1

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*4.53[in2]) = **195.36**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	183.52	15.00	DL	0.08	Eq. J4-2

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (14.5[in] - 5*0.875[in])*0.313[in] = **3.16**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.53[in2], 3.16[in2]) = **3.16**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3.16[in2]) = **183.52**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	106.08	30.00	DL	0.28	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (5*10.61[kip]) = **106.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	148.85	30.00	DL	0.20	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	30.00	DL	0.23	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	30.00	DL	0.27	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.20	30.00	DL	0.30	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.186[in2])) = **100.2**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.10	15.00	DL	0.83	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 30[kip]/(0.442[in2]*10) = **6787.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*6787.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 30[kip]/(0.442[in2]*10) = **6787.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*6787.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.34**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.34[in]/0.313[in])^2 - 1) = **9.24** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.34[in])^2*(1 + 0.729) = **0.0946** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.4**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.4[in]/0.313[in])^2 - 1) = **10.49** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.4[in])^2*(1 + 0.705) = **0.0855** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0855 + (5 - 2)*0.0946)/5 = **0.091** p. 9-13

T_{avail} = 10 * (B*Q) = 10 * (19.89[kip]*0.091) = **18.1**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	121.39	30.00	DL	0.25	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 5.85[in] - 0.813[in]/2) = **5.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*5.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.415[in]*65000[lb/in2]*1 = **121.39**[kip] Eq. J3-6

Shear yielding	[Kip]	196.71	30.00	DL	0.15	Eq. J4-3

A_g = L_p*t_p = 23.7[in]*0.415[in] = **9.84**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9.84[in2] = **196.71**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	121.39	15.00	DL	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.415[in]*65000[lb/in2]*5 = **121.39**[kip] Eq. J3-6

Tear out under axial load	[Kip]	142.66	15.00	DL	0.11	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.415[in] =$ **1.87**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.415[in] =$ **1.5**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.415[in] =$ **3.53**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*3.53[in2], 0.6*50000[lb/in2]*1.87[in2] + 1*65000[lb/in2]*3.53[in2]) =$ **142.66**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	473.85	30.00	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.81[in]*65000[lb/in2]*1) =$ **473.85**[kip] Eq. J3-6

Web crippling	[Kip]	628.06	15.00	DL2	0.02	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **24**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515[in]^2*(1 + 3*(24[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])^{1/2} =$ **628.06**[kip] Eq. J10-4

Global critical strength ratio **0.83**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

Current Date: 2016-05-25 5:29 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-05 Beam to Column Shear Connection with Axial Load\SC-05.cnx\

Steel connections

Results

Connection name : DA BCF All bolted
Connection ID : SC-05-13

Family: Beam - Column flange (BCF)
Type: Angle(s)
Description: W24X68

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	15.00	Design
DL2	30.00	-15.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	10.76	21.52	✔	p. 10-8
$L_{min} = T/2 = 21.52[in]/2 = \mathbf{10.76}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.7[in] - \max(1.09[in], 0[in]) - \max(1.09[in], 0[in]) = \mathbf{21.52}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.313[in], 12\ [in]) = \mathbf{7.5}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in] — Sec. J3.5

Beam

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Support

Horizontal edge distance	[in]	1.13	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	33.54	DL	0.32	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (5*10.61$[kip]$) =$ **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	30.00	DL	0.20	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4* 0.75[in]$)*(5 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	30.00	DL	0.23	Eq. J4-3
$A_g = L_p*t_p = 14.5$[in]$*0.313$[in] = **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*4.53$[in2]$) =$ **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	30.00	DL	0.27	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 14.5$[in] $- 5*0.875$[in] $=$ **10.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.13$[in]$*0.313$[in] = **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.16$[in2]$) =$ **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	30.00	DL	0.29	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 0.875[in]$)*0.313$[in] = **0.254**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in] $+ (5 - 1)*3$[in]$)*0.313$[in] = **4.14**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in] $+ (5 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.313$[in] = **2.91**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*$ $A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*2.91$[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$, 0.6*36000$[lb/in2]$*$ 4.14[in2]$ + 1*58000$[lb/in2]$*0.254$[in2]$)) =$ **104.16**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	91.76	15.00	DL	0.16	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(1 - 1))*0.313[in]*58000[lb/in2]*5) = **91.76**[kip] Eq. J3-6

Tear out under axial load	[Kip]	170.94	15.00	DL	0.09	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.25[in] + (1 - 1)*3[in])*0.313[in] = **0.781**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.313[in] = **0.508**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.313[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*0.508[in2] + 1*58000[lb/in2]*2.66[in2], 0.6*36000[lb/in2]* 0.781[in2] + 1*58000[lb/in2]*2.66[in2])) = **170.94**[kip] Eq. J4-5

Leg tensile yielding	[Kip]	195.36	15.00	DL	0.08	Eq. J4-1

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*4.53[in2]) = **195.36**[kip] Eq. J4-1

Leg tensile rupture	[Kip]	183.52	15.00	DL	0.08	Eq. J4-2

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (14.5[in] - 5*0.875[in])*0.313[in] = **3.16**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.53[in2], 3.16[in2]) = **3.16**[in2] Sec. J4-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_u*A_e) = 2 * (0.5*58000[lb/in2]*3.16[in2]) = **183.52**[kip] Eq. J4-2

Angle (Support side)

Bolts shear	[Kip]	106.08	30.00	DL	0.28	Tables (7-1..14)

$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (5*10.61[kip]) = **106.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	148.85	30.00	DL	0.20	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	30.00	DL	0.23	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	30.00	DL	0.27	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.20	30.00	DL	0.30	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) -

0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.186[in2])) = **100.2**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.10	15.00	DL	0.83	p. 9-13, p. 9-10

f_v = $F/(A_b*N_{bolts})$ = 30[kip]/(0.442[in2]*10) = **6787.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*6787.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = $F/(A_b*N_{bolts})$ = 30[kip]/(0.442[in2]*10) = **6787.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*6787.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.34**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.34[in]/0.313[in])^2 - 1) = **9.24** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.34[in])^2*(1 + 0.729) = **0.0946** p. 9-13

a' = Min(a + $d/2$, 1.25*b + $d/2$) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - $d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/2.75[in] = **0.705** p. 9-11

t_c = ((3.33*B*b')/($(1/\Omega)$*p*F_u))$^{0.5}$ = ((3.33*19.89[kip]*2.34[in])/(0.5*2.75[in]*58000[lb/in2]))$^{0.5}$ = **1.4**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.4[in]/0.313[in])^2 - 1) = **10.49** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.4[in])^2*(1 + 0.705) = **0.0855** p. 9-13

HasEqualLengths → **False**

Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0855 + (5 - 2)*0.0946)/5 = **0.091** p. 9-13

T_{avail} = 10 * (B*Q) = 10 * (19.89[kip]*0.091) = **18.1**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	121.39	30.00	DL	0.25	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 5.85[in] - 0.813[in]/2) = **5.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*5.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.415[in]*65000[lb/in2]*1 = **121.39**[kip] Eq. J3-6

Shear yielding	[Kip]	196.71	30.00	DL	0.15	Eq. J4-3

A_g = L_p*t_p = 23.7[in]*0.415[in] = **9.84**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9.84[in2] = **196.71**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	121.39	15.00	DL	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - $d_h/2$) = Max(0.0, 2.25[in] - 0.813[in]/2) = **1.84**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.84[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(1 - 1))*0.415[in]*65000[lb/in2]*5 = **121.39**[kip] Eq. J3-6

Tear out under axial load	[Kip]	142.66	15.00	DL	0.11	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.415[in] =$ **1.87**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 0.875[in]*(1 - 0.5))*0.415[in] =$ **1.5**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(5 - 1)*0.415[in] =$ **3.53**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*3.53[in2], 0.6*50000[lb/in2]*1.87[in2] + 1*65000[lb/in2]*3.53[in2]) =$ **142.66**[kip] Eq. J4-5

Support

Bolt bearing under shear load	[Kip]	353.93	30.00	DL	0.08	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(5 - 1))*0.605[in]*65000[lb/in2]*1) =$ **353.93**[kip] Eq. J3-6

Web crippling	[Kip]	372.26	15.00	DL2	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **24**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.39[in]^2*(1 + 3*(24[in]/12.1[in])*(0.39[in]/0.605[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.605[in]/0.39[in])^{1/2} =$ **372.26**[kip] Eq. J10-4

Global critical strength ratio **0.83**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
N: Bearing length
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
C_2: Edge distance increment
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F_{yw}: Specified minimum yield stress of web
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
g: Transversal gage between bolts
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamReaction: Is beam reaction
IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_f: Thickness of the loaded flange
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index

SC-06 BEAM TO GIRDER WEB DOUBLE ANGLE CONNECTION (ALL BOLTED)

Connection ID	Beam Size	Beam Web Thickness "t_w" (inch)	Design Reaction (kip)	Double Angle Size	3/4" Dia. A325N Bolt Rows	MINIMUM NP.OF BOLTS	Bolt Spacing（inch） "Spa."	Bolt Gage on Column Flange (inch) "Ga."	Beam Side Bolt Edge Distance（inch）		Girder Side Bolt Edge （inch）		Max. Cope Value (inch)				
									Vertical "L_{evb}"	Horizontal "L_{ehb}"	Vertical "L_{evg}"	Horizontal "L_{ehg}"	Cope	"d_{ct}"	"c_t"	"d_{cb}"	"c_b"
SC-06-01	W10X17	1/4	≤15	(2)L4x4x5/16	2	2	3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	1.5	5	0	0
													Top & Bottom Cope	1	2	1	2
SC-06-02	W10X33	5/16	≤25	(2)L4x4x5/16	2		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	1.5	5	0	0
SC-06-03	W12X14	3/16	≤10	(2)L4x4x5/16	3	3	3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1	3	1	3
SC-06-04	W12X19	1/4	≤20	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.25	4	1.25	4
SC-06-04a	W12X19		≤20	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	0.7	2	2.8	2
SC-06-04b	W12X19		≤18	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	2.7	7.9	0	0
SC-06-04c	W12X19		≤14	(2)L4x4x5/16	2		3	6	1.25	1.125	1.25	≥1.125	Top Bottom Only	0	0	4	3
SC-06-05	W12X22	1/4	≤10	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	1.5	3	0	0
SC-06-06	W12X26	1/4	≤15	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	1.25	5	0	0
SC-06-07	W14X22	1/4	≤30	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	1.5	5	0	0
SC-06-07a	W14X22		≤30	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.5	3	1.5	3
SC-06-07b	W14X22		≤25	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	2.7	7.9	0	0
SC-06-08	W14X26	1/4	≤20	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	1.5	5	0	0
SC-06-09	W16X26	1/4	≤30	(2)L4x4x5/16	3	4	3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.5	5.5	1.5	5.5
SC-06-10	W16X31	1/4	≤30	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.5	5	1.5	5
SC-06-10a	W16X31		≤20	(2)L4x4x5/16	3		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	3	8	0	0
SC-06-11	W18X35	5/16	≤40	(2)L4x4x5/16	4	5	3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.5	5	3	5
SC-06-11a	W18X35		≤30	(2)L4x4x5/16	4		3	6	1.25	1.125	1.25	≥1.125	Top Cope Only	3	8	0	0
SC-06-12	W18X40	5/16	≤45	(2)L4x4x5/16	4		3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.5	4	1.5	4
SC-06-13	W18X65	7/16	≤45	(2)L4x4x5/16	4		3	6.25	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.5	4	1.5	4
SC-06-14	W21X44	3/8	≤55	(2)L4x4x5/16	5	6	3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.25	4	4	4
SC-06-17	W24X55	3/8	≤60	(2)L4x4x5/16	5	7	3	6	1.25	1.125	1.25	≥1.125	Top & Bottom Cope	1.25	3.5	4	3.5

** SSL on outstanding legs against girder web. Other holes are standard.
See attached files for beam to girder erection sequence. Please distinguish the shop bolts and field bolts per erection sequence.
If the cope values required are greated than values in the table, please point out.
Stagger (P=1.5 inch) bolts when beam of gage 6.25 inch frames into girder with beam of gage=6 inch framing into from the other side. Use gage=6 inch

Current Date: 2016-05-25 1:03 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L3\W12X14 & W12X19.cnx\

Steel connections

Results

Connection name : DA BG All bolted
Connection ID : SC-06-04a

Family: Beam - Girder (BG)
Type: Angle(s)

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	5.45	9.70	✔	p. 10-8
$L_{min} = T/2 = 10.9[in]/2 = \mathbf{5.45}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 12.2[in] - \max(0.65[in], 1.25[in]) - \max(0.65[in], 1.25[in]) = \mathbf{9.7}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.235[in], 12\ [in]) = \mathbf{5.64}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Beam						
Top cope length	[in]	4.00	--	24.40	✔	
c_{max} = 2*d = 2*12.2[in] = **24.4**[in]						
Bottom cope length	[in]	4.00	--	24.40	✔	
c_{max} = 2*d = 2*12.2[in] = **24.4**[in]						
Top cope depth	[in]	1.25	--	1.85	✔	
d_{ctmax} = min(d/2, d_{top} - w) = min(12.2[in]/2, 1.85[in] - 0[in]) = **1.85**[in]						
Bottom cope depth	[in]	1.25	--	1.85	✔	
d_{cbmax} = min(d/2, d - L - d_{top} - w) = min(12.2[in]/2, 12.2[in] - 8.5[in] - 1.85[in] - 0[in]) = **1.85**[in]						
Vertical edge distance	[in]	1.85	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.38	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	20.00	DL	0.31	Tables (7-1..14)
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (3*10.61[kip]) = **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	20.00	DL	0.24	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	20.00	DL	0.26	Eq. J4-3
A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	20.00	DL	0.31	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	59.70	20.00	DL	0.34	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*3[in] - (1 - 0.5)*						

1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}))$ = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.186[in2])) = **59.7**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	63.65	20.00	DL	0.31	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n)$ = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	20.00	DL	0.24	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - dh/2)$ = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - dh)$ = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c)$ = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	20.00	DL	0.26	Eq. J4-3

$A_g = L_p*t_p$ = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g)$ = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	20.00	DL	0.31	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h$ = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv})$ = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	59.70	20.00	DL	0.34	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}))$ = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.186[in2])) = **59.7**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	10.57	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts})$ = 20[kip]/(0.442[in2]*6) = **7541.48**[lb/in2] Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt})$ = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*7541.48[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **88719.46**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*88719.46[lb/in2]*0.442[in2] = **19.61**[kip] Eq. J3-2

$f_v = F/(A_b*N_{bolts})$ = 20[kip]/(0.442[in2]*6) = **7541.48**[lb/in2] Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt})$ = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*7541.48[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **88719.46**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*88719.46[lb/in2]*0.442[in2] = **19.61**[kip] Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2)$ = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

$b' = b - d/2$ = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

$\rho = b'/a'$ = 2.34[in]/1.5[in] = **1.56** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/3\text{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.61\text{[kip]}*2.34\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.33}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.33\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{9.1}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.33\text{[in]})^2*(1 + 0.729) = \mathbf{0.096}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.5}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.34}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.61\text{[kip]}*2.34\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.39}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.39\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{10.33}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.39\text{[in]})^2*(1 + 0.705) = \mathbf{0.0868}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0868 + (3 - 2)*0.096)/3 = \mathbf{0.0898}$ p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (19.61\text{[kip]}*0.0898) = \mathbf{10.57}\text{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	40.73	20.00	DL	0.49	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.85\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.44}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*1.44\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*0.235\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{40.73}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	45.59	20.00	DL	0.44	Eq. J4-3

$A_g = L_p*t_p = 9.7\text{[in]}*0.235\text{[in]} = \mathbf{2.28}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*2.28\text{[in2]} = \mathbf{45.59}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	32.42	20.00	DL	0.62	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 9.7\text{[in]} - 3*0.875\text{[in]} = \mathbf{7.08}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 7.08\text{[in]}*0.235\text{[in]} = \mathbf{1.66}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*1.66\text{[in2]} = \mathbf{32.42}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	40.75	20.00	DL	0.49	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.38\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.235\text{[in]} = \mathbf{0.455}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.85\text{[in]} + (3 - 1)*3\text{[in]})*0.235\text{[in]} = \mathbf{1.84}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.85\text{[in]} + (3 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.235\text{[in]} = \mathbf{1.33}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*1.33\text{[in2]} + 1*65000\text{[lb/in2]}*0.455\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.84\text{[in2]} + 1*65000\text{[lb/in2]}*0.455\text{[in2]}) = \mathbf{40.75}\text{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	24.52	20.00	DL	0.82	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*3.69\text{[in3]}/4.5\text{[in]} = \mathbf{24.52}\text{[kip]}$ p. 9-6

Flexural rupture	[Kip]	26.62	20.00	DL	0.75	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*3.69\text{[in3]}/4.5\text{[in]} = \mathbf{26.62}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	24.52	20.00	DL	0.82	p. 9-8, p. 9-7

$h_o = d - d_c = 12.2\text{[in]} - 2.5\text{[in]} = \mathbf{9.7}\text{[in]}$ p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (4[in]<=2*12.2[in]) and (1.25[in]<=0.2*12.2[in]) and (4[in]<=2*12.2[in]) and (1.25[in]<=0.2*

12.2[in]) = **True** p. 9-8

f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1.25[in]/12.2[in]) = **2.73** p. 9-8

F_{cr} = 0.62*π*E*t_w^2/(c*h_o)*f_d = 0.62*π*2.90E+07[lb/in2]*0.235[in]^2/(4[in]*9.7[in])*2.73 = **2.20E+05**[lb/in2] p. 9-8

(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 2.20E+05[lb/in2])*3.69[in3]/4.5[in] = **24.52**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	138.65	20.00	DL	0.14	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.395[in]*65000[lb/in2]*1) = **138.65**[kip] Eq. J3-6

Global critical strength ratio **0.82**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length
$L_{c\text{-}end}$: Clear distance

L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:49 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L3\W14X22 & W14X26.cnx\

Steel connections

Results

Connection name : DA BG All bolted
Connection ID : SC-06-04b

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W12X19

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	18.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	5.45	8.85	✔	p. 10-8
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 2.7[in]) - max(0.65[in], 0[in]) = **8.85**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.235[in], 12 [in]) = **5.64**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in] — Sec. J3.5

Beam

Top cope length	[in]	8.00	--	24.40	✔	

$c_{max} = 2*d = 2*12.2$[in] = **24.4**[in]

Bottom cope length	[in]	0.00	--	24.40	✔	

$c_{max} = 2*d = 2*12.2$[in] = **24.4**[in]

Top cope depth	[in]	2.70	--	3.05	✔	

$d_{ctmax} = \min(d/2, d_{top} - w) = \min(12.2$[in]$/2, 3.05$[in] - 0[in]$) =$ **3.05**[in]

Bottom cope depth	[in]	0.00	--	0.65	✔	

$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(12.2$[in]$/2, 12.2$[in] - 8.5[in] - 3.05[in] - 0[in]$) =$ **0.65**[in]

Vertical edge distance	[in]	1.60	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	18.00	DL	0.28	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	18.00	DL	0.22	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] - 0.813[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 0.813[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4* 0.75[in]$)*(3 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	18.00	DL	0.24	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.313$[in] = **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*2.66$[in2]$) =$ **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	18.00	DL	0.28	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in] - 3*0.875[in]$ =$ **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.313$[in] = **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*1.84$[in2]$) =$ **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	63.66	18.00	DL	0.28	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.313[in] = **0.254**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]* 2.27[in2] + 1*58000[lb/in2]*0.254[in2])) = **63.66**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	63.65	18.00	DL	0.28	Tables (7-1..14)

(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	18.00	DL	0.22	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * ((1/Ω)*(*C*/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2* 2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	18.00	DL	0.24	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	18.00	DL	0.28	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	63.66	18.00	DL	0.28	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.313[in] = **0.254**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]* 2.27[in2] + 1*58000[lb/in2]*0.254[in2])) = **63.66**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	11.16	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 18[kip]/(0.442[in2]*6) = **6787.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*6787.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 18[kip]/(0.442[in2]*6) = **6787.33**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*6787.33[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **90000**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*90000[lb/in2]*0.442[in2] = **19.89**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.25[in] + 0.75[in]/2, 1.25*2.59[in] + 0.75[in]/2) = **1.63**[in] p. 9-12

b' = b - d/2 = 2.59[in] - 0.75[in]/2 = **2.22**[in] p. 9-12

$\rho = b'/a' = 2.22_{[in]}/1.63_{[in]} = \mathbf{1.37}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813_{[in]}/3_{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.89_{[kip]}*2.22_{[in]})/(0.5*3_{[in]}*58000_{[lb/in2]}))^{0.5} = \mathbf{1.3}_{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.37)))*((1.3_{[in]}/0.313_{[in]})^2 - 1) = \mathbf{9.45}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313_{[in]}/1.3_{[in]})^2*(1 + 0.729) = \mathbf{0.1}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.25_{[in]} + 0.75_{[in]}/2, 1.25*2.59_{[in]} + 0.75_{[in]}/2) = \mathbf{1.63}_{[in]}$ p. 9-12

$b' = b - d/2 = 2.59_{[in]} - 0.75_{[in]}/2 = \mathbf{2.22}_{[in]}$ p. 9-12

$\rho = b'/a' = 2.22_{[in]}/1.63_{[in]} = \mathbf{1.37}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813_{[in]}/2.75_{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.89_{[kip]}*2.22_{[in]})/(0.5*2.75_{[in]}*58000_{[lb/in2]}))^{0.5} = \mathbf{1.36}_{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.37)))*((1.36_{[in]}/0.313_{[in]})^2 - 1) = \mathbf{10.72}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313_{[in]}/1.36_{[in]})^2*(1 + 0.705) = \mathbf{0.0903}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0903 + (3 - 2)*0.1)/3 = \mathbf{0.0935}$ p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (19.89_{[kip]}*0.0935) = \mathbf{11.16}_{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	38.44	18.00	DL	0.47	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.6_{[in]} - 0.813_{[in]}/2) = \mathbf{1.19}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 0.813_{[in]}) = \mathbf{2.19}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*1.19_{[in]}, 2.4*0.75_{[in]}) + \text{min}(1.2*2.19_{[in]}, 2.4*0.75_{[in]})*(3 - 1))*0.235_{[in]}*65000_{[lb/in2]}*1 = \mathbf{38.44}_{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	44.65	18.00	DL	0.40	Eq. J4-3

$A_g = L_p*t_p = 9.5_{[in]}*0.235_{[in]} = \mathbf{2.23}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*2.23_{[in2]} = \mathbf{44.65}_{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	31.50	18.00	DL	0.57	Eq. J4-4

$L_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 9.5_{[in]} - 3*0.875_{[in]} = \mathbf{6.88}_{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 6.88_{[in]}*0.235_{[in]} = \mathbf{1.62}_{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000_{[lb/in2]}*1.62_{[in2]} = \mathbf{31.5}_{[kip]}$ Eq. J4-4

Block shear	[Kip]	38.65	18.00	DL	0.47	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25_{[in]} + (1 - 1)*3_{[in]} - (1 - 0.5)*0.875_{[in]})*0.235_{[in]} = \mathbf{0.426}_{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.6_{[in]} + (3 - 1)*3_{[in]})*0.235_{[in]} = \mathbf{1.79}_{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.6_{[in]} + (3 - 1)*(3_{[in]} - 0.875_{[in]}) - 0.875_{[in]}/2)*0.235_{[in]} = \mathbf{1.27}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000_{[lb/in2]}*1.27_{[in2]} + 1*65000_{[lb/in2]}*0.426_{[in2]}, 0.6*50000_{[lb/in2]}*1.79_{[in2]} + 1*65000_{[lb/in2]}*0.426_{[in2]}) = \mathbf{38.65}_{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	18.74	18.00	DL	0.96	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000_{[lb/in2]}*5.32_{[in3]}/8.5_{[in]} = \mathbf{18.74}_{[kip]}$ p. 9-6

Flexural rupture	[Kip]	20.34	18.00	DL	0.88	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000_{[lb/in2]}*5.32_{[in3]}/8.5_{[in]} = \mathbf{20.34}_{[kip]}$ p. 9-6

Local web buckling	[Kip]	18.74	18.00	DL	0.96	p. 9-7

$h_o = d - d_c = 12.2_{[in]} - 2.7_{[in]} = \mathbf{9.5}_{[in]}$ p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (8[in]<=2*12.2[in]) and (2.7[in]<=12.2[in]/2) = **True** p. 9-7

c/d<=1 → 8[in]/12.2[in]<=1 → **True**

$f = 2*c/d = 2*8[in]/12.2[in] =$ **1.31** p. 9-7

c/h_o<=1 → 8[in]/9.5[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(9.5[in]/8[in])^{1.65} =$ **2.92** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*$
$(0.235[in]/9.5[in])^2*1.31*2.92 =$ **61445.76**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000[lb/in2], 61445.76[lb/in2])*5.32[in3]/$
$8.5[in] =$ **18.74**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	331.70	18.00	DL	0.05	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(3 - 1))*0.945[in]*65000[lb/in2]*1) =$ **331.7**[kip] Eq. J3-6

Global critical strength ratio **0.96**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subject to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor

k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
ν: Poisson's ratio
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-13 3:38 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L1\B2G.cnx\

Steel connections

Results

Connection name : DA BG All bolted
Connection ID : SC-06-07a

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	6.11	10.70	✔	p. 10-8
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 1.5[in]) - \max(0.735[in], 1.5[in]) = \mathbf{10.7}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Top cope length	[in]	3.00	--	27.40	✔	
c_{max} = 2*d = 2*13.7[in] = **27.4**[in]						
Bottom cope length	[in]	3.00	--	27.40	✔	
c_{max} = 2*d = 2*13.7[in] = **27.4**[in]						
Top cope depth	[in]	1.50	--	2.60	✔	
d_{ctmax} = min(d/2, d_{top} - w) = min(13.7[in]/2, 2.6[in] - 0[in]) = **2.6**[in]						
Bottom cope depth	[in]	1.50	--	2.60	✔	
d_{cbmax} = min(d/2, d - L - d_{top} - w) = min(13.7[in]/2, 13.7[in] - 8.5[in] - 2.6[in] - 0[in]) = **2.6**[in]						
Vertical edge distance	[in]	2.35	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	30.00	DL	0.47	Tables (7-1..14)
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (3*10.61[kip]) = **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	30.00	DL	0.36	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	30.00	DL	0.39	Eq. J4-3
A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	30.00	DL	0.47	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	61.96	30.00	DL	0.48	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)*						

1.06[in])*0.313[in] = **0.225**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.225[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.225[in2])) = **61.96**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	63.65	30.00	DL	0.47	Tables (7-1..14)

(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	30.00	DL	0.36	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - dh/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - dh) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * ((1/Ω)*(*C*/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	30.00	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	30.00	DL	0.47	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	61.96	30.00	DL	0.48	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.225**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.225[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.225[in2])) = **61.96**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	11.16	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 30[kip]/(0.442[in2]*6) = **11312.22**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*11312.22[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **74579.19**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*74579.19[lb/in2]*0.442[in2] = **16.48**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 30[kip]/(0.442[in2]*6) = **11312.22**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*11312.22[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **74579.19**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*74579.19[lb/in2]*0.442[in2] = **16.48**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.25[in] + 0.75[in]/2, 1.25*2.59[in] + 0.75[in]/2) = **1.63**[in] p. 9-12

b' = b - d/2 = 2.59[in] - 0.75[in]/2 = **2.22**[in] p. 9-12

ρ = b'/a' = 2.22[in]/1.63[in] = **1.37** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/3\text{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*16.48\text{[kip]}*2.22\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.18}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.37)))*((1.18\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{7.73}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.18\text{[in]})^2*(1 + 0.729) = \mathbf{0.121}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.25\text{[in]} + 0.75\text{[in]}/2, 1.25*2.59\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.63}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.59\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.22}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.22\text{[in]}/1.63\text{[in]} = \mathbf{1.37}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*16.48\text{[kip]}*2.22\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.24}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.37)))*((1.24\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{8.78}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.24\text{[in]})^2*(1 + 0.705) = \mathbf{0.109}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.109 + (3 - 2)*0.121)/3 = \mathbf{0.113}$ p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (16.48\text{[kip]}*0.113) = \mathbf{11.16}\text{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	40.37	30.00	DL	0.74	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*1.94\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*0.23\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{40.37}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	49.22	30.00	DL	0.61	Eq. J4-3

$A_g = L_p*t_p = 10.7\text{[in]}*0.23\text{[in]} = \mathbf{2.46}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*2.46\text{[in2]} = \mathbf{49.22}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	36.22	30.00	DL	0.83	Eq. J4-4

$L_h = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 10.7\text{[in]} - 3*0.875\text{[in]} = \mathbf{8.08}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8.08\text{[in]}*0.23\text{[in]} = \mathbf{1.86}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*1.86\text{[in2]} = \mathbf{36.22}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	41.19	30.00	DL	0.73	Eq. J4-5

$dh_h = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ \text{[in]} = 0.813\text{[in]} + 1/16\ \text{[in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.23\text{[in]} = \mathbf{0.417}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2.35\text{[in]} + (3 - 1)*3\text{[in]})*0.23\text{[in]} = \mathbf{1.92}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2.35\text{[in]} + (3 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.23\text{[in]} = \mathbf{1.42}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*1.42\text{[in2]} + 1*65000\text{[lb/in2]}*0.417\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.92\text{[in2]} + 1*65000\text{[lb/in2]}*0.417\text{[in2]}) = \mathbf{41.19}\text{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	37.54	30.00	DL	0.80	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*4.39\text{[in3]}/3.5\text{[in]} = \mathbf{37.54}\text{[kip]}$ p. 9-6

Flexural rupture	[Kip]	40.75	30.00	DL	0.74	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*4.39\text{[in3]}/3.5\text{[in]} = \mathbf{40.75}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	37.54	30.00	DL	0.80	p. 9-8, p. 9-7

$h_o = d - d_c = 13.7\text{[in]} - 3\text{[in]} = \mathbf{10.7}\text{[in]}$ p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) =

(3[in]<=2*13.7[in]) and (1.5[in]<=0.2*13.7[in]) and (3[in]<=2*13.7[in]) and (1.5[in]<=0.2*13.7[in]) = **True** p. 9-8

f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1.5[in]/13.7[in]) = **2.68** p. 9-8

F_{cr} = 0.62*π*E*t_w^2/(c*h_o)*f_d = 0.62*π*2.90E+07[lb/in2]*0.23[in]^2/(3[in]*10.7[in])*2.68 = **2.49E+05**[lb/in2] p. 9-8

(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 2.49E+05[lb/in2])*4.39[in3]/3.5[in] = **37.54**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	80.73	30.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.23[in]*65000[lb/in2]*1) = **80.73**[kip] Eq. J3-6

Global critical strength ratio **0.83**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length

L: Angle length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:51 PM
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Steel connections

Results

Connection name : DA BG All bolted
Connection ID : SC-06-07b

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	6.11	10.26	✔	p. 10-8
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 2.7[in]) - \max(0.735[in], 0[in]) = \mathbf{10.27}[in]$						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in] — Sec. J3.5

Beam

Top cope length	[in]	7.90	--	27.40	✔	

$c_{max} = 2*d = 2*13.7$[in] = **27.4**[in]

Bottom cope length	[in]	0.00	--	27.40	✔	

$c_{max} = 2*d = 2*13.7$[in] = **27.4**[in]

Top cope depth	[in]	2.70	--	4.47	✔	

$d_{ctmax} = \min(d/2, d_{top} - w) = \min(13.7$[in]$/2, 4.47$[in] - 0[in]$) =$ **4.47**[in]

Bottom cope depth	[in]	0.00	--	0.74	✔	

$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(13.7$[in]$/2, 13.7$[in] - 8.5[in] - 4.47[in] - 0[in]$) =$ **0.735**[in]

Vertical edge distance	[in]	3.02	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	25.00	DL	0.39	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	25.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] - 0.813[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 0.813[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4* 0.75[in]$)*(3 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	25.00	DL	0.33	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.313$[in] = **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*2.66$[in2]$) =$ **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	25.00	DL	0.39	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in] - 3*0.875[in]$ =$ **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.313$[in]$ =$ **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*1.84$[in2]$) =$ **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	63.66	25.00	DL	0.39	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.313\text{[in]} = \mathbf{0.254}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25\text{[in]} + (3 - 1)*3\text{[in]})*0.313\text{[in]} = \mathbf{2.27}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25\text{[in]} + (3 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.313\text{[in]} = \mathbf{1.58}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000\text{[lb/in2]}*1.58\text{[in2]} + 1*58000\text{[lb/in2]}*0.254\text{[in2]}, 0.6*36000\text{[lb/in2]}*2.27\text{[in2]} + 1*58000\text{[lb/in2]}*0.254\text{[in2]})) = \mathbf{63.66}\text{[kip]}$ Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	63.65	25.00	DL	0.39	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000\text{[lb/in2]}*0.442\text{[in2]} = \mathbf{10.61}\text{[kip]}$ Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61\text{[kip]}) = \mathbf{63.65}\text{[kip]}$ Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	25.00	DL	0.30	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - dh/2) = \text{Max}(0.0, 1.25\text{[in]} - 0.813\text{[in]}/2) = \mathbf{0.844}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(\min(1.2*0.844\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*0.313\text{[in]}*58000\text{[lb/in2]}*1) = \mathbf{83.6}\text{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	25.00	DL	0.33	Eq. J4-3

$A_g = L_p*t_p = 8.5\text{[in]}*0.313\text{[in]} = \mathbf{2.66}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000\text{[lb/in2]}*2.66\text{[in2]}) = \mathbf{76.5}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	63.89	25.00	DL	0.39	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 8.5\text{[in]} - 3*0.875\text{[in]} = \mathbf{5.88}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 5.88\text{[in]}*0.313\text{[in]} = \mathbf{1.84}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000\text{[lb/in2]}*1.84\text{[in2]}) = \mathbf{63.89}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	59.70	25.00	DL	0.42	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1\text{[in]} + 1/16\text{ [in]} = \mathbf{1.06}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13\text{[in]} + (1 - 1)*5.5\text{[in]} - (1 - 0.5)*1.06\text{[in]})*0.313\text{[in]} = \mathbf{0.186}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25\text{[in]} + (3 - 1)*3\text{[in]})*0.313\text{[in]} = \mathbf{2.27}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25\text{[in]} + (3 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.313\text{[in]} = \mathbf{1.58}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000\text{[lb/in2]}*1.58\text{[in2]} + 1*58000\text{[lb/in2]}*0.186\text{[in2]}, 0.6*36000\text{[lb/in2]}*2.27\text{[in2]} + 1*58000\text{[lb/in2]}*0.186\text{[in2]})) = \mathbf{59.7}\text{[kip]}$ Eq. J4-5

Resulting tension capacity due prying action	[Kip]	10.57	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts}) = 25\text{[kip]}/(0.442\text{[in2]}*6) = \mathbf{9426.85}\text{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000\text{[lb/in2]} - 90000\text{[lb/in2]}*9426.85\text{[lb/in2]}/(0.5*48000\text{[lb/in2]}), 0.0), 90000\text{[lb/in2]}) = \mathbf{81649.32}\text{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*81649.32\text{[lb/in2]}*0.442\text{[in2]} = \mathbf{18.04}\text{[kip]}$ Eq. J3-2

$f_v = F/(A_b*N_{bolts}) = 25\text{[kip]}/(0.442\text{[in2]}*6) = \mathbf{9426.85}\text{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000\text{[lb/in2]} - 90000\text{[lb/in2]}*9426.85\text{[lb/in2]}/(0.5*48000\text{[lb/in2]}), 0.0), 90000\text{[lb/in2]}) = \mathbf{81649.32}\text{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*81649.32\text{[lb/in2]}*0.442\text{[in2]} = \mathbf{18.04}\text{[kip]}$ Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.5}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.34}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/3\text{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*18.04\text{[kip]}*2.34\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.27}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.27\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{8.34}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.27\text{[in]})^2*(1 + 0.729) = \mathbf{0.104}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.5}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.34}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*18.04\text{[kip]}*2.34\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.33}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.33\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{9.46}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.33\text{[in]})^2*(1 + 0.705) = \mathbf{0.0943}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0943 + (3 - 2)*0.104)/3 = \mathbf{0.0976}$ p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (18.04\text{[kip]}*0.0976) = \mathbf{10.57}\text{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	40.37	25.00	DL	0.62	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.02\text{[in]} - 0.813\text{[in]}/2) = \mathbf{2.61}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*2.61\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*0.23\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{40.37}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	50.60	25.00	DL	0.49	Eq. J4-3

$A_g = L_p*t_p = 11\text{[in]}*0.23\text{[in]} = \mathbf{2.53}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*2.53\text{[in2]} = \mathbf{50.6}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	37.56	25.00	DL	0.67	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 11\text{[in]} - 3*0.875\text{[in]} = \mathbf{8.38}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8.38\text{[in]}*0.23\text{[in]} = \mathbf{1.93}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*1.93\text{[in2]} = \mathbf{37.56}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	44.17	25.00	DL	0.57	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.23\text{[in]} = \mathbf{0.417}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (3.02\text{[in]} + (3 - 1)*3\text{[in]})*0.23\text{[in]} = \mathbf{2.07}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (3.02\text{[in]} + (3 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.23\text{[in]} = \mathbf{1.57}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*1.57\text{[in2]} + 1*65000\text{[lb/in2]}*0.417\text{[in2]}, 0.6*50000\text{[lb/in2]}*2.07\text{[in2]} + 1*65000\text{[lb/in2]}*0.417\text{[in2]}) = \mathbf{44.17}\text{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	25.23	25.00	DL	0.99	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*7.08\text{[in3]}/8.4\text{[in]} = \mathbf{25.23}\text{[kip]}$ p. 9-6

Flexural rupture	[Kip]	27.39	25.00	DL	0.91	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*7.08\text{[in3]}/8.4\text{[in]} = \mathbf{27.39}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	25.23	25.00	DL	0.99	p. 9-7

$h_o = d - d_c = 13.7\text{[in]} - 2.7\text{[in]} = \mathbf{11}\text{[in]}$ p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (7.9[in]<=2*13.7[in]) and (2.7[in]<=13.7[in]/2) = **True** p. 9-7

$c/d <= 1 \rightarrow 7.9[in]/13.7[in] <= 1 \rightarrow$ **True**

$f = 2*c/d = 2*7.9[in]/13.7[in] =$ **1.15** p. 9-7

$c/h_o <= 1 \rightarrow 7.9[in]/11[in] <= 1 \rightarrow$ **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(11[in]/7.9[in])^{1.65} =$ **3.8** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*$
$(0.23[in]/11[in])^2*1.15*3.8 =$ **50201.63**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000[lb/in2], 50201.63[lb/in2])*7.08[in3]/$
$8.4[in] =$ **25.23**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	331.70	25.00	DL	0.08	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*$
$0.75[in])*(3 - 1))*0.945[in]*65000[lb/in2]*1) =$ **331.7**[kip] Eq. J3-6

Global critical strength ratio **0.99**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length

L: Angle length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
ν: Poisson's ratio
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:06 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L2\SC-06-L2.cnx\

Steel connections

Results

Connection name : DA BG All bolted
Connection ID : SC-06-07c

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W12X19

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	14.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	5.50	5.45	7.55	✔	p. 10-8
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 0[in]) - max(0.65[in], 4[in]) = **7.55**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.235[in], 12 [in]) = **5.64**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0.125$[in] $=$ **1.13**[in]						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Beam						
Top cope length	[in]	0.00	--	24.40	✔	
c_{max} = 2*d = 2*12.2[in] = **24.4**[in]						
Bottom cope length	[in]	3.00	--	24.40	✔	
c_{max} = 2*d = 2*12.2[in] = **24.4**[in]						
Top cope depth	[in]	0.00	--	2.70	✔	
d_{ctmax} = min(d/2, d_{top} - w) = min(12.2[in]/2, 2.7[in] - 0[in]) = **2.7**[in]						
Bottom cope depth	[in]	4.00	--	4.00	✔	
d_{cbmax} = min(d/2, d - L - d_{top} - w) = min(12.2[in]/2, 12.2[in] - 5.5[in] - 2.7[in] - 0[in]) = **4**[in]						
Vertical edge distance	[in]	3.95	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	42.43	14.00	DL	0.33	Tables (7-1..14)
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (2*10.61[kip]) = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	50.98	14.00	DL	0.27	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(2 - 1))*0.313[in]*58000[lb/in2]*1) = **50.98**[kip]						Eq. J3-6
Shear yielding	[Kip]	49.50	14.00	DL	0.28	Eq. J4-3
A_g = L_p*t_p = 5.5[in]*0.313[in] = **1.72**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*1.72[in2]) = **49.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	40.78	14.00	DL	0.34	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 5.5[in] - 2*0.875[in] = **3.75**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 3.75[in]*0.313[in] = **1.17**[in2]						Sec. J4-2
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.17[in2]) = **40.78**[kip]						Eq. J4-4
Block shear	[Kip]	43.41	14.00	DL	0.32	Eq. J4-5
dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)*						

$0.875_{[in]}*0.313_{[in]} = \mathbf{0.254}_{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25_{[in]} + (2 - 1)*3_{[in]})*0.313_{[in]} = \mathbf{1.33}_{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25_{[in]} + (2 - 1)*(3_{[in]} - 0.875_{[in]}) - 0.875_{[in]}/2)*0.313_{[in]} = \mathbf{0.918}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000_{[lb/in2]}*0.918_{[in2]} + 1*58000_{[lb/in2]}*0.254_{[in2]}, 0.6*36000_{[lb/in2]}*1.33_{[in2]} + 1*58000_{[lb/in2]}*0.254_{[in2]})) = \mathbf{43.41}_{[kip]}$ Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	42.43	14.00	DL	0.33	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000_{[lb/in2]}*0.442_{[in2]} = \mathbf{10.61}_{[kip]}$ Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (2*10.61_{[kip]}) = \mathbf{42.43}_{[kip]}$ Tables (7-1..14)

Bolt bearing under shear load	[Kip]	50.98	14.00	DL	0.27	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - dh/2) = \text{Max}(0.0, 1.25_{[in]} - 0.813_{[in]}/2) = \mathbf{0.844}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 0.813_{[in]}) = \mathbf{2.19}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(2/(1*2))*(\min(1.2*0.844_{[in]}, 2.4*0.75_{[in]}) + \min(1.2*2.19_{[in]}, 2.4*0.75_{[in]})*(2 - 1))*0.313_{[in]}*58000_{[lb/in2]}*1) = \mathbf{50.98}_{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	49.50	14.00	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 5.5_{[in]}*0.313_{[in]} = \mathbf{1.72}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000_{[lb/in2]}*1.72_{[in2]}) = \mathbf{49.5}_{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	40.78	14.00	DL	0.34	Eq. J4-4

$L_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 5.5_{[in]} - 2*0.875_{[in]} = \mathbf{3.75}_{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 3.75_{[in]}*0.313_{[in]} = \mathbf{1.17}_{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000_{[lb/in2]}*1.17_{[in2]}) = \mathbf{40.78}_{[kip]}$ Eq. J4-4

Block shear	[Kip]	39.45	14.00	DL	0.35	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 1_{[in]} + 1/16\ _{[in]} = \mathbf{1.06}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13_{[in]} + (1 - 1)*5.5_{[in]} - (1 - 0.5)*1.06_{[in]})*0.313_{[in]} = \mathbf{0.186}_{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25_{[in]} + (2 - 1)*3_{[in]})*0.313_{[in]} = \mathbf{1.33}_{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25_{[in]} + (2 - 1)*(3_{[in]} - 0.875_{[in]}) - 0.875_{[in]}/2)*0.313_{[in]} = \mathbf{0.918}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000_{[lb/in2]}*0.918_{[in2]} + 1*58000_{[lb/in2]}*0.186_{[in2]}, 0.6*36000_{[lb/in2]}*1.33_{[in2]} + 1*58000_{[lb/in2]}*0.186_{[in2]})) = \mathbf{39.45}_{[kip]}$ Eq. J4-5

Resulting tension capacity due prying action	[Kip]	6.80	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts}) = 14_{[kip]}/(0.442_{[in2]}*4) = \mathbf{7918.55}_{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000_{[lb/in2]} - 90000_{[lb/in2]}*7918.55_{[lb/in2]}/(0.5*48000_{[lb/in2]}), 0.0), 90000_{[lb/in2]}) = \mathbf{87305.43}_{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*87305.43_{[lb/in2]}*0.442_{[in2]} = \mathbf{19.29}_{[kip]}$ Eq. J3-2

$f_v = F/(A_b*N_{bolts}) = 14_{[kip]}/(0.442_{[in2]}*4) = \mathbf{7918.55}_{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000_{[lb/in2]} - 90000_{[lb/in2]}*7918.55_{[lb/in2]}/(0.5*48000_{[lb/in2]}), 0.0), 90000_{[lb/in2]}) = \mathbf{87305.43}_{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*87305.43_{[lb/in2]}*0.442_{[in2]} = \mathbf{19.29}_{[kip]}$ Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13_{[in]} + 0.75_{[in]}/2, 1.25*2.72_{[in]} + 0.75_{[in]}/2) = \mathbf{1.5}_{[in]}$ p. 9-12

$b' = b - d/2 = 2.72_{[in]} - 0.75_{[in]}/2 = \mathbf{2.34}_{[in]}$ p. 9-12

$\rho = b'/a' = 2.34_{[in]}/1.5_{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/3\text{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.29\text{[kip]}*2.34\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.32}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.32\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{8.95}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.32\text{[in]})^2*(1 + 0.729) = \mathbf{0.0976}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.5}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.34}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.29\text{[kip]}*2.34\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.37}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.37\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{10.16}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.37\text{[in]})^2*(1 + 0.705) = \mathbf{0.0882}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0882 + (2 - 2)*0.0976)/2 = \mathbf{0.0882}$ p. 9-13

$T_{avail} = 4 * (B*Q) = 4 * (19.29\text{[kip]}*0.0882) = \mathbf{6.8}\text{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	27.50	14.00	DL	0.51	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.95\text{[in]} - 0.813\text{[in]}/2) = \mathbf{3.54}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*3.54\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(2 - 1))*0.235\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{27.5}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	38.54	14.00	DL	0.36	Eq. J4-3

$A_g = L_p*t_p = 8.2\text{[in]}*0.235\text{[in]} = \mathbf{1.93}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*1.93\text{[in2]} = \mathbf{38.54}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	29.56	14.00	DL	0.47	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 8.2\text{[in]} - 2*0.875\text{[in]} = \mathbf{6.45}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 6.45\text{[in]}*0.235\text{[in]} = \mathbf{1.52}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*1.52\text{[in2]} = \mathbf{29.56}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	38.34	14.00	DL	0.37	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.235\text{[in]} = \mathbf{0.426}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (3.95\text{[in]} + (2 - 1)*3\text{[in]})*0.235\text{[in]} = \mathbf{1.63}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (3.95\text{[in]} + (2 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.235\text{[in]} = \mathbf{1.32}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*1.32\text{[in2]} + 1*65000\text{[lb/in2]}*0.426\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.63\text{[in2]} + 1*65000\text{[lb/in2]}*0.426\text{[in2]}) = \mathbf{38.34}\text{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	34.50	14.00	DL	0.41	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*4.03\text{[in3]}/3.5\text{[in]} = \mathbf{34.5}\text{[kip]}$ p. 9-6

Flexural rupture	[Kip]	37.45	14.00	DL	0.37	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*4.03\text{[in3]}/3.5\text{[in]} = \mathbf{37.45}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	34.50	14.00	DL	0.41	p. 9-8, p. 9-7

$h_o = d - d_c = 12.2\text{[in]} - 4\text{[in]} = \mathbf{8.2}\text{[in]}$ p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (0[in]<=2*12.2[in]) and (0[in]<=0.2*12.2[in]) and (3[in]<=2*12.2[in]) and (4[in]<=0.2*

12.2[in]) = **False** p. 9-8

$\lambda = h_o*(F_y/(1\ [ksi]))^{1/2}/(10*t_w*(475 + 280*(h_o/c)^2)^{1/2}) = 8.2[in]*(50000[lb/in2]/(1\ [ksi]))^{1/2}/(10*0.235[in]*(475 + 280*(8.2[in]/3[in])^2)^{1/2}) =$ **0.487** p. 9-9

$\lambda Limit = \lambda <= 0.7 = 0.487 <= 0.7 =$ **True** p. 9-9

$Q = 1$ p. 9-9

$F_{cr} = F_y*Q = 50000[lb/in2]*1 =$ **50000**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000[lb/in2], 50000[lb/in2])*4.03[in3]/3.5[in] =$ **34.5**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	81.90	14.00	DL	0.17	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31[in] - 0.813[in]/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))*0.35[in]*65000[lb/in2]*1) =$ **81.9**[kip] Eq. J3-6

Global critical strength ratio **0.51**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length

$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
λ: Slenderness
$\lambda Limit$: Slenderness limit
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
Q: Slenderness factor
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:08 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L3\W16X31 &W16X26.cnx\

Steel connections

Results

Connection name : DA_BG
Connection ID : SC-06-10a

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W16X31

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	8.50	7.11	12.06	✔	p. 10-8
$L_{min} = T/2 = 14.22[in]/2 =$ **7.11**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.9[in] - max(0.842[in], 3[in]) - max(0.842[in], 0[in]) = **12.06**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] =$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] =$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.60	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] =$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.275[in], 12 [in]) = **6.6**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] =$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0.125[in] = **1.13**[in] — Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.313$[in], 12 [in]$) =$ **7.5**[in] — Sec. J3.5

Beam

Top cope length	[in]	8.00	--	31.80	✔	

$c_{max} = 2*d = 2*15.9$[in] = **31.8**[in]

Bottom cope length	[in]	0.00	--	31.80	✔	

$c_{max} = 2*d = 2*15.9$[in] = **31.8**[in]

Top cope depth	[in]	3.00	--	3.70	✔	

$d_{ctmax} = \min(d/2, d_{top} - w) = \min(15.9$[in]$/2, 3.7$[in] - 0[in]$) =$ **3.7**[in]

Bottom cope depth	[in]	0.00	--	3.70	✔	

$d_{cbmax} = \min(d/2, d - L - d_{top} - w) = \min(15.9$[in]$/2, 15.9$[in] - 8.5[in] - 3.7[in] - 0[in]$) =$ **3.7**[in]

Vertical edge distance	[in]	1.95	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in] — Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	63.65	20.00	DL	0.31	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (3*10.61$[kip]$) =$ **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	83.60	20.00	DL	0.24	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] - 0.813[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 0.813[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*0.844$[in], 2.4*0.75[in]$) + \min(1.2*2.19$[in], 2.4* 0.75[in]$)*(3 - 1))*0.313$[in]$*58000$[lb/in2]$*1) =$ **83.6**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.50	20.00	DL	0.26	Eq. J4-3
$A_g = L_p*t_p = 8.5$[in]$*0.313$[in] = **2.66**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*2.66$[in2]$) =$ **76.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.89	20.00	DL	0.31	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 8.5$[in] - 3*0.875[in]$ =$ **5.88**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 5.88$[in]$*0.313$[in]$ =$ **1.84**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*1.84$[in2]$) =$ **63.89**[kip]						Eq. J4-4
Block shear	[Kip]	63.66	20.00	DL	0.31	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)*0.875[in])*0.313[in] = **0.254**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * (*(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.254[in2])) = **63.66**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	63.65	20.00	DL	0.31	Tables (7-1..14)

(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (3*10.61[kip]) = **63.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	83.60	20.00	DL	0.24	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * (*(1/Ω)*(*C*/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **83.6**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	76.50	20.00	DL	0.26	Eq. J4-3

A_g = L_p*t_p = 8.5[in]*0.313[in] = **2.66**[in2] Sec. D3-1

(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.66[in2]) = **76.5**[kip] Eq. J4-3

Shear rupture	[Kip]	63.89	20.00	DL	0.31	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 8.5[in] - 3*0.875[in] = **5.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.88[in]*0.313[in] = **1.84**[in2] Sec. J4-2

(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.84[in2]) = **63.89**[kip] Eq. J4-4

Block shear	[Kip]	59.70	20.00	DL	0.34	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (3 - 1)*3[in])*0.313[in] = **2.27**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **1.58**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * (*(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.58[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*2.27[in2] + 1*58000[lb/in2]*0.186[in2])) = **59.7**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	10.57	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 20[kip]/(0.442[in2]*6) = **7541.48**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/(*(1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*7541.48[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **88719.46**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*88719.46[lb/in2]*0.442[in2] = **19.61**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 20[kip]/(0.442[in2]*6) = **7541.48**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/(*(1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*7541.48[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **88719.46**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*88719.46[lb/in2]*0.442[in2] = **19.61**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - d/2 = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/3\text{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.61\text{[kip]}*2.34\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.33}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.33\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{9.1}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.33\text{[in]})^2*(1 + 0.729) = \mathbf{0.096}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.5}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.34}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*19.61\text{[kip]}*2.34\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.39}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.39\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{10.33}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.39\text{[in]})^2*(1 + 0.705) = \mathbf{0.0868}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0868 + (3 - 2)*0.096)/3 = \mathbf{0.0898}$ p. 9-13

$T_{avail} = 6 * (B*Q) = 6 * (19.61\text{[kip]}*0.0898) = \mathbf{10.57}\text{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	48.26	20.00	DL	0.41	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.95\text{[in]} - 0.813\text{[in]}/2) = \mathbf{1.54}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*1.54\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(3 - 1))*0.275\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{48.26}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	70.95	20.00	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 12.9\text{[in]}*0.275\text{[in]} = \mathbf{3.55}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*3.55\text{[in2]} = \mathbf{70.95}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	55.10	20.00	DL	0.36	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 12.9\text{[in]} - 3*0.875\text{[in]} = \mathbf{10.28}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 10.28\text{[in]}*0.275\text{[in]} = \mathbf{2.83}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*2.83\text{[in2]} = \mathbf{55.1}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	47.10	20.00	DL	0.42	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25\text{[in]} + (1 - 1)*5.5\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.275\text{[in]} = \mathbf{0.498}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.95\text{[in]} + (3 - 1)*3\text{[in]})*0.275\text{[in]} = \mathbf{2.19}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.95\text{[in]} + (3 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.275\text{[in]} = \mathbf{1.58}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*1.58\text{[in2]} + 1*65000\text{[lb/in2]}*0.498\text{[in2]}, 0.6*50000\text{[lb/in2]}*2.19\text{[in2]} + 1*65000\text{[lb/in2]}*0.498\text{[in2]}) = \mathbf{47.1}\text{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	41.09	20.00	DL	0.49	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*11.67\text{[in3]}/8.5\text{[in]} = \mathbf{41.09}\text{[kip]}$ p. 9-6

Flexural rupture	[Kip]	44.61	20.00	DL	0.45	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*11.67\text{[in3]}/8.5\text{[in]} = \mathbf{44.61}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	41.09	20.00	DL	0.49	p. 9-7

$h_o = d - d_c = 15.9\text{[in]} - 3\text{[in]} = \mathbf{12.9}\text{[in]}$ p. 9-7

IsTopFlangeBeamCoped = (c<=$2*d$) and (d_c<=$d/2$) = (8[in]<=$2*15.9\text{[in]}$) and (3[in]<=$15.9\text{[in]}/2$) = **True** p. 9-7

c/d<=1 → $8\text{[in]}/15.9\text{[in]}$<=$1$ → **True**

$f = 2*c/d = 2*8$[in]$/15.9$[in] $=$ **1.01** p. 9-7

$c/h_o <= 1 \rightarrow 8$[in]$/12.9$[in]$ <= 1 \rightarrow$ **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(12.9$[in]$/8$[in]$)^{1.65} =$ **4.84** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*$
$(0.275$[in]$/12.9$[in]$)^2*1.01*4.84 =$ **58007.1**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 58007.1$[lb/in2]$)*11.67$[in3]$/$
8.5[in] $=$ **41.09**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	331.70	20.00	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in]$ - 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$
0.75[in]$)*(3 - 1))*0.945$[in]$*65000$[lb/in2]$*1) =$ **331.7**[kip] Eq. J3-6

Global critical strength ratio **0.49**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length

$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
ν: Poisson's ratio
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

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Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L3\W18X35 & W18X40.cnx\

Steel connections

Results

Connection name : DA BG All bolted
Connection ID : SC-06-11a

Family: Beam - Girder (BG)
Type: Angle(s)

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	11.51	8.02	13.87	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 3[in]) - max(0.827[in], 0[in]) = **13.87**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0.125$[in] $=$ **1.13**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.3$[in]$, 12$ [in]$) =$ **7.2**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0.125$[in] $=$ **1.13**[in]						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5

Beam

Top cope length	[in]	8.00	--	35.40	✔	
c_{max} = 2*d = 2*17.7[in] = **35.4**[in]						
Bottom cope length	[in]	0.00	--	35.40	✔	
c_{max} = 2*d = 2*17.7[in] = **35.4**[in]						
Top cope depth	[in]	3.00	--	3.10	✔	
d_{ctmax} = min(d/2, d_{top} - w) = min(17.7[in]/2, 3.1[in] - 0[in]) = **3.1**[in]						
Bottom cope depth	[in]	0.00	--	3.10	✔	
d_{cbmax} = min(d/2, d - L - d_{top} - w) = min(17.7[in]/2, 17.7[in] - 11.51[in] - 3.1[in] - 0[in]) = **3.1**[in]						
Vertical edge distance	[in]	1.35	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	84.86	30.00	DL	0.35	Tables (7-1..14)
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (4*10.61[kip]) = **84.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	116.23	30.00	DL	0.26	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(4 - 1))*0.313[in]*58000[lb/in2]*1) = **116.23**[kip]						Eq. J3-6
Shear yielding	[Kip]	103.55	30.00	DL	0.29	Eq. J4-3
A_g = L_p*t_p = 11.51[in]*0.313[in] = **3.6**[in2]						Sec. D3-1
(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*3.6[in2]) = **103.55**[kip]						Eq. J4-3
Shear rupture	[Kip]	87.07	30.00	DL	0.34	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 11.51[in] - 4*0.875[in] = **8.01**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 8.01[in]*0.313[in] = **2.5**[in2]						Sec. J4-2
(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*2.5[in2]) = **87.07**[kip]						Eq. J4-4
Block shear	[Kip]	82.21	30.00	DL	0.36	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.06[in])*0.313[in] = **0.225**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (4 - 1)*3[in])*0.313[in] = **3.2**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (4 - 1)*(3[in] - 0.875[in]) -						

$0.875_{[in]}/2)*0.313_{[in]} = \mathbf{2.25}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000_{[lb/in2]}*2.25_{[in2]} + 1*58000_{[lb/in2]}*0.225_{[in2]}, 0.6*36000_{[lb/in2]}*3.2_{[in2]} + 1*58000_{[lb/in2]}*0.225_{[in2]})) = \mathbf{82.21}_{[kip]}$ Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	84.86	30.00	DL	0.35	Tables (7-1..14)

$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000_{[lb/in2]}*0.442_{[in2]} = \mathbf{10.61}_{[kip]}$ Eq. J3-1

$(1/\Omega)R_n = 2 * (C*(1/\Omega)R_n) = 2 * (4*10.61_{[kip]}) = \mathbf{84.86}_{[kip]}$ Tables (7-1..14)

Bolt bearing under shear load	[Kip]	116.29	30.00	DL	0.26	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25_{[in]} - 0.813_{[in]}/2) = \mathbf{0.847}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 0.813_{[in]}) = \mathbf{2.19}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(4/(1*4))*(\min(1.2*0.847_{[in]}, 2.4*0.75_{[in]}) + \min(1.2*2.19_{[in]}, 2.4*0.75_{[in]})*(4 - 1))*0.313_{[in]}*58000_{[lb/in2]}*1) = \mathbf{116.29}_{[kip]}$ p. 7-18, Sec. J3.10

Shear yielding	[Kip]	103.55	30.00	DL	0.29	Eq. J4-3

$A_g = L_p*t_p = 11.51_{[in]}*0.313_{[in]} = \mathbf{3.6}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000_{[lb/in2]}*3.6_{[in2]}) = \mathbf{103.55}_{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	87.07	30.00	DL	0.34	Eq. J4-4

$L_h = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 11.51_{[in]} - 4*0.875_{[in]} = \mathbf{8.01}_{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 8.01_{[in]}*0.313_{[in]} = \mathbf{2.5}_{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000_{[lb/in2]}*2.5_{[in2]}) = \mathbf{87.07}_{[kip]}$ Eq. J4-4

Block shear	[Kip]	79.97	30.00	DL	0.38	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 1_{[in]} + 1/16\ _{[in]} = \mathbf{1.06}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 0.813_{[in]} + 1/16\ _{[in]} = \mathbf{0.875}_{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13_{[in]} + (1 - 1)*5.5_{[in]} - (1 - 0.5)*1.06_{[in]})*0.313_{[in]} = \mathbf{0.186}_{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25_{[in]} + (4 - 1)*3_{[in]})*0.313_{[in]} = \mathbf{3.2}_{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25_{[in]} + (4 - 1)*(3_{[in]} - 0.875_{[in]}) - 0.875_{[in]}/2)*0.313_{[in]} = \mathbf{2.25}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000_{[lb/in2]}*2.25_{[in2]} + 1*58000_{[lb/in2]}*0.186_{[in2]}, 0.6*36000_{[lb/in2]}*3.2_{[in2]} + 1*58000_{[lb/in2]}*0.186_{[in2]})) = \mathbf{79.97}_{[kip]}$ Eq. J4-5

Resulting tension capacity due prying action	[Kip]	14.34	0.00	DL	0.00	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts}) = 30_{[kip]}/(0.442_{[in2]}*8) = \mathbf{8484.16}_{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000_{[lb/in2]} - 90000_{[lb/in2]}*8484.16_{[lb/in2]}/(0.5*48000_{[lb/in2]}), 0.0), 90000_{[lb/in2]}) = \mathbf{85184.39}_{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*85184.39_{[lb/in2]}*0.442_{[in2]} = \mathbf{18.83}_{[kip]}$ Eq. J3-2

$f_v = F/(A_b*N_{bolts}) = 30_{[kip]}/(0.442_{[in2]}*8) = \mathbf{8484.16}_{[lb/in2]}$ Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*90000_{[lb/in2]} - 90000_{[lb/in2]}*8484.16_{[lb/in2]}/(0.5*48000_{[lb/in2]}), 0.0), 90000_{[lb/in2]}) = \mathbf{85184.39}_{[lb/in2]}$ Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*85184.39_{[lb/in2]}*0.442_{[in2]} = \mathbf{18.83}_{[kip]}$ Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13_{[in]} + 0.75_{[in]}/2, 1.25*2.72_{[in]} + 0.75_{[in]}/2) = \mathbf{1.5}_{[in]}$ p. 9-12

$b' = b - d/2 = 2.72_{[in]} - 0.75_{[in]}/2 = \mathbf{2.34}_{[in]}$ p. 9-12

$\rho = b'/a' = 2.34_{[in]}/1.5_{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813_{[in]}/3_{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*18.83_{[kip]}*2.34_{[in]})/(0.5*3_{[in]}*58000_{[lb/in2]}))^{0.5} = \mathbf{1.3}_{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.3\text{[in]}/0.313\text{[in]})^2 - 1) =$
8.72 p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.3\text{[in]})^2*(1 + 0.729) =$ **0.1** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) =$ **1.5**[in] p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 =$ **2.34**[in] p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} =$ **1.56** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} =$ **0.705** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*18.83\text{[kip]}*2.34\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} =$ **1.36**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.36\text{[in]}/0.313\text{[in]})^2 - 1) =$
9.88 p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.36\text{[in]})^2*(1 + 0.705) =$ **0.0905** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0905 + (4 - 2)*0.1)/4 =$ **0.0952** p. 9-13

$T_{avail} = 8 * (B*Q) = 8 * (18.83\text{[kip]}*0.0952) =$ **14.34**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	63.66	30.00	DL	0.47	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.35\text{[in]} - 0.813\text{[in]}/2) =$ **0.941**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*0.941\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(4 - 1))*$
$0.3\text{[in]}*65000\text{[lb/in2]}*1 =$ **63.66**[kip] Eq. J3-6

Shear yielding	[Kip]	88.20	30.00	DL	0.34	Eq. J4-3

$A_g = L_p*t_p = 14.7\text{[in]}*0.3\text{[in]} =$ **4.41**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*4.41\text{[in2]} =$ **88.2**[kip] Eq. J4-3

Shear rupture	[Kip]	65.52	30.00	DL	0.46	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} =$ **0.875**[in] Sec. D3-2

$L_e = L - n*L_h = 14.7\text{[in]} - 4*0.875\text{[in]} =$ **11.2**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 11.2\text{[in]}*0.3\text{[in]} =$ **3.36**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*3.36\text{[in2]} =$ **65.52**[kip] Eq. J4-4

Block shear	[Kip]	60.29	30.00	DL	0.50	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} =$ **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} =$ **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*$
$0.875\text{[in]})*0.3\text{[in]} =$ **0.544**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.35\text{[in]} + (4 - 1)*3\text{[in]})*0.3\text{[in]} =$ **3.1**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.35\text{[in]} + (4 - 1)*(3\text{[in]} - 0.875\text{[in]}) -$
$0.875\text{[in]}/2)*0.3\text{[in]} =$ **2.19**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\text{min}(0.6*65000\text{[lb/in2]}*2.19\text{[in2]} + 1*65000\text{[lb/in2]}*0.544\text{[in2]}, 0.6*50000\text{[lb/in2]}*3.1\text{[in2]} + 1*65000\text{[lb/in2]}*0.544\text{[in2]}) =$ **60.29**[kip] Eq. J4-5

Flexural yielding	[Kip]	56.94	30.00	DL	0.53	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*16.16\text{[in3]}/8.5\text{[in]} =$ **56.94**[kip] p. 9-6

Flexural rupture	[Kip]	61.80	30.00	DL	0.49	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*16.16\text{[in3]}/8.5\text{[in]} =$ **61.8**[kip] p. 9-6

Local web buckling	[Kip]	56.94	30.00	DL	0.53	p. 9-7

$h_o = d - d_c = 17.7\text{[in]} - 3\text{[in]} =$ **14.7**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=$2*d$) and (d_c<=$d/2$) = (8[in]<=$2*17.7\text{[in]}$) and (3[in]<=$17.7\text{[in]}/2$) = **True** p. 9-7

c/d<=1 → $8\text{[in]}/17.7\text{[in]}$<=$1$ → **True**

$f = 2*c/d = 2*8\text{[in]}/17.7\text{[in]} =$ **0.904** p. 9-7

c/h_o<=1 → $8\text{[in]}/14.7\text{[in]}$<=$1$ → **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(14.7\text{[in]}/8\text{[in]})^{1.65} =$ **6** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*(0.3$[in]$/14.7$[in]$)^2*0.904*6 =$ **59241.69**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 59241.69$[lb/in2]$)*16.16$[in3]$/8.5$[in] = **56.94**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	442.26	30.00	DL	0.07	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in]$ - 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*0.945$[in]$*65000$[lb/in2]$*1) =$ **442.26**[kip] Eq. J3-6

Global critical strength ratio **0.53**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
ν: Poisson's ratio
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:17 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-06 Beam to Girder Double Angle All Bolted\L2\SC-06-L2.cnx\

Steel connections

Results

Connection name : DA_BG
Connection ID : SC-06-17

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W24X55

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	60.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	14.50	10.79	18.35	✔	p. 10-8
$L_{min} = T/2 = 21.58[in]/2 = \mathbf{10.79}[in]$						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 23.6[in] - max(1.01[in], 1.25[in]) - max(1.01[in], 4[in]) = **18.35**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.313[in], 12\ [in]) = \mathbf{7.5}[in]$						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8\ [in]$						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Beam						
Top cope length	[in]	3.50	--	47.20	✔	
c_{max} = 2*d = 2*23.6[in] = **47.2**[in]						
Bottom cope length	[in]	3.50	--	47.20	✔	
c_{max} = 2*d = 2*23.6[in] = **47.2**[in]						
Top cope depth	[in]	1.25	--	5.10	✔	
d_{ctmax} = min(d/2, d_{top} - w) = min(23.6[in]/2, 5.1[in] - 0[in]) = **5.1**[in]						
Bottom cope depth	[in]	4.00	--	4.00	✔	
d_{cbmax} = min(d/2, d - L - d_{top} - w) = min(23.6[in]/2, 23.6[in] - 14.5[in] - 5.1[in] - 0[in]) = **4**[in]						
Vertical edge distance	[in]	5.10	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	106.08	60.00	DL	0.57	Tables (7-1..14)
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (5*10.61[kip]) = **106.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	148.85	60.00	DL	0.40	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n$ = 2 * (($1/\Omega$)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	130.50	60.00	DL	0.46	Eq. J4-3
A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * (($1/\Omega$)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.11	60.00	DL	0.54	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2]						Sec. J4-2
$(1/\Omega)R_n$ = 2 * (($1/\Omega$)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip]						Eq. J4-4
Block shear	[Kip]	104.16	60.00	DL	0.58	Eq. J4-5
dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)*						

0.875[in])*0.313[in] = **0.254**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.254[in2])) = **104.16**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	106.08	60.00	DL	0.57	Tables (7-1..14)

(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

(1/Ω)R_n = 2 * (C*(1/Ω)R_n) = 2 * (5*10.61[kip]) = **106.08**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	148.85	60.00	DL	0.40	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - dh/2) = Max(0.0, 1.25[in] - 0.813[in]/2) = **0.844**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - dh) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * ((1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(5/(1*5))*(min(1.2*0.844[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(5 - 1))*0.313[in]*58000[lb/in2]*1) = **148.85**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	130.50	60.00	DL	0.46	Eq. J4-3

A_g = L_p*t_p = 14.5[in]*0.313[in] = **4.53**[in2] Sec. D3-1

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.53[in2]) = **130.5**[kip] Eq. J4-3

Shear rupture	[Kip]	110.11	60.00	DL	0.54	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 14.5[in] - 5*0.875[in] = **10.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 10.13[in]*0.313[in] = **3.16**[in2] Sec. J4-2

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.16[in2]) = **110.11**[kip] Eq. J4-4

Block shear	[Kip]	100.20	60.00	DL	0.60	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25[in] + (5 - 1)*3[in])*0.313[in] = **4.14**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **2.91**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.91[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*4.14[in2] + 1*58000[lb/in2]*0.186[in2])) = **100.2**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	18.10	0.00	DL	0.00	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 60[kip]/(0.442[in2]*10) = **13574.66**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*13574.66[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **66095.02**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*66095.02[lb/in2]*0.442[in2] = **14.61**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 60[kip]/(0.442[in2]*10) = **13574.66**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*13574.66[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **66095.02**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*66095.02[lb/in2]*0.442[in2] = **14.61**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - d/2 = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/3\text{[in]} = \mathbf{0.729}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*14.61\text{[kip]}*2.34\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.14}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.14\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{6.65}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.14\text{[in]})^2*(1 + 0.729) = \mathbf{0.129}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.13\text{[in]} + 0.75\text{[in]}/2, 1.25*2.72\text{[in]} + 0.75\text{[in]}/2) = \mathbf{1.5}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 0.75\text{[in]}/2 = \mathbf{2.34}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.34\text{[in]}/1.5\text{[in]} = \mathbf{1.56}$ p. 9-12

$\delta = 1 - d'/p = 1 - 0.813\text{[in]}/2.75\text{[in]} = \mathbf{0.705}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*14.61\text{[kip]}*2.34\text{[in]})/(0.5*2.75\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.2}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.705*(1 + 1.56)))*((1.2\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{7.55}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.2\text{[in]})^2*(1 + 0.705) = \mathbf{0.116}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.116 + (5 - 2)*0.129)/5 = \mathbf{0.124}$ p. 9-13

$T_{avail} = 10 * (B*Q) = 10 * (14.61\text{[kip]}*0.124) = \mathbf{18.1}\text{[kip]}$ p. 9-10

Beam

Bolt bearing under shear load	[Kip]	115.54	60.00	DL	0.52	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.1\text{[in]} - 0.813\text{[in]}/2) = \mathbf{4.69}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 0.813\text{[in]}) = \mathbf{2.19}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*4.69\text{[in]}, 2.4*0.75\text{[in]}) + \text{min}(1.2*2.19\text{[in]}, 2.4*0.75\text{[in]})*(5 - 1))*0.395\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{115.54}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	144.97	60.00	DL	0.41	Eq. J4-3

$A_g = L_p*t_p = 18.35\text{[in]}*0.395\text{[in]} = \mathbf{7.25}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*7.25\text{[in2]} = \mathbf{144.97}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	107.64	60.00	DL	0.56	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n*L_h = 18.35\text{[in]} - 5*0.875\text{[in]} = \mathbf{13.98}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 13.98\text{[in]}*0.395\text{[in]} = \mathbf{5.52}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000\text{[lb/in2]}*5.52\text{[in2]} = \mathbf{107.64}\text{[kip]}$ Eq. J4-4

Block shear	[Kip]	124.59	60.00	DL	0.48	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25\text{[in]} + (1 - 1)*5.5\text{[in]} - (1 - 0.5)*0.875\text{[in]})*0.395\text{[in]} = \mathbf{0.716}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (5.1\text{[in]} + (5 - 1)*3\text{[in]})*0.395\text{[in]} = \mathbf{6.75}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (5.1\text{[in]} + (5 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.395\text{[in]} = \mathbf{5.2}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*5.2\text{[in2]} + 1*65000\text{[lb/in2]}*0.716\text{[in2]}, 0.6*50000\text{[lb/in2]}*6.75\text{[in2]} + 1*65000\text{[lb/in2]}*0.716\text{[in2]}) = \mathbf{124.59}\text{[kip]}$ Eq. J4-5

Flexural yielding	[Kip]	165.92	60.00	DL	0.36	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000\text{[lb/in2]}*22.17\text{[in3]}/4\text{[in]} = \mathbf{165.92}\text{[kip]}$ p. 9-6

Flexural rupture	[Kip]	180.11	60.00	DL	0.33	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*22.17\text{[in3]}/4\text{[in]} = \mathbf{180.11}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	165.92	60.00	DL	0.36	p. 9-8, p. 9-7

$h_o = d - d_c = 23.6\text{[in]} - 5.25\text{[in]} = \mathbf{18.35}\text{[in]}$ p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3.5[in]<=2*23.6[in]) and (1.25[in]<=0.2*23.6[in]) and (3.5[in]<=2*23.6[in]) and (4[in]<=0.2*

23.6[in]) = **True** p. 9-8

f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(4[in]/23.6[in]) = **2.23** p. 9-8

F_{cr} = 0.62*π*E*t_w^2/(c*h_o)*f_d = 0.62*π*2.90E+07[lb/in2]*0.395[in]^2/(3.5[in]*18.35[in])*
2.23 = **3.06E+05**[lb/in2] p. 9-8

(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 3.06E+05[lb/in2])*
22.17[in3]/4[in] = **165.92**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	204.75	60.00	DL	0.29	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*
t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*
0.75[in])*(5 - 1))*0.35[in]*65000[lb/in2]*1) = **204.75**[kip] Eq. J3-6

Global critical strength ratio **0.60**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
E: Elastic modulus
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
HasEqualLengths: Has equal tributary length for interior and exterior bolts
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length
$L_{c\text{-}end}$: Clear distance

L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts
Q: Prying action coefficient
Q_{ext}: Prying action coefficient for exterior bolts
Q_{int}: Prying action coefficient for interior bolts
Q: Prying action coefficient
ρ: Prying distances ratio
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
T_{avail}: Available tensile strength per bolt including effects of prying action
t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w: Weld size
Z_{net}: Net plastic section modulus

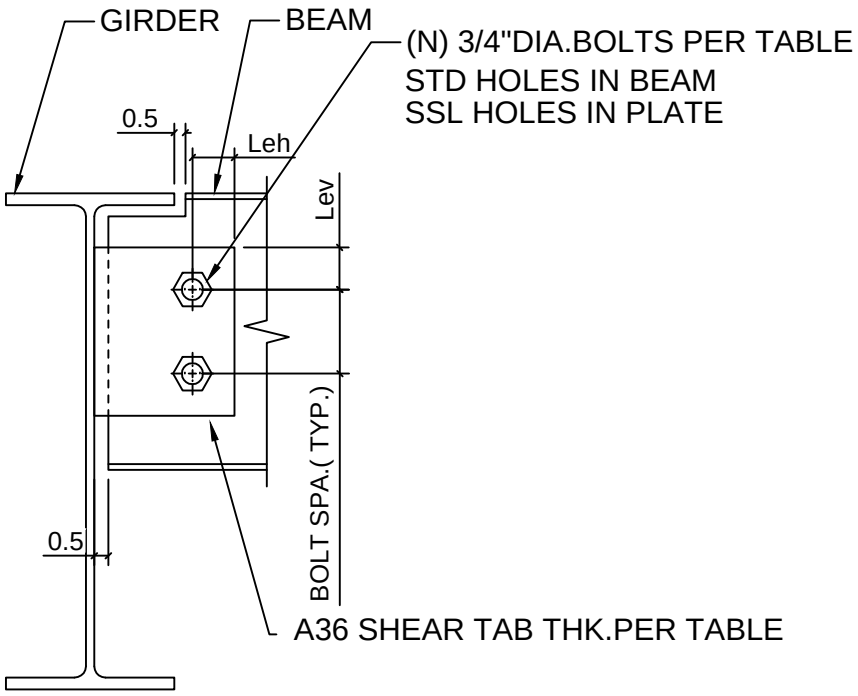
SC-07 Beam to Girder Shear Tab Connection

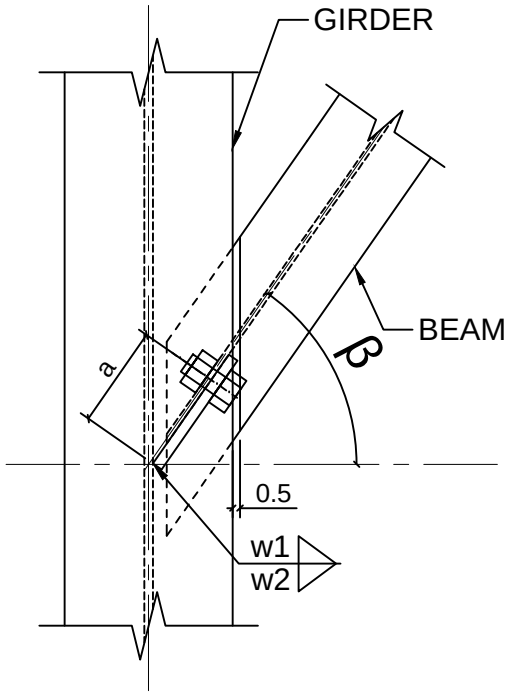
Level	Connection ID	Location	Beam	Girder	Shear Loading (kips)	Angle β	Feature*	Bolt Size and Grade	3/4" Dia. A325N Bolt Rows	Bolt Spacing (inch) "Spa."	A36 Plate Thk. (inch) "tp"	Distance of Bolt Line to Support (inch) "a"	Weld Size"w" (inch)	Horizontal Bolt Edge Distance (inch) "L_{eh}"	Vertical Bolt Edge Distance (inch) "L_{ev}"	Max. Top Dep. Cope Value (inch) "dct"	Max. Top Width Cope Value (inch) "ct"	Max. Bottom Dep. Cope Value (inch) "dcb"	Max. Bottom Width Cope Value (inch) "cb"
ROOF	**SC-07-01**	7.3,8.1-F2,F1	W10X12	W12X14	≤15	40	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.25	3	0	0
L1	**SC-07-02**	7-E,D	W10X17	W18X65	≤15	0	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.25	3.6	0	0
L2,L3	**SC-07-03**	3,4-A1,A2	W10X17	W24X62 W24X55	≤15	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.25	3.5	0	0
L2	**SC-07-04**	2.6,3-B3,A5	W10X17	W27X84	≤15	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.5	5.5	0	0
L2	**SC-07-05**	2,2.6-A1,A	W10X17	W27X94	≤15	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L2	**SC-07-06**	2,2.6-A1,A	W10X17	W24X131	≤15	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.5	7	0	0
L4	**SC-07-07**	2.6,3-B3,A5	W10X17	W24X76	≤15	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L4	**SC-07-08**	4,5-D,C3	W10X17	W14X22	≤20	45	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1	3	0	0
L3	**SC-07-09**	1,1.6-A1,A2	W10X17	W16X26	≤20	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1	3	0	0
L2,L3	**SC-07-10**	2.6,3-B3,A5	W10X33	W27X84	≤10	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L4	**SC-07-11**	2.6,3-B3,A5	W10X33	W24X76	≤15	26	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.5	4.5	0	0
ROOF	**SC-07-12**	7.3,8-F2,F1	W12X14	W16X31	≤15	40	SP	3/4" A325N	2	3	3/8	3	1/4	1.5	1.5	1.25	4	0	0
SLOPED ROOF	**SC-07-13**	1,1.6-A1,A2	W12X14	W14X22	≤20	64	SBP	1" A490N	3	3	3/8	3	1/4	2	2	1	6.5	0	0
ROOF		2,5-A2		W21X44															
L3	**SC-07-14**	3,4-A2	W12X19	W24X55	≤20	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	3.5	0	0
L2		3,4-B3,A1		W24X62															
L4	**SC-07-15**	1.7,2-A5,A2	W12X19	W27X84	≤20	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	5.5	0	0
L4	**SC-07-16**	2.6,3-B3,A5	W12X19	W24X76	≤20	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L4	**SC-07-17**	2.6,3-A1,A2	W12X19	W16X26	≤20	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1	3	0	0
L4	**SC-07-18**	3,4-B3,A1	W12X19	W18X35	≤20	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1	3	0	0
L2,L3	**SC-07-19**	2,3-B3,Z	W14X22	W27X84	≤25	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	5.5	0	0
L2	**SC-07-20**	1.9,2-A2	W14X22	W14X22	≤10	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1	2.5	1	2.5
L3,L2	**SC-07-21**	2,2.6-A5,A1	W14X22	W24X131	≤25	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	6.5	0	0
L2	**SC-07-22**	1.6,1.9-A5,Z	W14X22	W27X94	≤25	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L3	**SC-07-23**	4,5-B3,A5	W14X22	W14X22	≤10	70	SBP	3/4" A325N	3	3	3/8	Weld to Beam Web **	1/4	1.5	1.5	1	7.5	1	6
L3	**SC-07-24**	4-5-C3.D	W14x22	W21x44	≤15	45	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1	4	0	0
SLOPED ROOF		2,3-A2,A1				26													
L3	**SC-07-25**	4,5-C3.D	W14x22	W18x35	≤15	45	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1	4	0	0
SLOPED ROOF		4,5-A2,A1				26													
ROOF	**SC-07-26**	1.7,2-A2	W14X22	W18X35	≤20	64	SBP	1" A490N	3	3	3/8	Weld to Beam Web **	1/4	2	2	1	6.5	0	0
L4	**SC-07-27**	2,2.6-B3,A5	W14X22	W24X76	≤20	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L3	**SC-07-28**	2,3-A1,A2	W14X22	W33X118	≤30	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	6	0	0
L2	**SC-07-29**	2.6,3-B3,A5	W14X26	W27X84	≤15	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	1.5	5.5	0	0
L2	**SC-07-30**	1.6,1.9-A2,A	W16X26	W16X26	≤35	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1	3	1	3
L2	**SC-07-31**	2,2.6-A1,1	W16X26	W24X131	≤15	26	SP	3/4" A325N	4	3	3/8	2.75	1/4	1.5	1.25	0	0	4	6.5
L2	**SC-07-32**	1.6,1.9-A2,A	W16X26	W27X94	≤30	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1.5	6	0	0
L4	**SC-07-33**	3,4-B3,A1	W16X26	W18X35	≤30	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1	3	0	0
SLOPED ROOF		3,4-A1,A2														1	3	0	0
L4	**SC-07-34**	5,6-F2,F1	W16X26	W21X50	≤30	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1.5	4	0	0
ROOF	**SC-07-35**	2.6,3-B3,A5	W16X26	W21X44	≤20	64	SBP	3/4" A325N	4	3	3/8	Weld to Beam Web **	1/4	1.5	1.5	1.25	6.5	0	0
SLOPED ROOF	**SC-07-36**	3,4-A2,A1	W16X26	W21X44	≤35	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1.25	6.5	0	0
L3	**SC-07-37**	1.9,2-A.2	W16X31	W16X31	≤10	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1	3	1	3
L4	**SC-07-38**	1.9,2-A2	W18X35	W18X35	≤30	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1	3	1	3
L4	**SC-07-39**	2.6-A2	W18X35	W24X76	≤30	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1.5	5	0	0
L1	**SC-07-40**	7-E,D	W18X35	W18X65	≤40	0	SP	3/4" A325N	5	3	3/8	3	1/4	1.5	1.5	1.25	3.6	1.25	3.6
L3	**SC-07-41**	1,1.6-A2	W18X35	W36X487	≤26	26	SP	3/4" A325N	3	3	3/8	3	1/4	1.5	1.5	4	8	0	0
SLOPED ROOF	**SC-07-42**	2-A2,A1	W18X35	W21X44	≤30	26	SP	3/4" A325N	4	3	3/8	3	1/4	1.5	1.5	1	3	1	3
L2	**SC-07-43**	3,4-5,Z	W24X55	W24X62	≤45	64	SBP	3/4" A325N	6	3	3/8	Weld to Beam Web **	1/4	1.5	1.5	1.5	6	1.5	6
L4	**SC-07-44**	2.6,3-B3,A5	W24X76	W24X55	≤60	26	SP	3/4" A325N	6	3	3/8	3	1/4	1.5	1.5	1.5	4	1.5	4
L2,L3	**SC-07-45**	2.6,3-B3,A5	W27X84	W24X55	≤60	26	SP	3/4" A325N	6	3	3/8	3	1/4	1.5	1.5	1.5	3.5	4.5	3.5

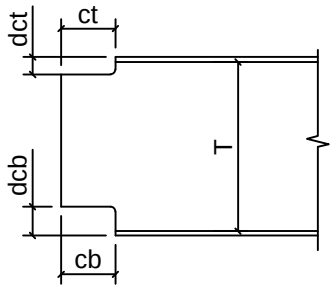
Cold bent plate inside radius =1.5tp

Inform us is cope values greater than specified in Table.

SC-07 Beam To Girder Shear Tab Connction

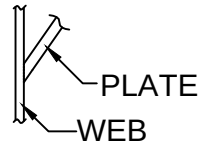






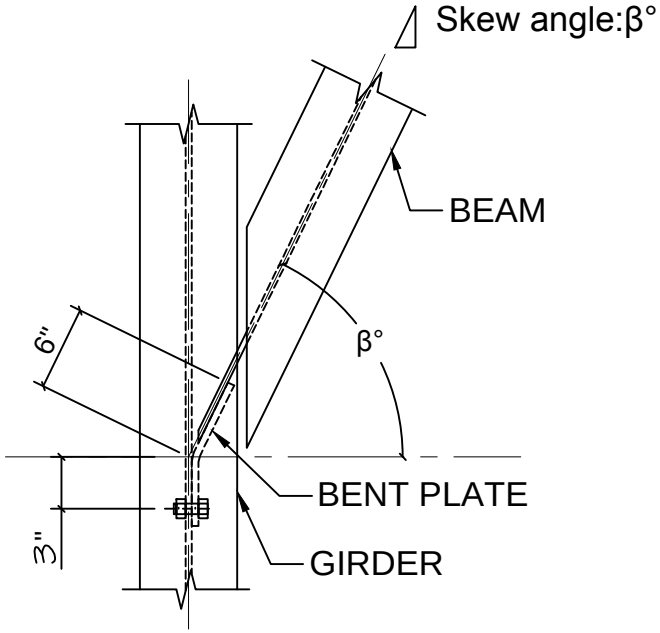
MAX.COPE VALUES PER TABLE

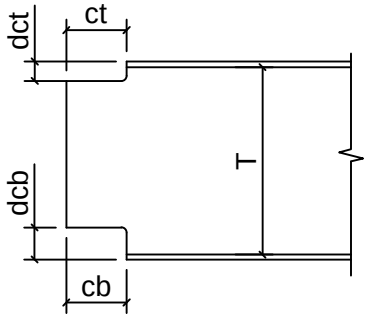
IF 30°≤β≤45°
THE PLATE EDGES
BEVELED



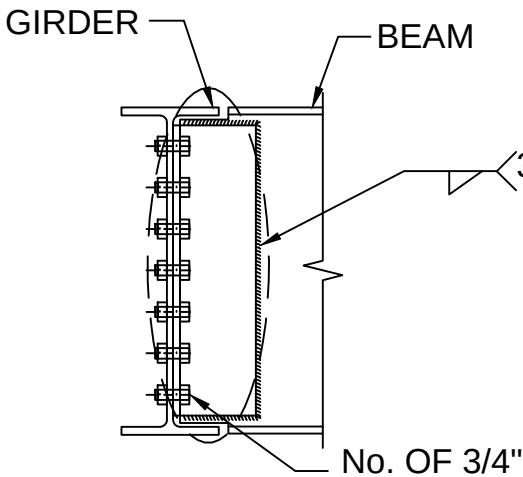
β°	w1	w2
β≤30°	1/4	1/2
β≤45°	1/4	5/16

SC-07 Beam-Girder Single Bent Plate Shear Connection





MAX. T&B COPE VALUES PER TABLE



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Units system: English
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Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-01

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X12

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.43	8.11	✔	p. 10-104
$L_{min} = T/2 = 8.85$[in]$/2 =$ **4.43**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 9.87[in] - max(0.51[in], 1.25[in]) - max(0.51[in], 0[in]) = **8.11**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.19$[in], 12 [in]$) =$ **4.56**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.19	--	0.28	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.669 =$ **0.28**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.18	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.07	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	22.23	15.00	DL	0.67	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.19$[in]$ - 0.813$[in]$/2) =$ **1.78**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.78$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.19[in]$*65000$[lb/in2]$*1$ = **22.23**[kip]						Eq. J3-6

Shear yielding	[Kip]	32.76	15.00	DL	0.46	Eq. J4-3
$A_g = L_p * t_p$ = 8.62[in]*0.19[in] = **1.64**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*1.64[in2] = **32.76**[kip]						Eq. J4-3
Shear rupture	[Kip]	25.45	15.00	DL	0.59	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 8.62[in] - 2*0.875[in] = **6.87**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 6.87[in]*0.19[in] = **1.31**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.31[in2] = **25.45**[kip]						Eq. J4-4
Flexural yielding	[Kip]	29.60	15.00	DL	0.51	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*3.46[in3]/3.5[in] = **29.6**[kip]						p. 9-6
Local web buckling	[Kip]	29.60	15.00	DL	0.51	p. 9-7
$h_o = d - d_c$ = 9.87[in] - 1.25[in] = **8.62**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3[in]<=2*9.87[in]) and (1.25[in]<=9.87[in]/2) = **True**						p. 9-7
c/d<=1 → 3[in]/9.87[in]<=1 → **True**						
$f = 2 * c/d$ = 2*3[in]/9.87[in] = **0.608**						p. 9-7
c/h_o<=1 → 3[in]/8.62[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(8.62[in]/3[in])$^{1.65}$ = **12.55**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.19[in]/8.62[in])^2*0.608*12.55 = **97176.55**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 97176.55[lb/in2])*3.46[in3]/ 3.5[in] = **29.6**[kip]						p. 9-7
Block shear	[Kip]	24.46	15.00	DL	0.61	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.07[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.19[in] = **0.311**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.19[in] + (2 - 1)*3[in])*0.19[in] = **0.985**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.19[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.19[in] = **0.736**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*0.736[in2] + 1*65000[lb/in2]*0.311[in2], 0.6*50000[lb/in2]*0.985[in2] + 1* 65000[lb/in2]*0.311[in2]) = **24.46**[kip]						Eq. J4-5
Flexural rupture	[Kip]	32.13	15.00	DL	0.47	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*3.46[in3]/3.5[in] = **32.13**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	93.60	30.00	DL	0.32	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.2[in] = **7.8**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-17 12:30 PM
Units system: English
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Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-02

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	8.22	✔	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1.25[in]) - max(0.63[in], 0[in]) = **8.22**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.30	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 2*10.61[kip]*1 = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))* 0.375[in]*58000[lb/in2]*1 = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p$ = 6[in]*0.375[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*2.25[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 6[in] - 2*0.875[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 4.25[in]*0.375[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*1.59[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.2[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*1.69[in2] + 1*58000[lb/in2]*0.363[in2]) = **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*6[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	15.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.3[in] - 0.813[in]/2) = **1.89**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.89[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(2 - 1))* 0.24[in]*65000[lb/in2]*1 = **28.08**[kip]						Eq. J3-6
Shear yielding	[Kip]	42.48	15.00	DL	0.35	Eq. J4-3
$A_g = L_p*t_p$ = 8.85[in]*0.24[in] = **2.12**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.12[in2] = **42.48**[kip]						Eq. J4-3
Shear rupture	[Kip]	33.23	15.00	DL	0.45	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 8.85[in] - 2*0.875[in] = **7.1**[in]						DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 7.1$[in]$*0.24$[in]$ = \mathbf{1.7}$[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*1.7$[in2]$ = \mathbf{33.23}$[kip] Eq. J4-4

Flexural yielding	[Kip]	34.37	15.00	DL	0.44	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*4.71$[in3]$/4.1$[in]$ = \mathbf{34.37}$[kip] p. 9-6

Local web buckling	[Kip]	34.37	15.00	DL	0.44	p. 9-7

$h_o = d - d_c = 10.1$[in]$ - 1.25$[in]$ = \mathbf{8.85}$[in] p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3.6[in]<=2*10.1[in]) and (1.25[in]<=10.1[in]/2) = **True** p. 9-7

c/d<=1 → 3.6[in]/10.1[in]<=1 → **True**

$f = 2*c/d = 2*3.6$[in]$/10.1$[in]$ = \mathbf{0.713}$ p. 9-7

c/h_o<=1 → 3.6[in]/8.85[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(8.85$[in]$/3.6$[in]$)^{1.65} = \mathbf{9.7}$ p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*$ $(0.24$[in]$/8.85$[in]$)^2*0.713*9.7 = \mathbf{1.33E+05}$[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 1.33E+05$[lb/in2]$)*4.71$[in3]$/$ 4.1[in]$ = \mathbf{34.37}$[kip] p. 9-7

Block shear	[Kip]	34.75	15.00	DL	0.43	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.24$[in]$ = \mathbf{0.495}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2.3$[in]$ + (2 - 1)*3$[in]$)*0.24$[in]$ = \mathbf{1.27}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2.3$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.24$[in]$ = \mathbf{0.957}$[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*0.957$[in2]$ + 1*65000$[lb/in2]$*0.495$[in2]$, 0.6*50000$[lb/in2]$*1.27$[in2]$ + 1*$ 65000[lb/in2]$*0.495$[in2]$) = \mathbf{34.75}$[kip] Eq. J4-5

Flexural rupture	[Kip]	37.31	15.00	DL	0.40	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*4.71$[in3]$/4.1$[in]$ = \mathbf{37.31}$[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	210.60	30.00	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.45$[in]$ = \mathbf{17.55}$[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 15$[kip]$/(0.5*3.71$[kip/in]$*1*6$[in]$) = \mathbf{1.35}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.35/16$ [in] $= \mathbf{2.5}$[kip/in] p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-17 12:33 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Bent Plate Shear Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-03

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	8.22	✔	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1.25[in]) - max(0.63[in], 0[in]) = **8.22**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.24$[in]$, 12$ [in]$) =$ **5.76**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.30	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in]$ - 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	15.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.3$[in]$ - 0.813$[in]$/2) =$ **1.89**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.89$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.24[in]$*65000$[lb/in2]$*1$ = **28.08**[kip]						Eq. J3-6

Shear yielding	[Kip]	42.48	15.00	DL	0.35	Eq. J4-3
$A_g = L_p*t_p$ = 8.85[in]*0.24[in] = **2.12**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.12[in2] = **42.48**[kip]						Eq. J4-3
Shear rupture	[Kip]	33.23	15.00	DL	0.45	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 8.85[in] - 2*0.875[in] = **7.1**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 7.1[in]*0.24[in] = **1.7**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.7[in2] = **33.23**[kip]						Eq. J4-4
Flexural yielding	[Kip]	35.23	15.00	DL	0.43	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*4.71[in3]/4[in] = **35.23**[kip]						p. 9-6
Local web buckling	[Kip]	35.23	15.00	DL	0.43	p. 9-7
$h_o = d - d_c$ = 10.1[in] - 1.25[in] = **8.85**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3.5[in]<=2*10.1[in]) and (1.25[in]<=10.1[in]/2) = **True**						p. 9-7
c/d<=1 → 3.5[in]/10.1[in]<=1 → **True**						
$f = 2*c/d$ = 2*3.5[in]/10.1[in] = **0.693**						p. 9-7
c/h_o<=1 → 3.5[in]/8.85[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(8.85[in]/3.5[in])$^{1.65}$ = **10.17**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.24[in]/8.85[in])^2*0.693*10.17 = **1.36E+05**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 1.36E+05[lb/in2])*4.71[in3]/ 4[in] = **35.23**[kip]						p. 9-7
Block shear	[Kip]	32.85	15.00	DL	0.46	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.26[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.24[in] = **0.437**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.3[in] + (2 - 1)*3[in])*0.24[in] = **1.27**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.3[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.24[in] = **0.957**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*0.957[in2] + 1*65000[lb/in2]*0.437[in2], 0.6*50000[lb/in2]*1.27[in2] + 1* 65000[lb/in2]*0.437[in2]) = **32.85**[kip]						Eq. J4-5
Flexural rupture	[Kip]	38.24	15.00	DL	0.39	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*4.71[in3]/4[in] = **38.24**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	201.24	30.00	DL	0.15	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.43[in] = **16.77**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-04

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	7.97	✔	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1.5[in]) - max(0.63[in], 0[in]) = **7.97**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.05	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	15.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.05$[in]$ - 0.813$[in]$/2) =$ **1.64**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.64$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.24[in]$*65000$[lb/in2]$*1$ = **28.08**[kip]						Eq. J3-6

Shear yielding	[Kip]	41.28	15.00	DL	0.36	Eq. J4-3
$A_g = L_p*t_p$ = 8.6[in]*0.24[in] = **2.06**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.06[in2] = **41.28**[kip]						Eq. J4-3
Shear rupture	[Kip]	32.06	15.00	DL	0.47	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 8.6[in] - 2*0.875[in] = **6.85**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.85[in]*0.24[in] = **1.64**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.64[in2] = **32.06**[kip]						Eq. J4-4
Flexural yielding	[Kip]	22.26	15.00	DL	0.67	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*4.46[in3]/6[in] = **22.26**[kip]						p. 9-6
Local web buckling	[Kip]	22.26	15.00	DL	0.67	p. 9-7
$h_o = d - d_c$ = 10.1[in] - 1.5[in] = **8.6**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5.5[in]<=2*10.1[in]) and (1.5[in]<=10.1[in]/2) = **True**						p. 9-7
c/d<=1 → 5.5[in]/10.1[in]<=1 → **True**						
$f = 2*c/d$ = 2*5.5[in]/10.1[in] = **1.09**						p. 9-7
c/h_o<=1 → 5.5[in]/8.6[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(8.6[in]/5.5[in])$^{1.65}$ = **4.6**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.24[in]/8.6[in])^2*1.09*4.6 = **1.02E+05**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 1.02E+05[lb/in2])*4.46[in3]/ 6[in] = **22.26**[kip]						p. 9-7
Block shear	[Kip]	31.68	15.00	DL	0.47	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.24[in] = **0.437**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.05[in] + (2 - 1)*3[in])*0.24[in] = **1.21**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.05[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.24[in] = **0.897**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*0.897[in2] + 1*65000[lb/in2]*0.437[in2], 0.6*50000[lb/in2]*1.21[in2] + 1* 65000[lb/in2]*0.437[in2]) = **31.68**[kip]						Eq. J4-5
Flexural rupture	[Kip]	24.16	15.00	DL	0.62	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*4.46[in3]/6[in] = **24.16**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	215.28	30.00	DL	0.14	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.46[in] = **17.94**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-05

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	7.97	✔	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1.5[in]) - max(0.63[in], 0[in]) = **7.97**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.05	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	15.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.05$[in]$ - 0.813$[in]$/2) =$ **1.64**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.64$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.24[in]$*65000$[lb/in2]$*1$ = **28.08**[kip]						Eq. J3-6

Shear yielding	[Kip]	41.28	15.00	DL	0.36	Eq. J4-3
$A_g = L_p * t_p$ = 8.6[in]*0.24[in] = **2.06**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.06[in2] = **41.28**[kip]						Eq. J4-3
Shear rupture	[Kip]	32.06	15.00	DL	0.47	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 8.6[in] - 2*0.875[in] = **6.85**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 6.85[in]*0.24[in] = **1.64**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.64[in2] = **32.06**[kip]						Eq. J4-4
Flexural yielding	[Kip]	22.26	15.00	DL	0.67	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*4.46[in3]/6[in] = **22.26**[kip]						p. 9-6
Local web buckling	[Kip]	22.26	15.00	DL	0.67	p. 9-7
$h_o = d - d_c$ = 10.1[in] - 1.5[in] = **8.6**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5.5[in]<=2*10.1[in]) and (1.5[in]<=10.1[in]/2) = **True**						p. 9-7
c/d<=1 → 5.5[in]/10.1[in]<=1 → **True**						
$f = 2 * c/d$ = 2*5.5[in]/10.1[in] = **1.09**						p. 9-7
c/h_o<=1 → 5.5[in]/8.6[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(8.6[in]/5.5[in])$^{1.65}$ = **4.6**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.24[in]/8.6[in])^2*1.09*4.6 = **1.02E+05**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 1.02E+05[lb/in2])*4.46[in3]/ 6[in] = **22.26**[kip]						p. 9-7
Block shear	[Kip]	31.68	15.00	DL	0.47	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.24[in] = **0.437**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.05[in] + (2 - 1)*3[in])*0.24[in] = **1.21**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.05[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.24[in] = **0.897**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*0.897[in2] + 1*65000[lb/in2]*0.437[in2], 0.6*50000[lb/in2]*1.21[in2] + 1* 65000[lb/in2]*0.437[in2]) = **31.68**[kip]						Eq. J4-5
Flexural rupture	[Kip]	24.16	15.00	DL	0.62	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*4.46[in3]/6[in] = **24.16**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	229.32	30.00	DL	0.13	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.49[in] = **19.11**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:40 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-06

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	7.97	✓	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1.5[in]) - max(0.63[in], 0[in]) = **7.97**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✓	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.24$[in]$, 12$ [in]$) =$ **5.76**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✓	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.05	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	15.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.05$[in]$ - 0.813$[in]$/2) =$ **1.64**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.64$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.24[in]$*65000$[lb/in2]$*1$ = **28.08**[kip]						Eq. J3-6

Shear yielding	[Kip]	41.28	15.00	DL	0.36	Eq. J4-3
$A_g = L_p * t_p$ = 8.6[in]*0.24[in] = **2.06**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.06[in2] = **41.28**[kip]						Eq. J4-3
Shear rupture	[Kip]	32.06	15.00	DL	0.47	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 8.6[in] - 2*0.875[in] = **6.85**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 6.85[in]*0.24[in] = **1.64**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.64[in2] = **32.06**[kip]						Eq. J4-4
Flexural yielding	[Kip]	17.81	15.00	DL	0.84	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*4.46[in3]/7.5[in] = **17.81**[kip]						p. 9-6
Local web buckling	[Kip]	17.81	15.00	DL	0.84	p. 9-7
$h_o = d - d_c$ = 10.1[in] - 1.5[in] = **8.6**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (7[in]<=2*10.1[in]) and (1.5[in]<=10.1[in]/2) = **True**						p. 9-7
c/d<=1 → 7[in]/10.1[in]<=1 → **True**						
$f = 2 * c/d$ = 2*7[in]/10.1[in] = **1.39**						p. 9-7
c/h_o<=1 → 7[in]/8.6[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(8.6[in]/7[in])$^{1.65}$ = **3.09**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.24[in]/8.6[in])^2*1.39*3.09 = **87426.02**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 87426.02[lb/in2])*4.46[in3]/ 7.5[in] = **17.81**[kip]						p. 9-7
Block shear	[Kip]	31.68	15.00	DL	0.47	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.24[in] = **0.437**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.05[in] + (2 - 1)*3[in])*0.24[in] = **1.21**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.05[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.24[in] = **0.897**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*0.897[in2] + 1*65000[lb/in2]*0.437[in2], 0.6*50000[lb/in2]*1.21[in2] + 1* 65000[lb/in2]*0.437[in2]) = **31.68**[kip]						Eq. J4-5
Flexural rupture	[Kip]	19.33	15.00	DL	0.78	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*4.46[in3]/7.5[in] = **19.33**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	283.14	30.00	DL	0.11	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.605[in] = **23.6**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.84**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:38 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-07

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	7.97	✔	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1.5[in]) - max(0.63[in], 0[in]) = **7.97**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.05	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	15.00	DL	0.53	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.05$[in]$ - 0.813$[in]$/2) =$ **1.64**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.64$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.24[in]$*65000$[lb/in2]$*1$ = **28.08**[kip]						Eq. J3-6

Shear yielding	[Kip]	41.28	15.00	DL	0.36	Eq. J4-3
$A_g = L_p * t_p$ = 8.6[in]*0.24[in] = **2.06**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.06[in2] = **41.28**[kip]						Eq. J4-3
Shear rupture	[Kip]	32.06	15.00	DL	0.47	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 8.6[in] - 2*0.875[in] = **6.85**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 6.85[in]*0.24[in] = **1.64**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.64[in2] = **32.06**[kip]						Eq. J4-4
Flexural yielding	[Kip]	24.28	15.00	DL	0.62	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*4.46[in3]/5.5[in] = **24.28**[kip]						p. 9-6
Local web buckling	[Kip]	24.28	15.00	DL	0.62	p. 9-7
$h_o = d - d_c$ = 10.1[in] - 1.5[in] = **8.6**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5[in]<=2*10.1[in]) and (1.5[in]<=10.1[in]/2) = **True**						p. 9-7
c/d<=1 → 5[in]/10.1[in]<=1 → **True**						
$f = 2 * c/d$ = 2*5[in]/10.1[in] = **0.99**						p. 9-7
c/h_o<=1 → 5[in]/8.6[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(8.6[in]/5[in])$^{1.65}$ = **5.38**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.24[in]/8.6[in])^2*0.99*5.38 = **1.09E+05**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 1.09E+05[lb/in2])*4.46[in3]/ 5.5[in] = **24.28**[kip]						p. 9-7
Block shear	[Kip]	31.68	15.00	DL	0.47	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.24[in] = **0.437**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.05[in] + (2 - 1)*3[in])*0.24[in] = **1.21**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.05[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.24[in] = **0.897**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*0.897[in2] + 1*65000[lb/in2]*0.437[in2], 0.6*50000[lb/in2]*1.21[in2] + 1* 65000[lb/in2]*0.437[in2]) = **31.68**[kip]						Eq. J4-5
Flexural rupture	[Kip]	26.36	15.00	DL	0.57	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*4.46[in3]/5.5[in] = **26.36**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	205.92	30.00	DL	0.15	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.44[in] = **17.16**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-08

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	4.42	8.47	✓	p. 10-104
$L_{min} = T/2 = 8.84$[in]$/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 1[in]) - max(0.63[in], 0[in]) = **8.47**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✓	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min($24*t_p$, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.55	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.99	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✓	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	20.00	DL	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	20.00	DL	0.59	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	20.00	DL	0.62	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	20.00	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in]$ - 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	20.00	DL	0.70	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	20.00	DL	0.45	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	28.08	20.00	DL	0.71	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.55$[in]$ - 0.813$[in]$/2)$ = **2.14**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*2.14$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.24[in]$*65000$[lb/in2]$*1$ = **28.08**[kip]						Eq. J3-6
Shear yielding	[Kip]	43.68	20.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 9.1$[in]$*0.24$[in] = **2.18**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.18$[in2] = **43.68**[kip]						Eq. J4-3
Shear rupture	[Kip]	34.40	20.00	DL	0.58	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2

$L_e = L - n*L_h$ = 9.1[in] - 2*0.875[in] = **7.35**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 7.35[in]*0.24[in] = **1.76**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.76[in2] = **34.4**[kip] Eq. J4-4

Flexural yielding	[Kip]	42.42	20.00	DL	0.47	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*4.96[in3]/3.5[in] = **42.42**[kip] p. 9-6

Local web buckling	[Kip]	42.42	20.00	DL	0.47	p. 9-7

$h_o = d - d_c$ = 10.1[in] - 1[in] = **9.1**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3[in]<=2*10.1[in]) and (1[in]<=10.1[in]/2) = **True** p. 9-7

c/d<=1 → 3[in]/10.1[in]<=1 → **True**

$f = 2*c/d$ = 2*3[in]/10.1[in] = **0.594** p. 9-7

c/h_o<=1 → 3[in]/9.1[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(9.1[in]/3[in])$^{1.65}$ = **13.73** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*
(0.24[in]/9.1[in])^2*0.594*13.73 = **1.49E+05**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 1.49E+05[lb/in2])*4.96[in3]/
3.5[in] = **42.42**[kip] p. 9-7

Block shear	[Kip]	31.95	20.00	DL	0.63	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.99[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
0.875[in])*0.24[in] = **0.373**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.55[in] + (2 - 1)*3[in])*0.24[in] = **1.33**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.55[in] + (2 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.24[in] = **1.02**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*1.02[in2] + 1*65000[lb/in2]*0.373[in2], 0.6*50000[lb/in2]*1.33[in2] + 1*65000[lb/
in2]*0.373[in2]) = **31.95**[kip] Eq. J4-5

Flexural rupture	[Kip]	46.05	20.00	DL	0.43	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*4.96[in3]/3.5[in] = **46.05**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	107.64	40.00	DL	0.37	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.23[in] = **8.97**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 20[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.8** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.8/16 [in] = **3.33**[kip/in] p. 9-5

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-10

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X33

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	3.93	7.30	✔	p. 10-104
$L_{min} = T/2 = 7.86$[in]$/2 =$ **3.93**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 9.73[in] - max(0.935[in], 1.5[in]) - max(0.935[in], 0[in]) = **7.3**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.96	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.29$[in], 12 [in]$) =$ **6.96**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.29	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.86	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	21.22	10.00	DL	0.47	Tables (7-1..14)
(*n*>=10) and (*n*<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	10.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	10.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	10.00	DL	0.36	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	10.00	DL	0.35	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **28.76**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	44.55	10.00	DL	0.22	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	33.46	10.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.87$[in]$ - 0.813$[in]$/2)$ = **1.46**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.46$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.29[in]$*65000$[lb/in2]$*1$ = **33.46**[kip]						Eq. J3-6
Shear yielding	[Kip]	47.73	10.00	DL	0.21	Eq. J4-3

$A_g = L_p * t_p$ = 8.23[in]*0.29[in] = **2.39**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.39[in2] = **47.73**[kip] Eq. J4-3

Shear rupture	[Kip]	36.64	10.00	DL	0.27	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h$ = 8.23[in] - 2*0.875[in] = **6.48**[in] DG4 Eq. 3-13

$A_{nv} = L_e * t_p$ = 6.48[in]*0.29[in] = **1.88**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.88[in2] = **36.64**[kip] Eq. J4-4

Flexural yielding	[Kip]	27.12	10.00	DL	0.37	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*5.43[in3]/6[in] = **27.12**[kip] p. 9-6

Local web buckling	[Kip]	27.12	10.00	DL	0.37	p. 9-7

$h_o = d - d_c$ = 9.73[in] - 1.5[in] = **8.23**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5.5[in]<=2*9.73[in]) and (1.5[in]<=9.73[in]/2) = **True** p. 9-7

c/d<=1 → 5.5[in]/9.73[in]<=1 → **True**

$f = 2*c/d$ = 2*5.5[in]/9.73[in] = **1.13** p. 9-7

c/h_o<=1 → 5.5[in]/8.23[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(8.23[in]/5.5[in])$^{1.65}$ = **4.28** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*
(0.29[in]/8.23[in])^2*1.13*4.28 = **1.57E+05**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)$*min($F_y$, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 1.57E+05[lb/in2])*5.43[in3]/
6[in] = **27.12**[kip] p. 9-7

Block shear	[Kip]	37.02	10.00	DL	0.27	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.23[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.29[in] = **0.521**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.87[in] + (2 - 1)*3[in])*0.29[in] = **1.41**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.87[in] + (2 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.29[in] = **1.03**[in2] Sec. J4-3

IsStressUniform → **True** Sec. J4-3

U_{bs} = 1

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.03[in2] + 1*65000[lb/in2]*0.521[in2], 0.6*50000[lb/in2]*1.41[in2] + 1*65000[lb/
in2]*0.521[in2]) = **37.02**[kip] Eq. J4-5

Flexural rupture	[Kip]	29.44	10.00	DL	0.34	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*5.43[in3]/6[in] = **29.44**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	215.28	20.00	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.46[in] = **17.94**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 10[kip]/(0.5*3.71[kip/in]*1*6[in]) = **0.898** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.898/16 [in] = **1.67**[kip/in] p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:55 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-11

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X33

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.00	3.93	7.30	✓	p. 10-104
$L_{min} = T/2 = 7.86$[in]$/2 =$ **3.93**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 9.73[in] - max(0.935[in], 1.5[in]) - max(0.935[in], 0[in]) = **7.3**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.96	✓	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.29$[in]$, 12$ [in]$) =$ **6.96**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.29	--	0.43	✓	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.86	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50		-- ✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4		-- ✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	21.22	15.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*10.61$[kip]$*1$ = **21.22**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	33.85	15.00	DL	0.44	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **33.85**[kip]						Eq. J3-6
Shear yielding	[Kip]	32.40	15.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*2.25$[in2] = **32.4**[kip]						Eq. J4-3
Shear rupture	[Kip]	27.73	15.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 6$[in] $- 2*0.875$[in] = **4.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 4.25$[in]$*0.375$[in] = **1.59**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*1.59$[in2] = **27.73**[kip]						Eq. J4-4
Block shear	[Kip]	28.76	15.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (2 - 1)*3$[in]$)*0.375$[in] = **1.69**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (2 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.2**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.2$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*1.69$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **28.76**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	44.55	15.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*6$[in] = **44.55**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	33.46	15.00	DL	0.45	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.87$[in]$ - 0.813$[in]$/2)$ = **1.46**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.46$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(2 - 1))*$ 0.29[in]$*65000$[lb/in2]$*1$ = **33.46**[kip]						Eq. J3-6

Shear yielding	[Kip]	47.73	15.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p$ = 8.23[in]*0.29[in] = **2.39**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.39[in2] = **47.73**[kip]						Eq. J4-3
Shear rupture	[Kip]	36.64	15.00	DL	0.41	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 8.23[in] - 2*0.875[in] = **6.48**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.48[in]*0.29[in] = **1.88**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.88[in2] = **36.64**[kip]						Eq. J4-4
Flexural yielding	[Kip]	32.54	15.00	DL	0.46	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*5.43[in3]/5[in] = **32.54**[kip]						p. 9-6
Local web buckling	[Kip]	32.54	15.00	DL	0.46	p. 9-7
$h_o = d - d_c$ = 9.73[in] - 1.5[in] = **8.23**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (4.5[in]<=2*9.73[in]) and (1.5[in]<=9.73[in]/2) = **True**						p. 9-7
c/d<=1 → 4.5[in]/9.73[in]<=1 → **True**						
$f = 2*c/d$ = 2*4.5[in]/9.73[in] = **0.925**						p. 9-7
c/h_o<=1 → 4.5[in]/8.23[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(8.23[in]/4.5[in])$^{1.65}$ = **5.96**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.29[in]/8.23[in])^2*0.925*5.96 = **1.79E+05**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 1.79E+05[lb/in2])*5.43[in3]/ 5[in] = **32.54**[kip]						p. 9-7
Block shear	[Kip]	37.02	15.00	DL	0.41	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.23[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.29[in] = **0.521**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.87[in] + (2 - 1)*3[in])*0.29[in] = **1.41**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.87[in] + (2 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.29[in] = **1.03**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.03[in2] + 1*65000[lb/in2]*0.521[in2], 0.6*50000[lb/in2]*1.41[in2] + 1*65000[lb/ in2]*0.521[in2]) = **37.02**[kip]						Eq. J4-5
Flexural rupture	[Kip]	35.33	15.00	DL	0.42	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*5.43[in3]/5[in] = **35.33**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	205.92	30.00	DL	0.15	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.44[in] = **17.16**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*6[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:29 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\Roof.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-13

Family: Beam - Girder (BG)
Type: Single plate
Description: W12X14

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	5.43	10.38	✔	p. 10-104
$L_{min} = T/2 = 10.85[in]/2 = \mathbf{5.43}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 11.9[in] - \max(0.525[in], 1[in]) - \max(0.525[in], 0[in]) = \mathbf{10.38}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	4.80	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.2[in], 12\ [in]) = \mathbf{4.8}[in]$						Sec. J3.5
Beam						
Thickness	[in]	0.20	--	0.28	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.669 = \mathbf{0.28}[in]$						p. 10-151
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	2.88	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.07	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	15.00	DL	0.37	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	35.10	15.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.88$[in]$ - 0.813$[in]$/2)$ = **2.47**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*2.47$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*0.2$[in]$*$ 65000[lb/in2]$*1$ = **35.1**[kip]						Eq. J3-6

Shear yielding	[Kip]	43.60	15.00	DL	0.34	Eq. J4-3
$A_g = L_p*t_p$ = 10.9[in]*0.2[in] = **2.18**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.18[in2] = **43.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	32.27	15.00	DL	0.46	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 10.9[in] - 3*0.875[in] = **8.28**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.28[in]*0.2[in] = **1.66**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.66[in2] = **32.27**[kip]						Eq. J4-4
Flexural yielding	[Kip]	37.50	15.00	DL	0.40	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*5.64[in3]/4.5[in] = **37.5**[kip]						p. 9-6
Local web buckling	[Kip]	37.50	15.00	DL	0.40	p. 9-7
$h_o = d - d_c$ = 11.9[in] - 1[in] = **10.9**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (4[in]<=2*11.9[in]) and (1[in]<=11.9[in]/2) = **True**						p. 9-7
c/d<=1 → 4[in]/11.9[in]<=1 → **True**						
$f = 2*c/d$ = 2*4[in]/11.9[in] = **0.672**						p. 9-7
c/h_o<=1 → 4[in]/10.9[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(10.9[in]/4[in])$^{1.65}$ = **11.5**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*(0.2[in]/ 10.9[in])^2*0.672*11.5 = **68234.27**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 68234.27[lb/in2])*5.64[in3]/ 4.5[in] = **37.5**[kip]						p. 9-7
Block shear	[Kip]	36.68	15.00	DL	0.41	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.07[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.2[in] = **0.326**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.88[in] + (3 - 1)*3[in])*0.2[in] = **1.78**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.88[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.2[in] = **1.34**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.34[in2] + 1*65000[lb/in2]*0.326[in2], 0.6*50000[lb/in2]*1.78[in2] + 1*65000[lb/ in2]*0.326[in2]) = **36.68**[kip]						Eq. J4-5
Flexural rupture	[Kip]	40.71	15.00	DL	0.37	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*5.64[in3]/4.5[in] = **40.71**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	128.70	20.00	DL	0.16	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.275[in] = **10.73**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*9[in]) = **0.898**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.898/16 [in] = **1.67**[kip/in]						p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-14

Family: Beam - Girder (BG)
Type: Single plate
Description: W10X33

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	5.45	10.05	✔	p. 10-104
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 1.5[in]) - max(0.65[in], 0[in]) = **10.05**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.235[in], 12 [in]) = **5.64**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.60	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	38.44	20.00	DL	0.52	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.6$[in]$ - 0.813$[in]$/2)$ = **1.19**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.19$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.235[in]$*65000$[lb/in2]$*1$ = **38.44**[kip]						Eq. J3-6
Shear yielding	[Kip]	50.29	20.00	DL	0.40	Eq. J4-3

$A_g = L_p * t_p = 10.7\text{[in]} * 0.235\text{[in]} = \mathbf{2.51}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g = 0.667 * 0.60 * 50000\text{[lb/in2]} * 2.51\text{[in2]} = \mathbf{50.29}\text{[kip]}$ Eq. J4-3

Shear rupture	[Kip]	37.00	20.00	DL	0.54	Eq. J4-4

$L_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$L_e = L - n * L_h = 10.7\text{[in]} - 3 * 0.875\text{[in]} = \mathbf{8.08}\text{[in]}$ DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 8.08\text{[in]} * 0.235\text{[in]} = \mathbf{1.9}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 65000\text{[lb/in2]} * 1.9\text{[in2]} = \mathbf{37}\text{[kip]}$ Eq. J4-4

Flexural yielding	[Kip]	49.75	20.00	DL	0.40	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e = 0.599 * 50000\text{[lb/in2]} * 6.65\text{[in3]}/4\text{[in]} = \mathbf{49.75}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	49.75	20.00	DL	0.40	p. 9-7

$h_o = d - d_c = 12.2\text{[in]} - 1.5\text{[in]} = \mathbf{10.7}\text{[in]}$ p. 9-7

$IsTopFlangeBeamCoped = (c <= 2 * d)\text{ and }(d_c <= d/2) = (3.5\text{[in]} <= 2 * 12.2\text{[in]})\text{ and }(1.5\text{[in]} <= 12.2\text{[in]}/2) =$ **True** p. 9-7

$c/d <= 1 \rightarrow 3.5\text{[in]}/12.2\text{[in]} <= 1 \rightarrow$ **True**

$f = 2 * c/d = 2 * 3.5\text{[in]}/12.2\text{[in]} = \mathbf{0.574}$ p. 9-7

$c/h_o <= 1 \rightarrow 3.5\text{[in]}/10.7\text{[in]} <= 1 \rightarrow$ **True**

$k = 2.2 * (h_o/c)^{1.65} = 2.2 * (10.7\text{[in]}/3.5\text{[in]})^{1.65} = \mathbf{13.91}$ p. 9-7

$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k = \pi^2 * 2.90\text{E+07}\text{[lb/in2]}/(12 * (1 - 0.3^2)) *$
$(0.235\text{[in]}/10.7\text{[in]})^2 * 0.574 * 13.91 = \mathbf{1.01E+05}\text{[lb/in2]}$ p. 9-7

$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e = 0.599 * \min(50000\text{[lb/in2]}, 1.01\text{E+05}\text{[lb/in2]}) * 6.65\text{[in3]}/$
$4\text{[in]} = \mathbf{49.75}\text{[kip]}$ p. 9-7

Block shear	[Kip]	38.71	20.00	DL	0.52	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p = (2.26\text{[in]} + (1 - 1) * 3\text{[in]} - (1 - 0.5) *$
$0.875\text{[in]}) * 0.235\text{[in]} = \mathbf{0.428}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1) * s) * t_p = (1.6\text{[in]} + (3 - 1) * 3\text{[in]}) * 0.235\text{[in]} = \mathbf{1.79}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p = (1.6\text{[in]} + (3 - 1) * (3\text{[in]} - 0.875\text{[in]}) -$
$0.875\text{[in]}/2) * 0.235\text{[in]} = \mathbf{1.27}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$
$0.5 * \min(0.6 * 65000\text{[lb/in2]} * 1.27\text{[in2]} + 1 * 65000\text{[lb/in2]} * 0.428\text{[in2]}, 0.6 * 50000\text{[lb/in2]} * 1.79\text{[in2]} + 1 * 65000\text{[lb/in2]} * 0.428\text{[in2]}) = \mathbf{38.71}\text{[kip]}$ Eq. J4-5

Flexural rupture	[Kip]	54.01	20.00	DL	0.37	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e = 0.5 * 65000\text{[lb/in2]} * 6.65\text{[in3]}/4\text{[in]} = \mathbf{54.01}\text{[kip]}$ p. 9-6

Support

Welds rupture	[Kip/ft]	184.86	26.67	DL	0.14	p. 9-5

$R_n = 0.6 * F_u * t_p = 0.6 * 65000\text{[lb/in2]} * 0.395\text{[in]} = \mathbf{15.41}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega) * C * C_1 * L) = 20\text{[kip]}/(0.5 * 3.71\text{[kip/in]} * 1 * 9\text{[in]}) = \mathbf{1.2}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow$ **False**

$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16\text{ [in]} = 0.6 * 70000\text{[lb/in2]} * (2)^{1/2}/2 * 1.2/16\text{ [in]} = \mathbf{2.22}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP_BG_1/4PL_3B3/4
Connection ID : SC-07-15

Family: Beam - Girder (BG)
Type: Single plate
Description: W12X19

Design code: AISC 360-10 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	5.45	10.05	✔	p. 10-104
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 1.5[in]) - max(0.65[in], 0[in]) = **10.05**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Number of bolts		3	2	12	✔	p 10-102
Min. nrow=2, Max. nrow = 12						p 10-102
Distance from the bolt line to the weld line	[in]	3.00	--	3.50	✔	p 10-102
Max. a = 3.4999999999999996 [in]						p 10-102
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-103
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-103
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min($24*t_p$, 12 [in]) = min(24*0.235[in], 12 [in]) = **5.64**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102

$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in] p. 10-102

Vertical edge distance	[in]	1.60	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-103
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-103

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101
Weld length	[in]	9.00	1.00	--	✔	Sec. J2.2b
$L_{min} = 4.0*w = 4.0*0.25$[in] = **1**[in]						Sec. J2.2b

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	29.61	20.00	DL	0.68	Tables (7-1..14)
e=1.5 [in], Max. tp = None						Table 10-9
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*54000$[lb/in2]*0.442[in2] = **11.93**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2.48*11.93$[kip]*1 = **29.61**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	44.18	20.00	DL	0.45	p. 7-18, Sec. J3.10
e=1.5 [in], Max. tp = None						Table 10-9
e=1.5 [in], Max. tp = None						Table 10-9
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*l_c, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(2.48/(1*3))*(\min(1.2*1.09$[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*0.375[in]*58000[lb/in2]*1 = **44.18**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h + 1/16$ [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.375[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.363[in2]) = **40.91**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] $=$ **66.82**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	31.79	20.00	DL	0.63	p. 7-18, Sec. J3.10
e=1.5 [in], Max. tp = None						Table 10-9
e=1.5 [in], Max. tp = None						Table 10-9
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.6$[in]$ - 0.813$[in]$/2) =$ **1.19**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*l_c, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(2.48/(1*3))*(\min(1.2*1.19$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*0.235$[in]$*65000$[lb/in2]$*1 =$ **31.79**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	50.29	20.00	DL	0.40	Eq. J4-3
$A_g = L_p*t_p = 10.7$[in]$*0.235$[in] $=$ **2.51**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.51$[in2] $=$ **50.29**[kip]						Eq. J4-3
Shear rupture	[Kip]	37.00	20.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 10.7$[in] $- 3*0.875$[in] $=$ **8.08**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.08$[in]$*0.235$[in] $=$ **1.9**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*1.9$[in2] $=$ **37**[kip]						Eq. J4-4
Flexural yielding	[Kip]	33.17	20.00	DL	0.60	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*6.65$[in3]$/6$[in] $=$ **33.17**[kip]						p. 9-6
Local web buckling	[Kip]	33.17	20.00	DL	0.60	p. 9-7
$h_o = d - d_c = 12.2$[in] $- 1.5$[in] $=$ **10.7**[in]						p. 9-7
IsTopFlangeBeamCoped $= (c<=2*d)$ and $(d_c<=d/2) = (5.5$[in]$<=2*12.2$[in]$)$ and $(1.5$[in]$<=12.2$[in]$/2) =$ **True**						p. 9-7
$c/d<=1 \rightarrow 5.5$[in]$/12.2$[in]$<=1 \rightarrow$ **True**						
$f = 2*c/d = 2*5.5$[in]$/12.2$[in] $=$ **0.902**						p. 9-7
$c/h_o<=1 \rightarrow 5.5$[in]$/10.7$[in]$<=1 \rightarrow$ **True**						
$k = 2.2*(h_o/c)^{1.65} = 2.2*(10.7$[in]$/5.5$[in]$)^{1.65} =$ **6.6**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*(0.235$[in]$/10.7$[in]$)^2*0.902*6.6 =$ **75194.07**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 75194.07$[lb/in2]$)*6.65$[in3]$/6$[in] $=$ **33.17**[kip]						p. 9-7
Block shear	[Kip]	38.71	20.00	DL	0.52	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.26$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*0.875$[in]$)*0.235$[in] $=$ **0.428**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.6$[in]$ + (3 - 1)*3$[in]$)*0.235$[in] $=$ **1.79**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.6$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) - 0.875$[in]$/2)*0.235$[in] $=$ **1.27**[in2]						Sec. J4-3
IsStressUniform $\rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000$[lb/in2]$*1.27$[in2] $+ 1*65000$[lb/in2]$*0.428$[in2]$, 0.6*50000$[lb/in2]$*1.79$[in2] $+ 1*65000$[lb/in2]$*0.428$[in2]$) =$ **38.71**[kip]						Eq. J4-5
Flexural rupture	[Kip]	36.01	20.00	DL	0.56	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*6.65$[in3]$/6$[in] $=$ **36.01**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	215.28	26.67	DL	0.12	p. 9-5
$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.46$[in] $=$ **17.94**[kip/in]						p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20[kip]/(0.5*3.71[kip/in]*1*9[in]) =$ **1.2** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*1.2/16$ [in] = **2.22**[kip/in] p. 9-5

Global critical strength ratio **0.68**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
l_c: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
w: Weld size
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:00 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-16

Family: Beam - Girder (BG)
Type: Single plate
Description: W12X19

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	5.45	10.05	✓	p. 10-104
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 1.5[in]) - max(0.65[in], 0[in]) = **10.05**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✓	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.235$[in]$, 12$ [in]$) =$ **5.64**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✓	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.60	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	38.44	20.00	DL	0.52	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.6$[in]$ - 0.813$[in]$/2) =$ **1.19**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.19$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.235[in]$*65000$[lb/in2]$*1$ = **38.44**[kip]						Eq. J3-6

Shear yielding	[Kip]	50.29	20.00	DL	0.40	Eq. J4-3
$A_g = L_p * t_p$ = 10.7[in]*0.235[in] = **2.51**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.51[in2] = **50.29**[kip]						Eq. J4-3
Shear rupture	[Kip]	37.00	20.00	DL	0.54	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 10.7[in] - 3*0.875[in] = **8.08**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 8.08[in]*0.235[in] = **1.9**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*1.9[in2] = **37**[kip]						Eq. J4-4
Flexural yielding	[Kip]	36.18	20.00	DL	0.55	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*6.65[in3]/5.5[in] = **36.18**[kip]						p. 9-6
Local web buckling	[Kip]	36.18	20.00	DL	0.55	p. 9-7
$h_o = d - d_c$ = 12.2[in] - 1.5[in] = **10.7**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5[in]<=2*12.2[in]) and (1.5[in]<=12.2[in]/2) = **True**						p. 9-7
c/d<=1 → 5[in]/12.2[in]<=1 → **True**						
$f = 2 * c/d$ = 2*5[in]/12.2[in] = **0.82**						p. 9-7
c/h_o<=1 → 5[in]/10.7[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(10.7[in]/5[in])$^{1.65}$ = **7.72**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.235[in]/10.7[in])^2*0.82*7.72 = **79999.79**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 79999.79[lb/in2])*6.65[in3]/ 5.5[in] = **36.18**[kip]						p. 9-7
Block shear	[Kip]	38.71	20.00	DL	0.52	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.235[in] = **0.428**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (1.6[in] + (3 - 1)*3[in])*0.235[in] = **1.79**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (1.6[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.235[in] = **1.27**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.27[in2] + 1*65000[lb/in2]*0.428[in2], 0.6*50000[lb/in2]*1.79[in2] + 1*65000[lb/ in2]*0.428[in2]) = **38.71**[kip]						Eq. J4-5
Flexural rupture	[Kip]	39.28	20.00	DL	0.51	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*6.65[in3]/5.5[in] = **39.28**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	205.92	26.67	DL	0.13	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.44[in] = **17.16**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 20[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.2**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.2/16 [in] = **2.22**[kip/in]						p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:01 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-17

Family: Beam - Girder (BG)
Type: Single plate
Description: W12X19

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	5.45	10.55	✔	p. 10-104
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 1[in]) - max(0.65[in], 0[in]) = **10.55**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.235$[in], 12 [in]$) =$ **5.64**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.10	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	41.24	20.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.1$[in]$ - 0.813$[in]$/2) =$ **1.69**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.69$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.235[in]$*65000$[lb/in2]$*1$ = **41.24**[kip]						Eq. J3-6

Shear yielding	[Kip]	52.64	20.00	DL	0.38	Eq. J4-3
$A_g = L_p*t_p$ = 11.2[in]*0.235[in] = **2.63**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.63[in2] = **52.64**[kip]						Eq. J4-3
Shear rupture	[Kip]	39.29	20.00	DL	0.51	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 11.2[in] - 3*0.875[in] = **8.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.58[in]*0.235[in] = **2.02**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.02[in2] = **39.29**[kip]						Eq. J4-4
Flexural yielding	[Kip]	61.92	20.00	DL	0.32	p. 9-6
(1/Ω)R_n = *(1/Ω)*F_y*S_{net}/e = 0.599*50000[lb/in2]*7.24[in3]/3.5[in] = **61.92**[kip]						p. 9-6
Local web buckling	[Kip]	61.92	20.00	DL	0.32	p. 9-7
$h_o = d - d_c$ = 12.2[in] - 1[in] = **11.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3[in]<=2*12.2[in]) and (1[in]<=12.2[in]/2) = **True**						p. 9-7
c/d<=1 → 3[in]/12.2[in]<=1 → **True**						
$f = 2*c/d$ = 2*3[in]/12.2[in] = **0.492**						p. 9-7
c/h_o<=1 → 3[in]/11.2[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(11.2[in]/3[in])$^{1.65}$ = **19.34**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*						
(0.235[in]/11.2[in])^2*0.492*19.34 = **1.10E+05**[lb/in2]						p. 9-7
(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 1.10E+05[lb/in2])*7.24[in3]/						
3.5[in] = **61.92**[kip]						p. 9-7
Block shear	[Kip]	41.00	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)*						
0.875[in])*0.235[in] = **0.428**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.1[in] + (3 - 1)*3[in])*0.235[in] = **1.9**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.1[in] + (3 - 1)*(3[in] - 0.875[in]) -						
0.875[in]/2)*0.235[in] = **1.39**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =						
0.5*min(0.6*65000[lb/in2]*1.39[in2] + 1*65000[lb/in2]*0.428[in2], 0.6*50000[lb/in2]*1.9[in2] + 1*65000[lb/						
in2]*0.428[in2]) = **41**[kip]						Eq. J4-5
Flexural rupture	[Kip]	67.21	20.00	DL	0.30	p. 9-6
(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*7.24[in3]/3.5[in] = **67.21**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	117.00	26.67	DL	0.23	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.25[in] = **9.75**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 20[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.2**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.2/16 [in] = **2.22**[kip/in]						p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
(1/Ω)R_n: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:05 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-18

Family: Beam - Girder (BG)
Type: Single plate
Description: W12X19

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	5.45	10.55	✔	p. 10-104
$L_{min} = T/2 = 10.9$[in]$/2 =$ **5.45**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 12.2[in] - max(0.65[in], 1[in]) - max(0.65[in], 0[in]) = **10.55**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.235$[in]$, 12$ [in]$) =$ **5.64**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.10	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	41.24	20.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.1$[in]$ - 0.813$[in]$/2) =$ **1.69**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.69$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.235[in]$*65000$[lb/in2]$*1$ = **41.24**[kip]						Eq. J3-6

Shear yielding	[Kip]	52.64	20.00	DL	0.38	Eq. J4-3
$A_g = L_p*t_p$ = 11.2[in]*0.235[in] = **2.63**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.63[in2] = **52.64**[kip]						Eq. J4-3
Shear rupture	[Kip]	39.29	20.00	DL	0.51	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L$ - $n*L_h$ = 11.2[in] - 3*0.875[in] = **8.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.58[in]*0.235[in] = **2.02**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.02[in2] = **39.29**[kip]						Eq. J4-4
Flexural yielding	[Kip]	61.92	20.00	DL	0.32	p. 9-6
(1/Ω)R_n = *(1/Ω)*F_y*S_{net}/e = 0.599*50000[lb/in2]*7.24[in3]/3.5[in] = **61.92**[kip]						p. 9-6
Local web buckling	[Kip]	61.92	20.00	DL	0.32	p. 9-7
$h_o = d - d_c$ = 12.2[in] - 1[in] = **11.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3[in]<=2*12.2[in]) and (1[in]<=12.2[in]/2) = **True**						p. 9-7
c/d<=1 → 3[in]/12.2[in]<=1 → **True**						
$f = 2*c/d$ = 2*3[in]/12.2[in] = **0.492**						p. 9-7
c/h_o<=1 → 3[in]/11.2[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(11.2[in]/3[in])$^{1.65}$ = **19.34**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*						
(0.235[in]/11.2[in])^2*0.492*19.34 = **1.10E+05**[lb/in2]						p. 9-7
(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 1.10E+05[lb/in2])*7.24[in3]/						
3.5[in] = **61.92**[kip]						p. 9-7
Block shear	[Kip]	41.00	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)*						
0.875[in])*0.235[in] = **0.428**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.1[in] + (3 - 1)*3[in])*0.235[in] = **1.9**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.1[in] + (3 - 1)*(3[in] - 0.875[in]) -						
0.875[in]/2)*0.235[in] = **1.39**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =						
0.5*min(0.6*65000[lb/in2]*1.39[in2] + 1*65000[lb/in2]*0.428[in2], 0.6*50000[lb/in2]*1.9[in2] + 1*65000[lb/						
in2]*0.428[in2]) = **41**[kip]						Eq. J4-5
Flexural rupture	[Kip]	67.21	20.00	DL	0.30	p. 9-6
(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*7.24[in3]/3.5[in] = **67.21**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	140.40	26.67	DL	0.19	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.3[in] = **11.7**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 20[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.2**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.2/16 [in] = **2.22**[kip/in]						p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
(1/Ω)R_n: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-19

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.47	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1.5[in]) - max(0.735[in], 0[in]) = **11.47**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	25.00	DL	0.79	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	25.00	DL	0.47	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	25.00	DL	0.51	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	25.00	DL	0.60	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	25.00	DL	0.61	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **40.91**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	25.00	DL	0.37	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	25.00	DL	0.62	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2)$ = **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	56.12	25.00	DL	0.45	Eq. J4-3
$A_g = L_p * t_p$ = 12.2[in]*0.23[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.81[in2] = **56.12**[kip]						Eq. J4-3
Shear rupture	[Kip]	42.94	25.00	DL	0.58	Eq. J4-4
$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 12.2[in] - 3*0.875[in] = **9.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 9.58[in]*0.23[in] = **2.2**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.2[in2] = **42.94**[kip]						Eq. J4-4
Flexural yielding	[Kip]	42.87	25.00	DL	0.58	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*8.59[in3]/6[in] = **42.87**[kip]						p. 9-6
Local web buckling	[Kip]	42.87	25.00	DL	0.58	p. 9-7
$h_o = d - d_c$ = 13.7[in] - 1.5[in] = **12.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5.5[in]<=2*13.7[in]) and (1.5[in]<=13.7[in]/2) = **True**						p. 9-7
c/d<=1 → 5.5[in]/13.7[in]<=1 → **True**						
$f = 2 * c/d$ = 2*5.5[in]/13.7[in] = **0.803**						p. 9-7
c/h_o<=1 → 5.5[in]/12.2[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(12.2[in]/5.5[in])$^{1.65}$ = **8.19**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.23[in]/12.2[in])^2*0.803*8.19 = **61263.41**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 61263.41[lb/in2])*8.59[in3]/ 6[in] = **42.87**[kip]						p. 9-7
Block shear	[Kip]	41.27	25.00	DL	0.61	Eq. J4-5
$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.23[in] = **0.419**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.35[in] + (3 - 1)*3[in])*0.23[in] = **1.92**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.35[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.23[in] = **1.42**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*0.419[in2], 0.6*50000[lb/in2]*1.92[in2] + 1*65000[lb/ in2]*0.419[in2]) = **41.27**[kip]						Eq. J4-5
Flexural rupture	[Kip]	46.53	25.00	DL	0.54	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*8.59[in3]/6[in] = **46.53**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	215.28	33.33	DL	0.15	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.46[in] = **17.94**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 25[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.5**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.5/16 [in] = **2.78**[kip/in]						p. 9-5

Global critical strength ratio	**0.79**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:28 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-20

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.70	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1[in]) - max(0.735[in], 1[in]) = **11.7**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	10.00	DL	0.31	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	10.00	DL	0.19	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	10.00	DL	0.21	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	10.00	DL	0.24	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	10.00	DL	0.24	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	10.00	DL	0.15	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	40.37	10.00	DL	0.25	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85$[in]$ - 0.813$[in]$/2) =$ **2.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*2.44$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	53.82	10.00	DL	0.19	Eq. J4-3
$A_g = L_p*t_p$ = 11.7[in]*0.23[in] = **2.69**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.69[in2] = **53.82**[kip]						Eq. J4-3
Shear rupture	[Kip]	40.70	10.00	DL	0.25	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 11.7[in] - 3*0.875[in] = **9.08**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 9.08[in]*0.23[in] = **2.09**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.09[in2] = **40.7**[kip]						Eq. J4-4
Flexural yielding	[Kip]	52.37	10.00	DL	0.19	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*5.25[in3]/3[in] = **52.37**[kip]						p. 9-6
Local web buckling	[Kip]	52.37	10.00	DL	0.19	p. 9-8, p. 9-7
$h_o = d - d_c$ = 13.7[in] - 2[in] = **11.7**[in]						p. 9-7
IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (2.5[in]<=2*13.7[in]) and (1[in]<=0.2*13.7[in]) and (2.5[in]<=2*13.7[in]) and (1[in]<=0.2*13.7[in]) = **True**						p. 9-8
f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1[in]/13.7[in]) = **2.95**						p. 9-8
$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d$ = 0.62*π*2.90E+07[lb/in2]*0.23[in]^2/(2.5[in]*11.7[in])*2.95 = **3.02E+05**[lb/in2]						p. 9-8
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 3.02E+05[lb/in2])*5.25[in3]/3[in] = **52.37**[kip]						p. 9-7
Block shear	[Kip]	43.51	10.00	DL	0.23	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.26[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.23[in] = **0.419**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.85[in] + (3 - 1)*3[in])*0.23[in] = **2.04**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.85[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.23[in] = **1.53**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.419[in2], 0.6*50000[lb/in2]*2.04[in2] + 1*65000[lb/in2]*0.419[in2]) = **43.51**[kip]						Eq. J4-5
Flexural rupture	[Kip]	56.85	10.00	DL	0.18	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*5.25[in3]/3[in] = **56.85**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	107.64	13.33	DL	0.12	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.23[in] = **8.97**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 10[kip]/(0.5*3.71[kip/in]*1*9[in]) = **0.599**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.599/16 [in] = **1.11**[kip/in]						p. 9-5

Global critical strength ratio **0.31**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length

c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:38 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-21

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.47	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1.5[in]) - max(0.735[in], 0[in]) = **11.47**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	25.00	DL	0.79	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	25.00	DL	0.47	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	25.00	DL	0.51	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	25.00	DL	0.60	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	25.00	DL	0.61	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$)$ = **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	25.00	DL	0.37	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	40.37	25.00	DL	0.62	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2)$ = **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	56.12	25.00	DL	0.45	Eq. J4-3
$A_g = L_p * t_p$ = 12.2[in]*0.23[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.81[in2] = **56.12**[kip]						Eq. J4-3
Shear rupture	[Kip]	42.94	25.00	DL	0.58	Eq. J4-4
$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 12.2[in] - 3*0.875[in] = **9.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 9.58[in]*0.23[in] = **2.2**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.2[in2] = **42.94**[kip]						Eq. J4-4
Flexural yielding	[Kip]	36.75	25.00	DL	0.68	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*8.59[in3]/7[in] = **36.75**[kip]						p. 9-6
Local web buckling	[Kip]	36.75	25.00	DL	0.68	p. 9-7
$h_o = d - d_c$ = 13.7[in] - 1.5[in] = **12.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (6.5[in]<=2*13.7[in]) and (1.5[in]<=13.7[in]/2) = **True**						p. 9-7
c/d<=1 → 6.5[in]/13.7[in]<=1 → **True**						
$f = 2 * c/d$ = 2*6.5[in]/13.7[in] = **0.949**						p. 9-7
c/h_o<=1 → 6.5[in]/12.2[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(12.2[in]/6.5[in])$^{1.65}$ = **6.22**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.23[in]/12.2[in])^2*0.949*6.22 = **54959.56**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 54959.56[lb/in2])*8.59[in3]/ 7[in] = **36.75**[kip]						p. 9-7
Block shear	[Kip]	41.27	25.00	DL	0.61	Eq. J4-5
$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.23[in] = **0.419**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.35[in] + (3 - 1)*3[in])*0.23[in] = **1.92**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.35[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.23[in] = **1.42**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*0.419[in2], 0.6*50000[lb/in2]*1.92[in2] + 1*65000[lb/in2]*0.419[in2]) = **41.27**[kip]						Eq. J4-5
Flexural rupture	[Kip]	39.89	25.00	DL	0.63	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*8.59[in3]/7[in] = **39.89**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	283.14	33.33	DL	0.12	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.605[in] = **23.6**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 25[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.5**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.5/16 [in] = **2.78**[kip/in]						p. 9-5

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:25 PM
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Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-22

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.47	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1.5[in]) - max(0.735[in], 0[in]) = **11.47**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	25.00	DL	0.79	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	25.00	DL	0.47	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	25.00	DL	0.51	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	25.00	DL	0.60	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	25.00	DL	0.61	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **40.91**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	25.00	DL	0.37	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	25.00	DL	0.62	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2)$ = **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	56.12	25.00	DL	0.45	Eq. J4-3
$A_g = L_p * t_p$ = 12.2[in]*0.23[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.81[in2] = **56.12**[kip]						Eq. J4-3
Shear rupture	[Kip]	42.94	25.00	DL	0.58	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 12.2[in] - 3*0.875[in] = **9.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 9.58[in]*0.23[in] = **2.2**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.2[in2] = **42.94**[kip]						Eq. J4-4
Flexural yielding	[Kip]	46.77	25.00	DL	0.53	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*8.59[in3]/5.5[in] = **46.77**[kip]						p. 9-6
Local web buckling	[Kip]	46.77	25.00	DL	0.53	p. 9-7
$h_o = d - d_c$ = 13.7[in] - 1.5[in] = **12.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5[in]<=2*13.7[in]) and (1.5[in]<=13.7[in]/2) = **True**						p. 9-7
c/d<=1 → 5[in]/13.7[in]<=1 → **True**						
$f = 2 * c/d$ = 2*5[in]/13.7[in] = **0.73**						p. 9-7
c/h_o<=1 → 5[in]/12.2[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(12.2[in]/5[in])$^{1.65}$ = **9.59**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.23[in]/12.2[in])^2*0.73*9.59 = **65178.81**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 65178.81[lb/in2])*8.59[in3]/ 5.5[in] = **46.77**[kip]						p. 9-7
Block shear	[Kip]	41.27	25.00	DL	0.61	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.23[in] = **0.419**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.35[in] + (3 - 1)*3[in])*0.23[in] = **1.92**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.35[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.23[in] = **1.42**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*0.419[in2], 0.6*50000[lb/in2]*1.92[in2] + 1*65000[lb/ in2]*0.419[in2]) = **41.27**[kip]						Eq. J4-5
Flexural rupture	[Kip]	50.77	25.00	DL	0.49	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*8.59[in3]/5.5[in] = **50.77**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	229.32	33.33	DL	0.15	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.49[in] = **19.11**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 25[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.5**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.5/16 [in] = **2.78**[kip/in]						p. 9-5

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : BP_BG_1/4PL_2B3/4
Connection ID : SC-07-23

Family: Beam - Girder (BG)
Type: Bent Plate(s)
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Bent Plate(s)						
Length	[in]	9.00	6.11	11.70	✔	p. 10-8
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 1[in]) - \max(0.735[in], 1[in]) = \mathbf{11.7}[in]$						p. 10-8
Bent plate(s) (beam side)						
Weld size	[1/16in]	4	3	5	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} = \mathbf{0.0156}$						table J2.4
$t_p<1/4$ [in] $\rightarrow 0.375[in]<1/4$ [in] $\rightarrow$ **False**						
$w_{max} = t_p - 1/16$ [in] $= 0.375[in] - 1/16$ [in] $= \mathbf{0.026}$						Sec. J2.2b
Bent plate(s) (support side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23[in], 12$ [in]$) = \mathbf{5.52}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	5.50	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in] Sec. J3.5

Beam

Top cope length	[in]	7.50	--	27.40	✔
Bottom cope length	[in]	7.50	--	27.40	✔
Top cope depth	[in]	1.00	--	2.10	✔
Bottom cope depth	[in]	1.00	--	2.10	✔

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Bent plate(s) (beam side)						
Weld capacity	[Kip]	35.71	10.00	DL	0.28	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*1.98[kip/in]*1*4*9[in] = **35.71**[kip]						Tables 8-4 .. 8-11
Shear yielding	[Kip]	48.60	10.00	DL	0.21	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Flexural yielding	[Kip]	30.31	10.00	DL	0.33	p. 15-7
$Z_x = t_p*L^2/4$ = 0.375[in]*9[in]^2/4 = **7.59**[in3]						T. 17-27
$(1/\Omega)R_n = (1/\Omega)*F_y*Z_x/e$ = 0.599*36000[lb/in2]*7.59[in3]/5.4[in] = **30.31**[kip]						p. 15-7
Bent plate(s) (support side)						
Bolts shear	[Kip]	18.61	10.00	DL	0.54	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n$ = 1.75*10.61[kip] = **18.61**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	10.00	DL	0.19	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	10.00	DL	0.21	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	10.00	DL	0.24	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	10.00	DL	0.24	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.363[in2]) = **40.91**[kip]						Eq. J4-5
Flexural yielding (Ecc. sum)	[Kip]	19.49	10.00	DL	0.51	p. 15-7
$Z_x = t_p*L^2/4$ = 0.375[in]*9[in]^2/4 = **7.59**[in3]						T. 17-27

$(1/\Omega)R_n = (1/\Omega)*F_y*Z_x/e = 0.599*36000$[lb/in2]$*7.59$[in3]$/8.4$[in] = **19.49**[kip] p. 15-7

Flexural rupture (Ecc. sum)	[Kip]	19.42	10.00	DL	0.51	p. 9-6

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375$[in]$/4*(9$[in]$^2 - 3$[in]$^2*3*(3^2 - 1)*$ 0.875[in]$/9$[in]$) =$ **5.63**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*5.63$[in3]$/8.4$[in] = **19.42**[kip] p. 9-6

Beam

Welds rupture	[Kip/ft]	107.64	24.95	DL	0.23	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.23$[in] $=$ **8.97**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10$[kip]$/(0.5*1.98$[kip/in]$*1*9$[in]$) =$ **1.12** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.12/16$ [in] $=$ **2.08**[kip/in] p. 9-5

Flexural yielding	[Kip]	17.53	10.00	DL	0.57	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*5.25$[in3]$/8.96$[in] $=$ **17.53**[kip] p. 9-6

Local web buckling	[Kip]	17.53	10.00	DL	0.57	p. 9-8, p. 9-7

$h_o = d - d_c = 13.7$[in] $- 2$[in] $=$ **11.7**[in] p. 9-7

IsBeamCopedAtBothFlanges $= (c_t <= 2*d)$ and $(d_{ct} <= 0.2*d)$ and $(c_b <= 2*d)$ and $(d_{cb} <= 0.2*d) =$ $(7.5$[in]$<=2*13.7$[in]$)$ and $(1$[in]$<=0.2*13.7$[in]$)$ and $(7.5$[in]$<=2*13.7$[in]$)$ and $(1$[in]$<=0.2*$ 13.7[in]$) =$ **True** p. 9-8

$f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1$[in]$/13.7$[in]$) =$ **2.95** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d = 0.62*\pi*2.90E+07$[lb/in2]$*0.23$[in]$^2/(7.5$[in]$*11.7$[in]$)*$ $2.95 =$ **1.01E+05**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 1.01E+05$[lb/in2]$)*5.25$[in3]$/$ 8.96[in] $=$ **17.53**[kip] p. 9-7

Block shear	[Kip]	76.82	10.00	DL	0.13	Eq. J4-5

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*2.38$[in2]$ + 1*65000$[lb/in2]$*1.27$[in2]$, 0.6*50000$[lb/in2]$*2.38$[in2]$ + 1*65000$[lb/in2]$*1.27$[in2]$) =$ **76.82**[kip] Eq. J4-5

Shear yielding	[Kip]	53.82	10.00	DL	0.19	Eq. J4-3

$A_g = L_p*t_p = 11.7$[in]$*0.23$[in] $=$ **2.69**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.69$[in2] $=$ **53.82**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	40.37	10.00	DL	0.25	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in] $- 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1 =$ **40.37**[kip] Eq. J3-6

Global critical strength ratio **0.57**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth

d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{max}: Maximum weld size required
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 3:23 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-24

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.97	✓	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 1[in]) - \max(0.735[in], 0[in]) = \mathbf{11.97}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✓	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.85	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✓	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in]$ - 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	15.00	DL	0.37	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	40.37	15.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85$[in]$ - 0.813$[in]$/2)$ = **2.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*2.44$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6
Shear yielding	[Kip]	58.42	15.00	DL	0.26	Eq. J4-3
$A_g = L_p*t_p = 12.7$[in]$*0.23$[in] = **2.92**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.92$[in2] = **58.42**[kip]						Eq. J4-3
Shear rupture	[Kip]	45.19	15.00	DL	0.33	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2

$L_e = L - n*L_h$ = 12.7[in] - 3*0.875[in] = **10.08**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 10.08[in]*0.23[in] = **2.32**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.32[in2] = **45.19**[kip] Eq. J4-4

Flexural yielding	[Kip]	61.60	15.00	DL	0.24	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*9.26[in3]/4.5[in] = **61.6**[kip] p. 9-6

Local web buckling	[Kip]	61.60	15.00	DL	0.24	p. 9-7

$h_o = d - d_c$ = 13.7[in] - 1[in] = **12.7**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (4[in]<=2*13.7[in]) and (1[in]<=13.7[in]/2) = **True** p. 9-7

c/d<=1 → 4[in]/13.7[in]<=1 → **True**

$f = 2*c/d$ = 2*4[in]/13.7[in] = **0.584** p. 9-7

c/h_o<=1 → 4[in]/12.7[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(12.7[in]/4[in])$^{1.65}$ = **14.8** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*
(0.23[in]/12.7[in])^2*0.584*14.8 = **74300.65**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 74300.65[lb/in2])*9.26[in3]/
4.5[in] = **61.6**[kip] p. 9-7

Block shear	[Kip]	41.54	15.00	DL	0.36	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.23[in] = **0.359**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.85[in] + (3 - 1)*3[in])*0.23[in] = **2.04**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.85[in] + (3 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.23[in] = **1.53**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.359[in2], 0.6*50000[lb/in2]*2.04[in2] + 1*65000[lb/
in2]*0.359[in2]) = **41.54**[kip] Eq. J4-5

Flexural rupture	[Kip]	66.87	15.00	DL	0.22	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*9.26[in3]/4.5[in] = **66.87**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	163.80	20.00	DL	0.12	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.35[in] = **13.65**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*9[in]) = **0.898** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.898/16 [in] = **1.67**[kip/in] p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:31 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-25

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.97	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1[in]) - max(0.735[in], 0[in]) = **11.97**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23$[in]$, 12$ [in]$) =$ **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.27	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.707 =$ **0.265**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	15.00	DL	0.37	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$)$ = **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	40.37	15.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85$[in]$ - 0.813$[in]$/2)$ = **2.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*2.44$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	58.42	15.00	DL	0.26	Eq. J4-3
$A_g = L_p*t_p$ = 12.7[in]*0.23[in] = **2.92**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.92[in2] = **58.42**[kip]						Eq. J4-3
Shear rupture	[Kip]	45.19	15.00	DL	0.33	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12.7[in] - 3*0.875[in] = **10.08**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 10.08[in]*0.23[in] = **2.32**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.32[in2] = **45.19**[kip]						Eq. J4-4
Flexural yielding	[Kip]	61.60	15.00	DL	0.24	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*9.26[in3]/4.5[in] = **61.6**[kip]						p. 9-6
Local web buckling	[Kip]	61.60	15.00	DL	0.24	p. 9-7
$h_o = d - d_c$ = 13.7[in] - 1[in] = **12.7**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (4[in]<=2*13.7[in]) and (1[in]<=13.7[in]/2) = **True**						p. 9-7
c/d<=1 → 4[in]/13.7[in]<=1 → **True**						
$f = 2*c/d$ = 2*4[in]/13.7[in] = **0.584**						p. 9-7
c/h_o<=1 → 4[in]/12.7[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(12.7[in]/4[in])$^{1.65}$ = **14.8**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*						
(0.23[in]/12.7[in])^2*0.584*14.8 = **74300.65**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 74300.65[lb/in2])*9.26[in3]/						
4.5[in] = **61.6**[kip]						p. 9-7
Block shear	[Kip]	41.54	15.00	DL	0.36	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*5.5[in] - (1 - 0.5)*						
0.875[in])*0.23[in] = **0.359**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.85[in] + (3 - 1)*3[in])*0.23[in] = **2.04**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.85[in] + (3 - 1)*(3[in] - 0.875[in]) -						
0.875[in]/2)*0.23[in] = **1.53**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =						
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.359[in2], 0.6*50000[lb/in2]*2.04[in2] + 1*65000[lb/						
in2]*0.359[in2]) = **41.54**[kip]						Eq. J4-5
Flexural rupture	[Kip]	66.87	15.00	DL	0.22	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*9.26[in3]/4.5[in] = **66.87**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	140.40	20.00	DL	0.14	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.3[in] = **11.7**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*9[in]) = **0.898**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.898/16 [in] = **1.67**[kip/in]						p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:19 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\Roof.cnx\

Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-26

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	19.86	2.39	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.97	✓	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 1[in]) - \max(0.735[in], 0[in]) = \mathbf{11.97}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✓	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.90	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✓	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✓	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	19.86	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	19.86	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	19.86	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in]$ - 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	19.86	DL	0.47	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$) =$ **41.93**[kip]						Eq. J4-5
Bolt bearing under axial load	[Kip]	42.82	2.39	DL	0.06	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 5.5$[in]$ - 0.813$[in]$)$ = **4.69**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*4.69$[in]$, 2.4*0.75$[in]$)*(1 - 1))*$ 0.375[in]$*58000$[lb/in2]$*3$ = **42.82**[kip]						Eq. J3-6
Tension yielding	[Kip]	72.75	2.39	DL	0.03	Eq. J4-1
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*36000$[lb/in2]$*3.38$[in2] = **72.75**[kip]						Eq. J4-1
Tension rupture	[Kip]	69.33	2.39	DL	0.03	Eq. J4-2
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p = (9$[in]$ - 3*0.875$[in]$)*0.375$[in] = **2.39**[in2]						Sec. D3-2
$A_e = \min(0.85*A_g, A_n) = \min(0.85*3.38$[in2]$, 2.39$[in2]$)$ = **2.39**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*2.39$[in2] = **69.33**[kip]						Eq. J4-2

Tear out under axial load	[Kip]	58.37	2.39	DL	0.04	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(1.5[in] + (1 - 1)*5.5[in])*0.375[in] =$ **1.13**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(1.5[in] + (1 - 1)*5.5[in] - 0.875[in]*$
$(1 - 0.5))*0.375[in] =$ **0.797**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.375[in] =$ **1.59**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*58000[lb/in2]*0.797[in2] + 1*58000[lb/in2]*1.59[in2], 0.6*36000[lb/in2]*1.13[in2] + 1*58000[lb/in2]*1.59[in2]) =$ **58.37**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	68.20	20.00	DL	0.29	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.79$[kip/in]$*1*4*9$[in] = **68.2**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	19.86	DL	0.49	Eq. J3-6

$L_{c\text{-}end} = \max(0.0, L_e - d_h/2) = \max(0.0, 2.9[in] - 0.813[in]/2) =$ **2.49**[in] Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - d_h) = \max(0.0, 3[in] - 0.813[in]) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.49[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))*$
$0.23[in]*65000[lb/in2]*1 =$ **40.37**[kip] Eq. J3-6

Shear yielding	[Kip]	58.42	19.86	DL	0.34	Eq. J4-3

$A_g = L_p*t_p = 12.7[in]*0.23[in] =$ **2.92**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.92[in2] =$ **58.42**[kip] Eq. J4-3

Shear rupture	[Kip]	45.19	19.86	DL	0.44	Eq. J4-4

$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$L_e = L - n*L_h = 12.7[in] - 3*0.875[in] =$ **10.08**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 10.08[in]*0.23[in] =$ **2.32**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.32[in2] =$ **45.19**[kip] Eq. J4-4

Flexural yielding	[Kip]	69.30	19.86	DL	0.29	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000[lb/in2]*9.26[in3]/4[in] =$ **69.3**[kip] p. 9-6

Local web buckling	[Kip]	69.30	19.86	DL	0.29	p. 9-7

$h_o = d - d_c = 13.7[in] - 1[in] =$ **12.7**[in] p. 9-7

IsTopFlangeBeamCoped = ($c<=2*d$) and ($d_c<=d/2$) = (3.5[in]$<=2*13.7$[in]) and (1[in]$<=13.7$[in]$/2$) = **True** p. 9-7

$c/d<=1 \rightarrow 3.5[in]/13.7[in]<=1 \rightarrow$ **True**

$f = 2*c/d = 2*3.5[in]/13.7[in] =$ **0.511** p. 9-7

$c/h_o<=1 \rightarrow 3.5[in]/12.7[in]<=1 \rightarrow$ **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(12.7[in]/3.5[in])^{1.65} =$ **18.45** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*$
$(0.23[in]/12.7[in])^2*0.511*18.45 =$ **81037.75**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000[lb/in2], 81037.75[lb/in2])*9.26[in3]/$
$4[in] =$ **69.3**[kip] p. 9-7

Block shear	[Kip]	45.52	19.86	DL	0.44	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)*$
$0.875[in])*0.23[in] =$ **0.474**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2.9[in] + (3 - 1)*3[in])*0.23[in] =$ **2.05**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2.9[in] + (3 - 1)*(3[in] - 0.875[in]) -$
$0.875[in]/2)*0.23[in] =$ **1.54**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.54[in2] + 1*65000[lb/in2]*0.474[in2], 0.6*50000[lb/in2]*2.05[in2] + 1*65000[lb/in2]*0.474[in2]) =$ **45.52**[kip] Eq. J4-5

Flexural rupture	[Kip]	75.23	19.86	DL	0.26	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*9.26[in3]/4[in] =$ **75.23**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	40.37	2.39	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5[in] - 0.813[in]/2) =$ **2.09**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 5.5[in] - 0.813[in]) =$ **4.69**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.09[in], 2.4*0.75[in]) + \min(1.2*4.69[in], 2.4*0.75[in])*(1 - 1))*$
$0.23[in]*65000[lb/in2]*3 =$ **40.37**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	194.31	2.39	DL	0.01	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*6.49[in2] =$ **194.31**[kip] Eq. D2-1

Tension rupture	[Kip]	106.06	2.39	DL	0.02	Eq. J4-2

$L_h = d_h + 1/16$ [in] $= 0.813[in] + 1/16$ [in] = **0.875**[in] Sec. D3-2

$U = 1 - x/l = 1 - 0.5[in]/3[in] =$ **0.833** Table D3.1

$A_n = A_g - n_h*t_p*L_h = 4.52[in2] - 3*0.23[in]*0.875[in] =$ **3.92**[in2] Sec. D3-2

$A_e = U*A_n = 0.833*3.92[in2] =$ **3.26**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*3.26[in2] =$ **106.06**[kip] Eq. J4-2

Tear out under axial load	[Kip]	49.02	2.39	DL	0.05	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813[in] + 1/16$ [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813[in] + 1/16$ [in] = **0.875**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5[in] + (1 - 1)*5.5[in])*0.23[in] =$ **1.15**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5[in] + (1 - 1)*5.5[in] - 0.875[in]*$
$(1 - 0.5))*0.23[in] =$ **0.949**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 0.875[in])*(3 - 1)*0.23[in] =$ **0.978**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*0.949[in2] + 1*65000[lb/in2]*0.978[in2], 0.6*50000[lb/in2]*1.15[in2] + 1*$
$65000[lb/in2]*0.978[in2]) =$ **49.02**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	140.40	26.13	DL	0.19	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.3[in] =$ **11.7**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 20[kip]/(0.5*3.79[kip/in]*1*9[in]) =$ **1.17** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*1.17/16$ [in] = **2.18**[kip/in] p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area
A_e: Effective net area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_n: Net area
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
g: Transversal gage between bolts
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBoltedConnection: Is bolted connection
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
l: Length
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
n_h: Holes number
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U: Shear lag factor
U_{bs}: Stress index
w_{min}: Minimum weld size required
x: Connection eccentricity
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:54 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-27

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.47	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1.5[in]) - max(0.735[in], 0[in]) = **11.47**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.23$[in]$, 12$ [in]$) =$ **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	20.00	DL	0.63	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	20.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	20.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	20.00	DL	0.48	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	20.00	DL	0.49	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	20.00	DL	0.30	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	40.37	20.00	DL	0.50	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2) =$ **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	56.12	20.00	DL	0.36	Eq. J4-3
$A_g = L_p * t_p$ = 12.2[in]*0.23[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.81[in2] = **56.12**[kip]						Eq. J4-3
Shear rupture	[Kip]	42.94	20.00	DL	0.47	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 12.2[in] - 3*0.875[in] = **9.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 9.58[in]*0.23[in] = **2.2**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.2[in2] = **42.94**[kip]						Eq. J4-4
Flexural yielding	[Kip]	46.77	20.00	DL	0.43	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*8.59[in3]/5.5[in] = **46.77**[kip]						p. 9-6
Local web buckling	[Kip]	46.77	20.00	DL	0.43	p. 9-7
$h_o = d - d_c$ = 13.7[in] - 1.5[in] = **12.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5[in]<=2*13.7[in]) and (1.5[in]<=13.7[in]/2) = **True**						p. 9-7
c/d<=1 → 5[in]/13.7[in]<=1 → **True**						
$f = 2 * c/d$ = 2*5[in]/13.7[in] = **0.73**						p. 9-7
c/h_o<=1 → 5[in]/12.2[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(12.2[in]/5[in])$^{1.65}$ = **9.59**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.23[in]/12.2[in])^2*0.73*9.59 = **65178.81**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 65178.81[lb/in2])*8.59[in3]/ 5.5[in] = **46.77**[kip]						p. 9-7
Block shear	[Kip]	41.27	20.00	DL	0.48	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.23[in] = **0.419**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.35[in] + (3 - 1)*3[in])*0.23[in] = **1.92**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.35[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.23[in] = **1.42**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*0.419[in2], 0.6*50000[lb/in2]*1.92[in2] + 1*65000[lb/ in2]*0.419[in2]) = **41.27**[kip]						Eq. J4-5
Flexural rupture	[Kip]	50.77	20.00	DL	0.39	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*8.59[in3]/5.5[in] = **50.77**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	205.92	26.67	DL	0.13	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.44[in] = **17.16**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 20[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.2**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.2/16 [in] = **2.22**[kip/in]						p. 9-5

Global critical strength ratio **0.63**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:37 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-28

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.47	✔	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 1.5[in]) - max(0.735[in], 0[in]) = **11.47**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.26	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	31.82	30.00	DL	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	30.00	DL	0.56	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	30.00	DL	0.62	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	30.00	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	30.00	DL	0.72	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$) =$ **41.93**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	66.82	30.00	DL	0.45	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	40.37	30.00	DL	0.74	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2) =$ **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.23[in]$*65000$[lb/in2]$*1$ = **40.37**[kip]						Eq. J3-6

Shear yielding	[Kip]	56.12	30.00	DL	0.53	Eq. J4-3
$A_g = L_p * t_p$ = 12.2[in]*0.23[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*2.81[in2] = **56.12**[kip]						Eq. J4-3
Shear rupture	[Kip]	42.94	30.00	DL	0.70	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 12.2[in] - 3*0.875[in] = **9.58**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 9.58[in]*0.23[in] = **2.2**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.2[in2] = **42.94**[kip]						Eq. J4-4
Flexural yielding	[Kip]	39.57	30.00	DL	0.76	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*8.59[in3]/6.5[in] = **39.57**[kip]						p. 9-6
Local web buckling	[Kip]	39.57	30.00	DL	0.76	p. 9-7
$h_o = d - d_c$ = 13.7[in] - 1.5[in] = **12.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (6[in]<=2*13.7[in]) and (1.5[in]<=13.7[in]/2) = **True**						p. 9-7
c/d<=1 → 6[in]/13.7[in]<=1 → **True**						
$f = 2 * c/d$ = 2*6[in]/13.7[in] = **0.876**						p. 9-7
c/h_o<=1 → 6[in]/12.2[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(12.2[in]/6[in])$^{1.65}$ = **7.1**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.23[in]/12.2[in])^2*0.876*7.1 = **57894.68**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 57894.68[lb/in2])*8.59[in3]/ 6.5[in] = **39.57**[kip]						p. 9-7
Block shear	[Kip]	41.27	30.00	DL	0.73	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.26[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.23[in] = **0.419**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.35[in] + (3 - 1)*3[in])*0.23[in] = **1.92**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.35[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.23[in] = **1.42**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*0.419[in2], 0.6*50000[lb/in2]*1.92[in2] + 1*65000[lb/in2]*0.419[in2]) = **41.27**[kip]						Eq. J4-5
Flexural rupture	[Kip]	42.96	30.00	DL	0.70	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*8.59[in3]/6.5[in] = **42.96**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	257.40	40.00	DL	0.16	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.55[in] = **21.45**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 30[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.8**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.8/16 [in] = **3.33**[kip/in]						p. 9-5

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:40 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-29

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.13	11.58	✔	p. 10-104
$L_{min} = T/2 = 12.26[in]/2 = \mathbf{6.13}[in]$						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.9[in] - max(0.82[in], 1.5[in]) - max(0.82[in], 0[in]) = **11.58**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.12	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.255[in], 12 [in]) = **6.12**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.26	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in])/$sin\alpha = (3/16$ [in])/0.438 = **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	15.00	DL	0.47	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	15.00	DL	0.28	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	15.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	15.00	DL	0.36	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	40.91	15.00	DL	0.37	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.363$[in2]$) =$ **40.91**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	15.00	DL	0.22	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	44.75	15.00	DL	0.34	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.45$[in]$ - 0.813$[in]$/2) =$ **2.04**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*2.04$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.255[in]$*65000$[lb/in2]$*1$ = **44.75**[kip]						Eq. J3-6

Shear yielding	[Kip]	63.24	15.00	DL	0.24	Eq. J4-3
$A_g = L_p*t_p$ = 12.4[in]*0.255[in] = **3.16**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*3.16[in2] = **63.24**[kip]						Eq. J4-3
Shear rupture	[Kip]	48.61	15.00	DL	0.31	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12.4[in] - 3*0.875[in] = **9.78**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 9.78[in]*0.255[in] = **2.49**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.49[in2] = **48.61**[kip]						Eq. J4-4
Flexural yielding	[Kip]	54.21	15.00	DL	0.28	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*9.96[in3]/5.5[in] = **54.21**[kip]						p. 9-6
Local web buckling	[Kip]	54.21	15.00	DL	0.28	p. 9-7
$h_o = d - d_c$ = 13.9[in] - 1.5[in] = **12.4**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5[in]<=2*13.9[in]) and (1.5[in]<=13.9[in]/2) = **True**						p. 9-7
c/d<=1 → 5[in]/13.9[in]<=1 → **True**						
$f = 2*c/d$ = 2*5[in]/13.9[in] = **0.719**						p. 9-7
c/h_o<=1 → 5[in]/12.4[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(12.4[in]/5[in])$^{1.65}$ = **9.85**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.255[in]/12.4[in])^2*0.719*9.85 = **78517.28**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 78517.28[lb/in2])*9.96[in3]/ 5.5[in] = **54.21**[kip]						p. 9-7
Block shear	[Kip]	46.16	15.00	DL	0.32	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.255[in] = **0.462**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.45[in] + (3 - 1)*3[in])*0.255[in] = **2.15**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.45[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.255[in] = **1.6**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.6[in2] + 1*65000[lb/in2]*0.462[in2], 0.6*50000[lb/in2]*2.15[in2] + 1*65000[lb/ in2]*0.462[in2]) = **46.16**[kip]						Eq. J4-5
Flexural rupture	[Kip]	58.84	15.00	DL	0.25	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*9.96[in3]/5.5[in] = **58.84**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	215.28	20.00	DL	0.09	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.46[in] = **17.94**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*9[in]) = **0.898**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.898/16 [in] = **1.67**[kip/in]						p. 9-5

Global critical strength ratio **0.47**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:41 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-30

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	35.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	7.10	13.70	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 1[in]) - max(0.747[in], 1[in]) = **13.7**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25$[in]$, 12$ [in]$) =$ **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	35.00	DL	0.82	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	35.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	35.00	DL	0.54	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	35.00	DL	0.63	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in]$ - 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	35.00	DL	0.65	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$) =$ **54.08**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	35.00	DL	0.39	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	58.50	35.00	DL	0.60	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2) =$ **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.25[in]$*65000$[lb/in2]$*1$ = **58.5**[kip]						Eq. J3-6

Shear yielding	[Kip]	68.50	35.00	DL	0.51	Eq. J4-3
$A_g = L_p * t_p$ = 13.7[in]*0.25[in] = **3.43**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*3.43[in2] = **68.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	49.73	35.00	DL	0.70	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 13.7[in] - 4*0.875[in] = **10.2**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 10.2[in]*0.25[in] = **2.55**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.55[in2] = **49.73**[kip]						Eq. J4-4
Flexural yielding	[Kip]	66.90	35.00	DL	0.52	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*7.82[in3]/3.5[in] = **66.9**[kip]						p. 9-6
Local web buckling	[Kip]	66.90	35.00	DL	0.52	p. 9-8, p. 9-7
$h_o = d - d_c$ = 15.7[in] - 2[in] = **13.7**[in]						p. 9-7
IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3[in]<=2*15.7[in]) and (1[in]<=0.2*15.7[in]) and (3[in]<=2*15.7[in]) and (1[in]<=0.2*15.7[in]) = **True**						p. 9-8
$f_d = 3.5 - 7.5 * (d_c/d)$ = 3.5 - 7.5*(1[in]/15.7[in]) = **3.02**						p. 9-8
$F_{cr} = 0.62 * \pi * E * t_w^2/(c * h_o) * f_d$ = 0.62*π*2.90E+07[lb/in2]*0.25[in]^2/(3[in]*13.7[in])*3.02 = **2.60E+05**[lb/in2]						p. 9-8
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 2.60E+05[lb/in2])*7.82[in3]/3.5[in] = **66.9**[kip]						p. 9-7
Block shear	[Kip]	55.14	35.00	DL	0.63	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.25[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.25[in] = **0.454**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (2.35[in] + (4 - 1)*3[in])*0.25[in] = **2.84**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (2.35[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.25[in] = **2.07**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*2.07[in2] + 1*65000[lb/in2]*0.454[in2], 0.6*50000[lb/in2]*2.84[in2] + 1*65000[lb/in2]*0.454[in2]) = **55.14**[kip]						Eq. J4-5
Flexural rupture	[Kip]	72.62	35.00	DL	0.48	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*7.82[in3]/3.5[in] = **72.62**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	117.00	35.00	DL	0.30	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.25[in] = **9.75**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 35[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.57**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.57/16 [in] = **2.92**[kip/in]						p. 9-5

Global critical strength ratio **0.82**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length

c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:42 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-31

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	10.75	7.10	10.95	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 0[in]) - max(0.747[in], 4[in]) = **10.95**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.25	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	2.75	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25$[in]$, 12$ [in]$) =$ **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.20	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	15.00	DL	0.35	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	69.74	15.00	DL	0.22	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.25$[in] $- 0.813$[in]$/2) =$ **0.844**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 2.75$[in] $- 0.813$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*0.844$[in]$, 2.4*0.75$[in]$) + \min(1.2*1.94$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **69.74**[kip]						Eq. J3-6
Shear yielding	[Kip]	58.05	15.00	DL	0.26	Eq. J4-3
$A_g = L_p*t_p = 10.75$[in]$*0.375$[in] = **4.03**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.03$[in2] = **58.05**[kip]						Eq. J4-3
Shear rupture	[Kip]	47.31	15.00	DL	0.32	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 10.75$[in]$ - 4*0.875$[in] = **7.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 7.25$[in]$*0.375$[in] = **2.72**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.72$[in2] = **47.31**[kip]						Eq. J4-4
Block shear	[Kip]	49.01	15.00	DL	0.31	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.25$[in]$ + (4 - 1)*2.75$[in]$)*0.375$[in] = **3.56**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.25$[in]$ + (4 - 1)*(2.75$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.41**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*2.41$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*3.56$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **49.01**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	79.81	15.00	DL	0.19	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*10.75$[in] = **79.81**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	58.50	15.00	DL	0.26	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.2$[in]$ - 0.813$[in]$/2) =$ **1.79**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 2.75$[in]$ - 0.813$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.79$[in]$, 2.4*0.75$[in]$) + \min(1.2*1.94$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.25[in]$*65000$[lb/in2]$*1$ = **58.5**[kip]						Eq. J3-6

Shear yielding	[Kip]	58.50	15.00	DL	0.26	Eq. J4-3
$A_g = L_p*t_p$ = 11.7[in]*0.25[in] = **2.93**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.93[in2] = **58.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	39.98	15.00	DL	0.38	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 11.7[in] - 4*0.875[in] = **8.2**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.2[in]*0.25[in] = **2.05**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.05[in2] = **39.98**[kip]						Eq. J4-4
Flexural yielding	[Kip]	37.15	15.00	DL	0.40	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*8.69[in3]/7[in] = **37.15**[kip]						p. 9-6
Local web buckling	[Kip]	33.71	15.00	DL	0.44	p. 9-8, p. 9-7
$h_o = d - d_c$ = 15.7[in] - 4[in] = **11.7**[in]						p. 9-7
IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (0[in]<=2*15.7[in]) and (0[in]<=0.2*15.7[in]) and (6.5[in]<=2*15.7[in]) and (4[in]<=0.2*15.7[in]) = **False**						p. 9-8
$\lambda = h_o*(F_y/(1\ [ksi]))^{1/2}/(10*t_w*(475 + 280*(h_o/c)^2)^{1/2})$ = 11.7[in]*(50000[lb/in2]/(1 [ksi]))$^{1/2}$/(10*0.25[in]*(475 + 280*(11.7[in]/6.5[in])^2)$^{1/2}$) = **0.89**						p. 9-9
$\lambda Limit$ = λ<=0.7 = 0.89<=0.7 = **False**						p. 9-9
$\lambda Limit$ = (λ>0.7) and (λ<=1.41) = (0.89>0.7) and (0.89<=1.41) = **True**						p. 9-9
Q = 1.34 - 0.486*λ = 1.34 - 0.486*0.89 = **0.907**						p. 9-9
$F_{cr} = F_y*Q$ = 50000[lb/in2]*0.907 = **45370.24**[lb/in2]						p. 9-8
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 45370.24[lb/in2])*8.69[in3]/7[in] = **33.71**[kip]						p. 9-7
Block shear	[Kip]	50.76	15.00	DL	0.30	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.25[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.25[in] = **0.454**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.2[in] + (4 - 1)*2.75[in])*0.25[in] = **2.61**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.2[in] + (4 - 1)*(2.75[in] - 0.875[in]) - 0.875[in]/2)*0.25[in] = **1.85**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.85[in2] + 1*65000[lb/in2]*0.454[in2], 0.6*50000[lb/in2]*2.61[in2] + 1*65000[lb/in2]*0.454[in2]) = **50.76**[kip]						Eq. J4-5
Flexural rupture	[Kip]	40.33	15.00	DL	0.37	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*8.69[in3]/7[in] = **40.33**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	283.14	16.74	DL	0.06	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.605[in] = **23.6**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 15[kip]/(0.5*3.71[kip/in]*1*10.75[in]) = **0.752**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.752/16 [in] = **1.4**[kip/in]						p. 9-5

Global critical strength ratio	**0.44**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient

c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
λ: Slenderness
$\lambda Limit$: Slenderness limit
$\lambda Limit$: Slenderness limit
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
Q: Slenderness factor
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:35 PM
Units system: English
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Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-32

Family: Beam - Girder (BG)
Type: Single plate
Description: W16X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	7.10	13.45	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 1.5[in]) - max(0.747[in], 0[in]) = **13.45**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.25[in], 12 [in]) = **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	30.00	DL	0.41	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	30.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	30.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in]$ - 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	53.06	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **53.06**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	30.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	57.95	30.00	DL	0.52	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.85$[in]$ - 0.813$[in]$/2)$ = **1.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.44$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.25[in]$*65000$[lb/in2]$*1$ = **57.95**[kip]						Eq. J3-6

Shear yielding	[Kip]	71.00	30.00	DL	0.42	Eq. J4-3
$A_g = L_p*t_p$ = 14.2[in]*0.25[in] = **3.55**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*3.55[in2] = **71**[kip]						Eq. J4-3
Shear rupture	[Kip]	52.16	30.00	DL	0.58	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 14.2[in] - 4*0.875[in] = **10.7**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 10.7[in]*0.25[in] = **2.68**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.68[in2] = **52.16**[kip]						Eq. J4-4
Flexural yielding	[Kip]	57.40	30.00	DL	0.52	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*12.46[in3]/6.5[in] = **57.4**[kip]						p. 9-6
Local web buckling	[Kip]	57.40	30.00	DL	0.52	p. 9-7
$h_o = d - d_c$ = 15.7[in] - 1.5[in] = **14.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (6[in]<=2*15.7[in]) and (1.5[in]<=15.7[in]/2) = **True**						p. 9-7
c/d<=1 → 6[in]/15.7[in]<=1 → **True**						
$f = 2*c/d$ = 2*6[in]/15.7[in] = **0.764**						p. 9-7
c/h_o<=1 → 6[in]/14.2[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(14.2[in]/6[in])$^{1.65}$ = **9.11**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.25[in]/14.2[in])^2*0.764*9.11 = **56599.02**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 56599.02[lb/in2])* 12.46[in3]/6.5[in] = **57.4**[kip]						p. 9-7
Block shear	[Kip]	52.71	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.25[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.25[in] = **0.454**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.85[in] + (4 - 1)*3[in])*0.25[in] = **2.71**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.85[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.25[in] = **1.95**[in2]						Sec. J4-3
IsStressUniform → **True**						Sec. J4-3
U_{bs} = 1						
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.95[in2] + 1*65000[lb/in2]*0.454[in2], 0.6*50000[lb/in2]*2.71[in2] + 1*65000[lb/in2]*0.454[in2]) = **52.71**[kip]						Eq. J4-5
Flexural rupture	[Kip]	62.31	30.00	DL	0.48	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*12.46[in3]/6.5[in] = **62.31**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	229.32	30.00	DL	0.13	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.49[in] = **19.11**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 30[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:02 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : SC-07-33

Family: Beam - Girder (BG)
Type: Single plate
Description: W16X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	7.10	13.95	✔	p. 10-104
$L_{min} = T/2 = 14.21$[in]$/2 =$ **7.1**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 1[in]) - max(0.747[in], 0[in]) = **13.95**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25$[in]$, 12$ [in]$) =$ **6**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	30.00	DL	0.41	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	30.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	30.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in]$ - 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	53.06	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **53.06**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	30.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	58.50	30.00	DL	0.51	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.35$[in]$ - 0.813$[in]$/2)$ = **1.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.94$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.25[in]$*65000$[lb/in2]$*1$ = **58.5**[kip]						Eq. J3-6

Shear yielding	[Kip]	73.50	30.00	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 14.7[in]*0.25[in] = **3.68**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*3.68[in2] = **73.5**[kip]						Eq. J4-3
Shear rupture	[Kip]	54.60	30.00	DL	0.55	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 14.7[in] - 4*0.875[in] = **11.2**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 11.2[in]*0.25[in] = **2.8**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.8[in2] = **54.6**[kip]						Eq. J4-4
Flexural yielding	[Kip]	113.68	30.00	DL	0.26	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*13.29[in3]/3.5[in] = **113.68**[kip]						p. 9-6
Local web buckling	[Kip]	113.68	30.00	DL	0.26	p. 9-7
$h_o = d - d_c$ = 15.7[in] - 1[in] = **14.7**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (3[in]<=2*15.7[in]) and (1[in]<=15.7[in]/2) = **True**						p. 9-7
c/d<=1 → 3[in]/15.7[in]<=1 → **True**						
$f = 2*c/d$ = 2*3[in]/15.7[in] = **0.382**						p. 9-7
c/h_o<=1 → 3[in]/14.7[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(14.7[in]/3[in])$^{1.65}$ = **30.29**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*						
(0.25[in]/14.7[in])^2*0.382*30.29 = **87744.17**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 87744.17[lb/in2])*						
13.29[in3]/3.5[in] = **113.68**[kip]						p. 9-7
Block shear	[Kip]	55.14	30.00	DL	0.54	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)*						
0.875[in])*0.25[in] = **0.454**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.35[in] + (4 - 1)*3[in])*0.25[in] = **2.84**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.35[in] + (4 - 1)*(3[in] - 0.875[in]) -						
0.875[in]/2)*0.25[in] = **2.07**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =						
0.5*min(0.6*65000[lb/in2]*2.07[in2] + 1*65000[lb/in2]*0.454[in2], 0.6*50000[lb/in2]*2.84[in2] + 1*65000[lb/						
in2]*0.454[in2]) = **55.14**[kip]						Eq. J4-5
Flexural rupture	[Kip]	123.40	30.00	DL	0.24	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*13.29[in3]/3.5[in] = **123.4**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	140.40	30.00	DL	0.21	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.3[in] = **11.7**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 30[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : **SP_BG_**
Connection ID : **SC-07-34**

Family: Beam - Girder (BG)
Type: Single plate
Description: W16X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	7.10	13.45	✔	p. 10-104
$L_{min} = T/2 = 14.21[in]/2 = \mathbf{7.1}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 15.7[in] - \max(0.747[in], 1.5[in]) - \max(0.747[in], 0[in]) = \mathbf{13.45}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.25[in], 12\ [in]) = \mathbf{6}[in]$						Sec. J3.5
Beam						
Thickness	[in]	0.25	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16\ [in])/sin\alpha = (3/16\ [in])/0.438 = \mathbf{0.428}[in]$						p. 10-151
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	30.00	DL	0.41	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	30.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	30.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in]$ - 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	53.06	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **53.06**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	30.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	57.95	30.00	DL	0.52	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.85$[in]$ - 0.813$[in]$/2) =$ **1.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.44$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.25[in]$*65000$[lb/in2]$*1$ = **57.95**[kip]						Eq. J3-6

Shear yielding	[Kip]	71.00	30.00	DL	0.42	Eq. J4-3
$A_g = L_p * t_p$ = 14.2[in]*0.25[in] = **3.55**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*3.55[in2] = **71**[kip]						Eq. J4-3
Shear rupture	[Kip]	52.16	30.00	DL	0.58	Eq. J4-4
$L_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n * L_h$ = 14.2[in] - 4*0.875[in] = **10.7**[in]						DG4 Eq. 3-13
$A_{nv} = L_e * t_p$ = 10.7[in]*0.25[in] = **2.68**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.68[in2] = **52.16**[kip]						Eq. J4-4
Flexural yielding	[Kip]	82.91	30.00	DL	0.36	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e$ = 0.599*50000[lb/in2]*12.46[in3]/4.5[in] = **82.91**[kip]						p. 9-6
Local web buckling	[Kip]	82.91	30.00	DL	0.36	p. 9-7
$h_o = d - d_c$ = 15.7[in] - 1.5[in] = **14.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (4[in]<=2*15.7[in]) and (1.5[in]<=15.7[in]/2) = **True**						p. 9-7
c/d<=1 → 4[in]/15.7[in]<=1 → **True**						
$f = 2 * c/d$ = 2*4[in]/15.7[in] = **0.51**						p. 9-7
c/h_o<=1 → 4[in]/14.2[in]<=1 → **True**						
$k = 2.2 * (h_o/c)^{1.65}$ = 2.2*(14.2[in]/4[in])$^{1.65}$ = **17.8**						p. 9-7
$F_{cr} = \pi^2 * E/(12 * (1 - \nu^2)) * (t_w/h_o)^2 * f * k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))* (0.25[in]/14.2[in])^2*0.51*17.8 = **73666.19**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega) * \min(F_y, F_{cr}) * S_{net}/e$ = 0.599*min(50000[lb/in2], 73666.19[lb/in2])* 12.46[in3]/4.5[in] = **82.91**[kip]						p. 9-7
Block shear	[Kip]	52.71	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1) * spa - (n_c - 0.5) * dh_h) * t_p$ = (2.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.25[in] = **0.454**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1) * s) * t_p$ = (1.85[in] + (4 - 1)*3[in])*0.25[in] = **2.71**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1) * (s - dh_v) - dh_v/2) * t_p$ = (1.85[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.25[in] = **1.95**[in2]						Sec. J4-3
IsStressUniform → **True**						Sec. J4-3
U_{bs} = 1						
$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.95[in2] + 1*65000[lb/in2]*0.454[in2], 0.6*50000[lb/in2]*2.71[in2] + 1*65000[lb/in2]*0.454[in2]) = **52.71**[kip]						Eq. J4-5
Flexural rupture	[Kip]	90.00	30.00	DL	0.33	p. 9-6
$(1/\Omega)R_n = (1/\Omega) * F_u * Z_{net}/e$ = 0.5*65000[lb/in2]*12.46[in3]/4.5[in] = **90**[kip]						p. 9-6
Support						
Welds rupture	[Kip/ft]	177.84	30.00	DL	0.17	p. 9-5
$R_n = 0.6 * F_u * t_p$ = 0.6*65000[lb/in2]*0.38[in] = **14.82**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega) * C * C_1 * L)$ = 30[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6 * F_{EXX} * (2)^{1/2}/2 * D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : BP_BG_
Connection ID : SC-07-35

Family: Beam - Girder (BG)
Type: Bent Plate(s)
Description: W16X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Bent Plate(s)						
Length	[in]	12.00	7.10	13.70	✔	p. 10-8
$L_{min} = T/2 = 14.21[in]/2 = \mathbf{7.1}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 15.7[in] - \max(0.747[in], 1.25[in]) - \max(0.747[in], 0[in]) = \mathbf{13.7}[in]$						p. 10-8
Bent plate(s) (beam side)						
Weld size	[1/16in]	4	3	5	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} = \mathbf{0.0156}$						table J2.4
$t_p<1/4$ [in] $\rightarrow 0.375[in]<1/4$ [in] $\rightarrow$ **False**						
$w_{max} = t_p - 1/16$ [in] $= 0.375[in] - 1/16$ [in] $= \mathbf{0.026}$						Sec. J2.2b
Bent plate(s) (support side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	8.40	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.35[in], 12$ [in]$) = \mathbf{8.4}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	5.50	2.00	8.40	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in] Sec. J3.5

Beam

Top cope length	[in]	6.50	--	31.40	✔
Bottom cope length	[in]	0.00	--	31.40	✔
Top cope depth	[in]	1.25	--	1.60	✔
Bottom cope depth	[in]	0.00	--	1.60	✔

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Bent plate(s) (beam side)						
Weld capacity	[Kip]	83.16	20.00	DL	0.24	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*C*C_1*D*L) = 2 * (0.5*1.73[kip/in]*1*4*12[in]) = **83.16**[kip]						Tables 8-4 .. 8-11
Shear yielding	[Kip]	129.60	20.00	DL	0.15	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.5[in2]) = **129.6**[kip]						Eq. J4-3
Flexural yielding	[Kip]	101.22	20.00	DL	0.20	p. 15-7
Z_x = t_p*L^2/4 = 0.375[in]*12[in]^2/4 = **13.5**[in3]						T. 17-27
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*Z_x/e) = 2 * (0.599*36000[lb/in2]*13.5[in3]/5.75[in]) = **101.22**[kip]						p. 15-7
Bent plate(s) (support side)						
Bolts shear	[Kip]	84.86	20.00	DL	0.24	Tables (7-1..14)
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (4*10.61[kip]) = **84.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	146.00	20.00	DL	0.14	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])* (4 - 1))*0.375[in]*58000[lb/in2]*1) = **146**[kip]						Eq. J3-6
Shear yielding	[Kip]	129.60	20.00	DL	0.15	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*4.5[in2]) = **129.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	110.93	20.00	DL	0.18	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 12[in] - 4*0.875[in] = **8.5**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 8.5[in]*0.375[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.19[in2]) = **110.93**[kip]						Eq. J4-4
Block shear	[Kip]	106.12	20.00	DL	0.19	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.363**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u* A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]* 3.94[in2] + 1*58000[lb/in2]*0.363[in2])) = **106.12**[kip]						Eq. J4-5
Beam						
Welds rupture	[Kip/ft]	117.00	42.86	DL	0.37	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.25$[in] = **9.75**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10$[kip]$/(0.5*1.73$[kip/in]$*1*12$[in]$) =$ **0.962** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 2 * (0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in]$) = 2 * (0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.962/16$ [in]$) =$ **3.57**[kip/in] p. 9-5

Flexural yielding	[Kip]	50.44	20.00	DL	0.40	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*12.87$[in3]$/7.64$[in] = **50.44**[kip] p. 9-6

Local web buckling	[Kip]	50.44	20.00	DL	0.40	p. 9-7

$h_o = d - d_c = 15.7$[in] $- 1.25$[in] = **14.45**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (6.5[in]<=2*15.7[in]) and (1.25[in]<=15.7[in]/2) = **True** p. 9-7

c/d<=1 → 6.5[in]/15.7[in]<=1 → **True**

$f = 2*c/d = 2*6.5$[in]$/15.7$[in] = **0.828** p. 9-7

c/h_o<=1 → 6.5[in]/14.45[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(14.45$[in]$/6.5$[in]$)^{1.65} =$ **8.22** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*$ $(0.25$[in]$/14.45$[in]$)^2*0.828*8.22 =$ **53402.39**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2], 53402.39[lb/in2]$)*$ 12.87[in3]$/7.64$[in] = **50.44**[kip] p. 9-7

Block shear	[Kip]	91.94	20.00	DL	0.22	Eq. J4-5

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*3.15$[in2] $+ 1*65000$[lb/in2]$*1.38$[in2], $0.6*50000$[lb/in2]$*3.15$[in2] $+ 1*65000$[lb/in2]$*1.38$[in2]$) =$ **91.94**[kip] Eq. J4-5

Shear yielding	[Kip]	72.25	20.00	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 14.45$[in]$*0.25$[in] = **3.61**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.61$[in2] = **72.25**[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	163.80	20.00	DL	0.12	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in] $- 0.813$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$ $t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31$[in], $2.4*0.75$[in]$) + \min(1.2*2.19$[in], $2.4*$ 0.75[in]$)*(4 - 1))*0.35$[in]$*65000$[lb/in2]$*1) =$ **163.8**[kip] Eq. J3-6

Global critical strength ratio **0.40**

NOTATION

A_b:	Nominal bolt area
A_g:	Gross area
A_{gv}:	Gross area subject to shear
A_{nt}:	Net area subject to tension
A_{nv}:	Net area subjected to shear
C:	Bolt group coefficient
c:	Coped length
C_1:	Electrode strength coefficient
C_2:	Edge distance increment
C:	Weld group coefficient
d:	Nominal bolt diameter
d_c:	Coped depth
d_{cb}:	Bottom cope depth
d_{ct}:	Top cope depth
d_h:	Nominal hole dimension
dh_h:	Horizontal hole dimension
dh_v:	Vertical hole dimension
D:	Number of sixteenths of an inch in the weld size
D_{min}:	Number of sixteenths of an inch in the minimum weld size
e:	Load eccentricity
E:	Elastic modulus
f:	Plate buckling model adjustment factor
F_{cr}:	Critical stress, flexural stress buckling
F_{EXX}:	Electrode classification number

F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{max}: Maximum weld size required
w_{min}: Minimum weld size required
Z_x: Plastic section modulus about the x-axis

Current Date: 2016-05-25 2:23 PM
Units system: English
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Steel connections

Results

Connection name : BP_BG_1/4PL_4B3/4
Connection ID : SC-07-36

Family: Beam - Girder (BG)
Type: Bent Plate(s)
Description: W24X55

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	45.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Bent Plate(s)						
Length	[in]	18.00	10.79	20.60	✔	p. 10-8
$L_{min} = T/2 = 21.58[in]/2 = \mathbf{10.79}[in]$						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.6[in] - \max(1.01[in], 1.5[in]) - \max(1.01[in], 1.5[in]) = \mathbf{20.6}[in]$						p. 10-8
Bent plate(s) (beam side)						
Weld size	[1/16in]	3	3	5	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} = \mathbf{0.0156}$						table J2.4
$t_p<1/4$ [in] $\rightarrow 0.375[in]<1/4$ [in] $\rightarrow$ **False**						
$w_{max} = t_p - 1/16$ [in] $= 0.375[in] - 1/16$ [in] $= \mathbf{0.026}$						Sec. J2.2b
Bent plate(s) (support side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0.125[in] = \mathbf{1.13}[in]$						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375[in], 12$ [in]$) = \mathbf{9}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	5.50	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in] Sec. J3.5

Beam

Top cope length	[in]	7.50	--	47.20	✔
Bottom cope length	[in]	7.50	--	47.20	✔
Top cope depth	[in]	1.50	--	2.61	✔
Bottom cope depth	[in]	1.50	--	2.61	✔

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Bent plate(s) (beam side)						
Weld capacity	[Kip]	62.69	45.00	DL	0.72	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*2.32[kip/in]*1*3*18[in] = **62.69**[kip]						Tables 8-4 .. 8-11
Shear yielding	[Kip]	97.20	45.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p$ = 18[in]*0.375[in] = **6.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*6.75[in2] = **97.2**[kip]						Eq. J4-3
Flexural yielding	[Kip]	118.84	45.00	DL	0.38	p. 15-7
$Z_x = t_p*L^2/4$ = 0.375[in]*18[in]^2/4 = **30.38**[in3]						T. 17-27
$(1/\Omega)R_n = (1/\Omega)*F_y*Z_x/e$ = 0.599*36000[lb/in2]*30.38[in3]/5.51[in] = **118.84**[kip]						p. 15-7
Bent plate(s) (support side)						
Bolts shear	[Kip]	52.87	45.00	DL	0.85	Tables (7-1..14)
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n$ = 4.98*10.61[kip] = **52.87**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	112.15	45.00	DL	0.40	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*$(min($k_1*L_{c\text{-}end}$, k_2*d) + min($k_1*L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))* 0.375[in]*58000[lb/in2]*1 = **112.15**[kip]						Eq. J3-6
Shear yielding	[Kip]	97.20	45.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p$ = 18[in]*0.375[in] = **6.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*6.75[in2] = **97.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	83.19	45.00	DL	0.54	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 18[in] - 6*0.875[in] = **12.75**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 12.75[in]*0.375[in] = **4.78**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*4.78[in2] = **83.19**[kip]						Eq. J4-4
Block shear	[Kip]	77.36	45.00	DL	0.58	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.375[in] = **0.363**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.375[in] = **6.19**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **4.38**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*$min(0.6*$F_u*A_{nv}$ + $U_{bs}*F_u*A_{nt}$, 0.6*F_y*A_{gv} + $U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*58000[lb/in2]*4.38[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*6.19[in2] + 1*58000[lb/ in2]*0.363[in2]) = **77.36**[kip]						Eq. J4-5
Flexural yielding (Ecc. sum)	[Kip]	76.94	45.00	DL	0.58	p. 15-7
$Z_x = t_p*L^2/4$ = 0.375[in]*18[in]^2/4 = **30.38**[in3]						T. 17-27

$(1/\Omega)R_n = (1/\Omega)*F_y*Z_x/e = 0.599*36000$[lb/in2]$*30.38$[in3]$/8.51$[in] $= \mathbf{76.94}$[kip] p. 15-7

Flexural rupture (Ecc. sum)	[Kip]	74.16	45.00	DL	0.61	p. 9-6

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $= \mathbf{0.875}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375$[in]$/4*(18$[in]$^2 - 3$[in]$^2*6*(6^2 - 1)*$ 0.875[in]$/18$[in]$) = \mathbf{21.76}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*21.76$[in3]$/8.51$[in] $= \mathbf{74.16}$[kip] p. 9-6

Beam

Welds rupture	[Kip/ft]	184.86	47.96	DL	0.26	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.395$[in] $= \mathbf{15.41}$[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 45$[kip]$/(0.5*2.32$[kip/in]$*1*18$[in]$) = \mathbf{2.15}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.15/16$ [in] $= \mathbf{4}$[kip/in] p. 9-5

Flexural yielding	[Kip]	96.80	45.00	DL	0.46	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*27.94$[in3]$/8.64$[in] $= \mathbf{96.8}$[kip] p. 9-6

Local web buckling	[Kip]	96.80	45.00	DL	0.46	p. 9-8, p. 9-7

$h_o = d - d_c = 23.6$[in] $- 3$[in] $= \mathbf{20.6}$[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (7.5[in]<=2*23.6[in]) and (1.5[in]<=0.2*23.6[in]) and (7.5[in]<=2*23.6[in]) and (1.5[in]<=0.2* 23.6[in]$) = \mathbf{True}$ p. 9-8

$f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1.5$[in]$/23.6$[in]$) = \mathbf{3.02}$ p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d = 0.62*\pi*2.90E+07$[lb/in2]$*0.395$[in]$^2/(7.5$[in]$*20.6$[in]$)*$ $3.02 = \mathbf{1.72E+05}$[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 1.72E+05$[lb/in2]$)*$ 27.94[in3]$/8.64$[in]$ = \mathbf{96.8}$[kip] p. 9-7

Block shear	[Kip]	184.96	45.00	DL	0.24	Eq. J4-5

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*7.62$[in2]$ + 1*65000$[lb/in2]$*2.17$[in2]$, 0.6*50000$[lb/in2]$*7.62$[in2]$ + 1*65000$[lb/in2]$*2.17$[in2]$) = \mathbf{184.96}$[kip] Eq. J4-5

Shear yielding	[Kip]	162.74	45.00	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 20.6$[in]$*0.395$[in] $= \mathbf{8.14}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*8.14$[in2] $= \mathbf{162.74}$[kip] Eq. J4-3

Support

Bolt bearing under shear load	[Kip]	150.93	45.00	DL	0.30	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31$[in]$ - 0.813$[in]$/2) = \mathbf{1.20E+31}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) = \mathbf{2.19}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.20E+31$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(6 - 1))*$ 0.43[in]$*65000$[lb/in2]$*1 = \mathbf{150.93}$[kip] Eq. J3-6

Global critical strength ratio **0.85**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth

d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{max}: Maximum weld size required
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 1:43 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-37

Family: Beam - Girder (BG)
Type: Single plate
Description: W16X31

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	10.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	7.11	13.90	✔	p. 10-104
$L_{min} = T/2 = 14.22[in]/2 = \mathbf{7.11}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 15.9[in] - \max(0.842[in], 1[in]) - \max(0.842[in], 1[in]) = \mathbf{13.9}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.60	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.275[in], 12\ [in]) = \mathbf{6.6}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.24	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	10.00	DL	0.24	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 4*10.61[kip]*1 = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	10.00	DL	0.14	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))* 0.375[in]*58000[lb/in2]*1 = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	10.00	DL	0.15	Eq. J4-3
$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	10.00	DL	0.18	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12[in] - 4*0.875[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.5[in]*0.375[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	10.00	DL	0.18	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/in2]*0.398[in2]) = **54.08**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	10.00	DL	0.11	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*12[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	64.35	10.00	DL	0.16	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.45[in] - 0.813[in]/2) = **2.04**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*2.04[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(4 - 1))* 0.275[in]*65000[lb/in2]*1 = **64.35**[kip]						Eq. J3-6
Shear yielding	[Kip]	76.45	10.00	DL	0.13	Eq. J4-3
$A_g = L_p*t_p$ = 13.9[in]*0.275[in] = **3.82**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*3.82[in2] = **76.45**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.77	10.00	DL	0.18	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 13.9[in] - 4*0.875[in] = **10.4**[in]						DG4 Eq. 3-13

$A_{nv} = L_e * t_p = 10.4\text{[in]} * 0.275\text{[in]} = \mathbf{2.86}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 65000\text{[lb/in2]} * 2.86\text{[in2]} = \mathbf{55.77}\text{[kip]}$ Eq. J4-4

Flexural yielding	[Kip]	75.75	10.00	DL	0.13	p. 9-6

$(1/\Omega)R_n = (1/\Omega) * F_y * S_{net}/e = 0.599 * 50000\text{[lb/in2]} * 8.86\text{[in3]}/3.5\text{[in]} = \mathbf{75.75}\text{[kip]}$ p. 9-6

Local web buckling	[Kip]	75.75	10.00	DL	0.13	p. 9-8, p. 9-7

$h_o = d - d_c = 15.9\text{[in]} - 2\text{[in]} = \mathbf{13.9}\text{[in]}$ p. 9-7

$IsBeamCopedAtBothFlanges = (c_t <= 2*d)$ and $(d_{ct} <= 0.2*d)$ and $(c_b <= 2*d)$ and $(d_{cb} <= 0.2*d) = (3\text{[in]} <= 2*15.9\text{[in]})$ and $(1\text{[in]} <= 0.2*15.9\text{[in]})$ and $(3\text{[in]} <= 2*15.9\text{[in]})$ and $(1\text{[in]} <= 0.2*15.9\text{[in]}) = \mathbf{True}$ p. 9-8

$f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1\text{[in]}/15.9\text{[in]}) = \mathbf{3.03}$ p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d = 0.62*\pi*2.90E+07\text{[lb/in2]}*0.275\text{[in]}^2/(3\text{[in]}*13.9\text{[in]})*3.03 = \mathbf{3.10E+05}\text{[lb/in2]}$ p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000\text{[lb/in2]}, 3.10E+05\text{[lb/in2]})*8.86\text{[in3]}/3.5\text{[in]} = \mathbf{75.75}\text{[kip]}$ p. 9-7

Block shear	[Kip]	60.26	10.00	DL	0.17	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1\text{[in]} + 1/16\text{ [in]} = \mathbf{1.06}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 0.813\text{[in]} + 1/16\text{ [in]} = \mathbf{0.875}\text{[in]}$ Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.24\text{[in]} + (1 - 1)*3\text{[in]} - (1 - 0.5)*1.06\text{[in]})*0.275\text{[in]} = \mathbf{0.47}\text{[in2]}$ Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2.45\text{[in]} + (4 - 1)*3\text{[in]})*0.275\text{[in]} = \mathbf{3.15}\text{[in2]}$ Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2.45\text{[in]} + (4 - 1)*(3\text{[in]} - 0.875\text{[in]}) - 0.875\text{[in]}/2)*0.275\text{[in]} = \mathbf{2.31}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000\text{[lb/in2]}*2.31\text{[in2]} + 1*65000\text{[lb/in2]}*0.47\text{[in2]}, 0.6*50000\text{[lb/in2]}*3.15\text{[in2]} + 1*65000\text{[lb/in2]}*0.47\text{[in2]}) = \mathbf{60.26}\text{[kip]}$ Eq. J4-5

Flexural rupture	[Kip]	82.23	10.00	DL	0.12	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000\text{[lb/in2]}*8.86\text{[in3]}/3.5\text{[in]} = \mathbf{82.23}\text{[kip]}$ p. 9-6

Support

Welds rupture	[Kip/ft]	128.70	10.00	DL	0.08	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.275\text{[in]} = \mathbf{10.73}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 10\text{[kip]}/(0.5*3.71\text{[kip/in]}*1*12\text{[in]}) = \mathbf{0.449}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*0.449/16\text{ [in]} = \mathbf{0.833}\text{[kip/in]}$ p. 9-5

Global critical strength ratio **0.24**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:58 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L4.cnx\

Steel connections

Results

Connection name : SP_BG_1/4PL_4B3/4
Connection ID : SC-07-38

Family: Beam - Girder (BG)
Type: Single plate
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	8.02	15.70	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 1[in]) - max(0.827[in], 1[in]) = **15.7**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	3.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50		--	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4		--	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	30.00	DL	0.41	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	30.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	30.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in]$ - 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	53.06	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) =$ **53.06**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	30.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	70.20	30.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.35$[in]$ - 0.813$[in]$/2) =$ **2.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*2.94$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*0.3$[in]$*$ 65000[lb/in2]$*1$ = **70.2**[kip]						Eq. J3-6

Shear yielding	[Kip]	94.20	30.00	DL	0.32	Eq. J4-3
$A_g = L_p*t_p$ = 15.7[in]*0.3[in] = **4.71**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.71[in2] = **94.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	71.37	30.00	DL	0.42	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 15.7[in] - 4*0.875[in] = **12.2**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 12.2[in]*0.3[in] = **3.66**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.66[in2] = **71.37**[kip]						Eq. J4-4
Flexural yielding	[Kip]	105.43	30.00	DL	0.28	p. 9-6
(1/Ω)R_n = *(1/Ω)*F_y*S_{net}/e = 0.599*50000[lb/in2]*12.32[in3]/3.5[in] = **105.43**[kip]						p. 9-6
Local web buckling	[Kip]	105.43	30.00	DL	0.28	p. 9-8, p. 9-7
$h_o = d - d_c$ = 17.7[in] - 2[in] = **15.7**[in]						p. 9-7
IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3[in]<=2*17.7[in]) and (1[in]<=0.2*17.7[in]) and (3[in]<=2*17.7[in]) and (1[in]<=0.2*17.7[in]) = **True**						p. 9-8
f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1[in]/17.7[in]) = **3.08**						p. 9-8
$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d$ = 0.62*π*2.90E+07[lb/in2]*0.3[in]^2/(3[in]*15.7[in])*3.08 = **3.32E+05**[lb/in2]						p. 9-8
(1/Ω)R_n = *(1/Ω)*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 3.32E+05[lb/in2])* 12.32[in3]/3.5[in] = **105.43**[kip]						p. 9-7
Block shear	[Kip]	71.81	30.00	DL	0.42	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.23[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.3[in] = **0.538**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (3.35[in] + (4 - 1)*3[in])*0.3[in] = **3.71**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (3.35[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.3[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.79[in2] + 1*65000[lb/in2]*0.538[in2], 0.6*50000[lb/in2]*3.71[in2] + 1*65000[lb/in2]*0.538[in2]) = **71.81**[kip]						Eq. J4-5
Flexural rupture	[Kip]	114.44	30.00	DL	0.26	p. 9-6
(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*12.32[in3]/3.5[in] = **114.44**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	140.40	30.00	DL	0.21	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.3[in] = **11.7**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 30[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length

c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Units system: English
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Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-39

Family: Beam - Girder (BG)
Type: Single plate
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	30.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	8.02	15.37	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 1.5[in]) - max(0.827[in], 0[in]) = **15.37**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.3$[in]$, 12$ [in]$) =$ **7.2**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	30.00	DL	0.41	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	30.00	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	30.00	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in] $- 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	53.06	30.00	DL	0.57	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\text{min}(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **53.06**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	89.10	30.00	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*12$[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	70.20	30.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85$[in]$ - 0.813$[in]$/2)$ = **2.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*2.44$[in]$, 2.4*0.75$[in]$) + \text{min}(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*0.3$[in]$*$ 65000[lb/in2]$*1$ = **70.2**[kip]						Eq. J3-6

Shear yielding	[Kip]	97.20	30.00	DL	0.31	Eq. J4-3
$A_g = L_p*t_p$ = 16.2[in]*0.3[in] = **4.86**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*4.86[in2] = **97.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	74.29	30.00	DL	0.40	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 16.2[in] - 4*0.875[in] = **12.7**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 12.7[in]*0.3[in] = **3.81**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*3.81[in2] = **74.3**[kip]						Eq. J4-4
Flexural yielding	[Kip]	105.44	30.00	DL	0.28	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*19.37[in3]/5.5[in] = **105.44**[kip]						p. 9-6
Local web buckling	[Kip]	105.44	30.00	DL	0.28	p. 9-7
$h_o = d - d_c$ = 17.7[in] - 1.5[in] = **16.2**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (5[in]<=2*17.7[in]) and (1.5[in]<=17.7[in]/2) = **True**						p. 9-7
c/d<=1 → 5[in]/17.7[in]<=1 → **True**						
$f = 2*c/d$ = 2*5[in]/17.7[in] = **0.565**						p. 9-7
c/h_o<=1 → 5[in]/16.2[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(16.2[in]/5[in])$^{1.65}$ = **15.3**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*(0.3[in]/16.2[in])^2*0.565*15.3 = **77720.62**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 77720.62[lb/in2])*19.37[in3]/5.5[in] = **105.44**[kip]						p. 9-7
Block shear	[Kip]	68.88	30.00	DL	0.44	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.23[in] + (1 - 1)*5.5[in] - (1 - 0.5)*0.875[in])*0.3[in] = **0.538**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.85[in] + (4 - 1)*3[in])*0.3[in] = **3.56**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.85[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.3[in] = **2.64**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*2.64[in2] + 1*65000[lb/in2]*0.538[in2], 0.6*50000[lb/in2]*3.56[in2] + 1*65000[lb/in2]*0.538[in2]) = **68.88**[kip]						Eq. J4-5
Flexural rupture	[Kip]	114.46	30.00	DL	0.26	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*19.37[in3]/5.5[in] = **114.46**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	205.92	30.00	DL	0.15	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.44[in] = **17.16**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 30[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.35**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.35/16 [in] = **2.5**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length

C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:34 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L1.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-40

Family: Beam - Girder (BG)
Type: Single plate
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	40.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	15.00	8.02	15.20	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 1.25[in]) - max(0.827[in], 1.25[in]) = **15.2**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	1.60	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	53.04	40.00	DL	0.75	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 5*10.61$[kip]$*1$ = **53.04**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	92.57	40.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(5 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **92.57**[kip]						Eq. J3-6
Shear yielding	[Kip]	81.00	40.00	DL	0.49	Eq. J4-3
$A_g = L_p*t_p = 15$[in]$*0.375$[in] = **5.63**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*5.63$[in2] = **81**[kip]						Eq. J4-3
Shear rupture	[Kip]	69.33	40.00	DL	0.58	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 15$[in]$ - 5*0.875$[in] = **10.63**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 10.63$[in]$*0.375$[in] = **3.98**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.98$[in2] = **69.33**[kip]						Eq. J4-4
Block shear	[Kip]	65.21	40.00	DL	0.61	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in]$ + 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (5 - 1)*3$[in]$)*0.375$[in] = **5.06**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (5 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **3.59**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*3.59$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*5.06$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **65.21**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	111.37	40.00	DL	0.36	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*15$[in] = **111.37**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	84.17	40.00	DL	0.48	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.6$[in]$ - 0.813$[in]$/2)$ = **1.19**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.19$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(5 - 1))*0.3$[in]$*$ 65000[lb/in2]$*1$ = **84.17**[kip]						Eq. J3-6
Shear yielding	[Kip]	91.20	40.00	DL	0.44	Eq. J4-3
$A_g = L_p*t_p = 15.2$[in]$*0.3$[in] = **4.56**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*4.56$[in2] = **91.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	63.33	40.00	DL	0.63	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in]$ + 1/16$ [in] = **0.875**[in]						Sec. D3-2

$L_e = L - n*L_h$ = 15.2[in] - 5*0.875[in] = **10.83**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 10.83[in]*0.3[in] = **3.25**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*3.25[in2] = **63.33**[kip] Eq. J4-4

Flexural yielding	[Kip]	84.36	40.00	DL	0.47	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*11.55[in3]/4.1[in] = **84.36**[kip] p. 9-6

Local web buckling	[Kip]	84.36	40.00	DL	0.47	p. 9-8, p. 9-7

$h_o = d - d_c$ = 17.7[in] - 2.5[in] = **15.2**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3.6[in]<=2*17.7[in]) and (1.25[in]<=0.2*17.7[in]) and (3.6[in]<=2*17.7[in]) and (1.25[in]<=0.2*17.7[in]) = **True** p. 9-8

f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(1.25[in]/17.7[in]) = **2.97** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d$ = 0.62*π*2.90E+07[lb/in2]*0.3[in]^2/(3.6[in]*15.2[in])*2.97 = **2.76E+05**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 2.76E+05[lb/in2])*11.55[in3]/4.1[in] = **84.36**[kip] p. 9-7

Block shear	[Kip]	76.63	40.00	DL	0.52	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.5[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.3[in] = **0.619**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.6[in] + (5 - 1)*3[in])*0.3[in] = **4.08**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.6[in] + (5 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.3[in] = **2.9**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*2.9[in2] + 1*65000[lb/in2]*0.619[in2], 0.6*50000[lb/in2]*4.08[in2] + 1*65000[lb/in2]*0.619[in2]) = **76.64**[kip] Eq. J4-5

Flexural rupture	[Kip]	91.57	40.00	DL	0.44	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*11.55[in3]/4.1[in] = **91.57**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	210.60	32.00	DL	0.15	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.45[in] = **17.55**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 40[kip]/(0.5*3.71[kip/in]*1*15[in]) = **1.44** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.44/16 [in] = **2.67**[kip/in] p. 9-5

Global critical strength ratio **0.75**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 2:39 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP_BG_1/4PL_3B3/4
Connection ID : SC-07-41

Family: Beam - Girder (BG)
Type: Single plate
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	26.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	8.02	12.87	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 4[in]) - max(0.827[in], 0[in]) = **12.87**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min($24*t_p$, 12 [in]) = min($24*0.3$[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	26.00	DL	0.82	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*10.61$[kip]$*1$ = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	26.00	DL	0.49	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	26.00	DL	0.53	Eq. J4-3
$A_g = L_p*t_p = 9$[in]$*0.375$[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*3.38$[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	26.00	DL	0.63	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 9$[in] $- 3*0.875$[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 6.38$[in]$*0.375$[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*2.39$[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	26.00	DL	0.62	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (3 - 1)*3$[in]$)*0.375$[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*1.99$[in2] $+ 1*58000$[lb/in2]$*0.398$[in2]$, 0.6*36000$[lb/in2]$*2.81$[in2] $+ 1*58000$[lb/in2]$*0.398$[in2]$) =$ **41.93**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	26.00	DL	0.39	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*9$[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	51.99	26.00	DL	0.50	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.85$[in]$ - 0.813$[in]$/2) =$ **1.44**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.44$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(3 - 1))*0.3$[in]$*$ 65000[lb/in2]$*1$ = **51.99**[kip]						Eq. J3-6

Shear yielding	[Kip]	82.20	26.00	DL	0.32	Eq. J4-3
$A_g = L_p*t_p$ = 13.7[in]*0.3[in] = **4.11**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*4.11[in2] = **82.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	64.79	26.00	DL	0.40	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 13.7[in] - 3*0.875[in] = **11.08**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 11.08[in]*0.3[in] = **3.32**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*3.32[in2] = **64.79**[kip]						Eq. J4-4
Flexural yielding	[Kip]	44.66	26.00	DL	0.58	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*14.17[in3]/9.5[in] = **44.66**[kip]						p. 9-6
Local web buckling	[Kip]	44.66	26.00	DL	0.58	p. 9-7
$h_o = d - d_c$ = 17.7[in] - 4[in] = **13.7**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (9[in]<=2*17.7[in]) and (4[in]<=17.7[in]/2) = **True**						p. 9-7
c/d<=1 → 9[in]/17.7[in]<=1 → **True**						
$f = 2*c/d$ = 2*9[in]/17.7[in] = **1.02**						p. 9-7
c/h_o<=1 → 9[in]/13.7[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(13.7[in]/9[in])$^{1.65}$ = **4.4**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k$ = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*(0.3[in]/ 13.7[in])^2*1.02*4.4 = **56245.42**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 56245.42[lb/in2])* 14.17[in3]/9.5[in] = **44.66**[kip]						p. 9-7
Block shear	[Kip]	49.69	26.00	DL	0.52	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.23[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 1.06[in])*0.3[in] = **0.51**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.85[in] + (3 - 1)*3[in])*0.3[in] = **2.36**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.85[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.3[in] = **1.7**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.7[in2] + 1*65000[lb/in2]*0.51[in2], 0.6*50000[lb/in2]*2.36[in2] + 1*65000[lb/ in2]*0.51[in2]) = **49.69**[kip]						Eq. J4-5
Flexural rupture	[Kip]	48.48	26.00	DL	0.54	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*14.17[in3]/9.5[in] = **48.48**[kip]						p. 9-6

Support

Welds rupture	[Kip/ft]	702.00	34.67	DL	0.05	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*1.5[in] = **58.5**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 26[kip]/(0.5*3.71[kip/in]*1*9[in]) = **1.56**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.56/16 [in] = **2.89**[kip/in]						p. 9-5

Global critical strength ratio **0.82**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment

C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:12 PM
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File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\Roof.cnx\

Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-42

Family: Beam - Girder (BG)
Type: Single plate
Description: W18X35

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	29.78	-3.59	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	8.02	15.87	✔	p. 10-104
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.7[in] - max(0.827[in], 1[in]) - max(0.827[in], 0[in]) = **15.87**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] $=$ **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.20	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.3[in], 12 [in]) = **7.2**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.30	--	0.43	✔	p. 10-151, p. 10-102
$t_{pmax} = (3/16$ [in]$)/sin\alpha = (3/16$ [in]$)/0.438 =$ **0.428**[in]						p. 10-151
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	3.41	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.23	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	42.43	30.00	DL	0.71	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*10.61$[kip]$*1$ = **42.43**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	73.00	29.78	DL	0.41	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2) =$ **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*$ 0.375[in]$*58000$[lb/in2]$*1$ = **73**[kip]						Eq. J3-6
Shear yielding	[Kip]	64.80	29.78	DL	0.46	Eq. J4-3
$A_g = L_p*t_p = 12$[in]$*0.375$[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.5$[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	29.78	DL	0.54	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 12$[in]$ - 4*0.875$[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 8.5$[in]$*0.375$[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.19$[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	29.78	DL	0.55	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$ 0.875[in]$)*0.375$[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (4 - 1)*3$[in]$)*0.375$[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (4 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*2.79$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$, 0.6*36000$[lb/in2]$*3.94$[in2]$ + 1*58000$[lb/in2]$*0.398$[in2]$) =$ **54.08**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	90.94	30.00	DL	0.33	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.79$[kip/in]$*1*4*12$[in] = **90.94**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	70.20	29.78	DL	0.42	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.41$[in]$ - 0.813$[in]$/2) =$ **3.01**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*3.01$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*0.3$[in]$*$ 65000[lb/in2]$*1$ = **70.2**[kip]						Eq. J3-6

Shear yielding	[Kip]	100.20	29.78	DL	0.30	Eq. J4-3
$A_g = L_p*t_p$ = 16.7[in]*0.3[in] = **5.01**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*5.01[in2] = **100.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	77.22	29.78	DL	0.39	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 16.7[in] - 4*0.875[in] = **13.2**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 13.2[in]*0.3[in] = **3.96**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*3.96[in2] = **77.22**[kip]						Eq. J4-4
Flexural yielding	[Kip]	136.36	29.78	DL	0.22	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*20.5[in3]/4.5[in] = **136.36**[kip]						p. 9-6
Local web buckling	[Kip]	136.36	29.78	DL	0.22	p. 9-7
$h_o = d - d_c$ = 17.7[in] - 1[in] = **16.7**[in]						p. 9-7
IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (4[in]<=2*17.7[in]) and (1[in]<=17.7[in]/2) = **True**						p. 9-7
c/d<=1 → 4[in]/17.7[in]<=1 → **True**						
$f = 2*c/d$ = 2*4[in]/17.7[in] = **0.452**						p. 9-7
c/h_o<=1 → 4[in]/16.7[in]<=1 → **True**						
$k = 2.2*(h_o/c)^{1.65}$ = 2.2*(16.7[in]/4[in])$^{1.65}$ = **23.25**						p. 9-7
$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2$*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*(0.3[in]/ 16.7[in])^2*0.452*23.25 = **88901.13**[lb/in2]						p. 9-7
$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 88901.13[lb/in2])*20.5[in3]/ 4.5[in] = **136.36**[kip]						p. 9-7
Block shear	[Kip]	72.18	29.78	DL	0.41	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.23[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.3[in] = **0.538**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (3.41[in] + (4 - 1)*3[in])*0.3[in] = **3.72**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (3.41[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.3[in] = **2.81**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*2.81[in2] + 1*65000[lb/in2]*0.538[in2], 0.6*50000[lb/in2]*3.72[in2] + 1*65000[lb/ in2]*0.538[in2]) = **72.18**[kip]						Eq. J4-5
Flexural rupture	[Kip]	148.02	29.78	DL	0.20	p. 9-6
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*20.5[in3]/4.5[in] = **148.02**[kip]						p. 9-6
Bolt bearing under axial load	[Kip]	70.20	0.00	DL	0.00	Eq. J3-6
$L_{c\text{-}end} = \max(0.0, L_e - d_h/2)$ = Max(0.0, 2.23[in] - 0.813[in]/2) = **1.82**[in]						Sec. J4.10
$L_{c\text{-}spa} = \max(0.0, s - d_h)$ = Max(0.0, 5.5[in] - 0.813[in]) = **4.69**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*1.82[in], 2.4*0.75[in]) + min(1.2*4.69[in], 2.4*0.75[in])*(1 - 1))*0.3[in]* 65000[lb/in2]*4 = **70.2**[kip]						Eq. J3-6

Support

Welds rupture	[Kip/ft]	163.80	29.39	DL	0.18	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.35[in] = **13.65**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 30[kip]/(0.5*3.79[kip/in]*1*12[in]) = **1.32**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.32/16 [in] = **2.45**[kip/in]						p. 9-5

Global critical strength ratio **0.71**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
$sin\alpha$: Sine of the skew angle
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

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Steel connections

Results

Connection name : SP_BG_
Connection ID : SC-07-43

Family: Beam - Girder (BG)
Type: Single plate
Description: W24X76

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	60.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	18.00	10.77	20.90	✔	p. 10-104
$L_{min} = T/2 = 21.54[in]/2 = \mathbf{10.77}[in]$						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 23.9[in] - max(1.18[in], 1.5[in]) - max(1.18[in], 1.5[in]) = **20.9**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.95	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.17	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$ p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	63.65	60.00	DL	0.94	Tables (7-1..14)
$(n>=10)$ and $(n<=12)$ and $(IsStandardHole) \rightarrow (6>=10)$ and $(6<=12)$ and (False) $\rightarrow$ **False**						
$BoltFactor = 1$						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = \mathbf{10.61}[kip]$						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6*10.61[kip]*1 = \mathbf{63.65}[kip]$						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	112.15	60.00	DL	0.54	Eq. J3-6
$L_{c\text{-}end} = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = \mathbf{1.09}[in]$						Sec. J4.10
$L_{c\text{-}spa} = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.09[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*$ $0.375[in]*58000[lb/in2]*1 = \mathbf{112.15}[kip]$						Eq. J3-6
Shear yielding	[Kip]	97.20	60.00	DL	0.62	Eq. J4-3
$A_g = L_p*t_p = 18[in]*0.375[in] = \mathbf{6.75}[in2]$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*6.75[in2] = \mathbf{97.2}[kip]$						Eq. J4-3
Shear rupture	[Kip]	83.19	60.00	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$						Sec. D3-2
$L_e = L - n*L_h = 18[in] - 6*0.875[in] = \mathbf{12.75}[in]$						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 12.75[in]*0.375[in] = \mathbf{4.78}[in2]$						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*4.78[in2] = \mathbf{83.19}[kip]$						Eq. J4-4
Block shear	[Kip]	77.36	60.00	DL	0.78	Eq. J4-5
$dh_h = d_h + 1/16\ [in] = 1[in] + 1/16\ [in] = \mathbf{1.06}[in]$						Sec. D3-2
$dh_v = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)*$ $1.06[in])*0.375[in] = \mathbf{0.363}[in2]$						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.375[in] = \mathbf{6.19}[in2]$						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 0.875[in]) -$ $0.875[in]/2)*0.375[in] = \mathbf{4.38}[in2]$						Sec. J4-3
$IsStressUniform \rightarrow$ **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000[lb/in2]*4.38[in2] + 1*58000[lb/in2]*0.363[in2], 0.6*36000[lb/in2]*6.19[in2] + 1*58000[lb/in2]*0.363[in2]) = \mathbf{77.36}[kip]$						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	133.64	60.00	DL	0.45	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71[kip/in]*1*4*18[in] = \mathbf{133.64}[kip]$						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	154.44	60.00	DL	0.39	Eq. J3-6
$L_{c\text{-}end} = Max(0.0, L_e - d_h/2) = Max(0.0, 2.95[in] - 0.813[in]/2) = \mathbf{2.54}[in]$						Sec. J4.10
$L_{c\text{-}spa} = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = \mathbf{2.19}[in]$						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*2.54[in], 2.4*0.75[in]) + \min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*$ $0.44[in]*65000[lb/in2]*1 = \mathbf{154.44}[kip]$						Eq. J3-6
Shear yielding	[Kip]	183.92	60.00	DL	0.33	Eq. J4-3
$A_g = L_p*t_p = 20.9[in]*0.44[in] = \mathbf{9.2}[in2]$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9.2[in2] = \mathbf{183.92}[kip]$						Eq. J4-3
Shear rupture	[Kip]	134.28	60.00	DL	0.45	Eq. J4-4
$L_h = d_h + 1/16\ [in] = 0.813[in] + 1/16\ [in] = \mathbf{0.875}[in]$						Sec. D3-2

$L_e = L - n*L_h$ = 20.9[in] - 6*0.875[in] = **15.65**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 15.65[in]*0.44[in] = **6.89**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*6.89[in2] = **134.28**[kip] Eq. J4-4

Flexural yielding	[Kip]	213.13	60.00	DL	0.28	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e$ = 0.599*50000[lb/in2]*32.03[in3]/4.5[in] = **213.13**[kip] p. 9-6

Local web buckling	[Kip]	213.13	60.00	DL	0.28	p. 9-8, p. 9-7

$h_o = d - d_c$ = 23.9[in] - 3[in] = **20.9**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (4[in]<=2*23.9[in]) and (1.5[in]<=0.2*23.9[in]) and (4[in]<=2*23.9[in]) and (1.5[in]<=0.2*23.9[in]) = **True** p. 9-8

$f_d = 3.5 - 7.5*(d_c/d)$ = 3.5 - 7.5*(1.5[in]/23.9[in]) = **3.03** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d$ = 0.62*π*2.90E+07[lb/in2]*0.44[in]^2/(4[in]*20.9[in])*3.03 = **3.96E+05**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e$ = 0.599*min(50000[lb/in2], 3.96E+05[lb/in2])*32.03[in3]/4.5[in] = **213.13**[kip] p. 9-7

Block shear	[Kip]	137.47	60.00	DL	0.44	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.17[in] + (1 - 1)*5.5[in] - (1 - 0.5)*0.875[in])*0.44[in] = **0.762**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (2.95[in] + (6 - 1)*3[in])*0.44[in] = **7.9**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (2.95[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.44[in] = **5.78**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*5.78[in2] + 1*65000[lb/in2]*0.762[in2], 0.6*50000[lb/in2]*7.9[in2] + 1*65000[lb/in2]*0.762[in2]) = **137.47**[kip] Eq. J4-5

Flexural rupture	[Kip]	231.35	60.00	DL	0.26	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*32.03[in3]/4.5[in] = **231.35**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	184.86	40.00	DL	0.22	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.395[in] = **15.41**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 60[kip]/(0.5*3.71[kip/in]*1*18[in]) = **1.8** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.8/16 [in] = **3.33**[kip/in] p. 9-5

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 1:44 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-44

Family: Beam - Girder (BG)
Type: Single plate
Description: W27X84

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	60.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	18.00	12.11	20.70	✔	p. 10-104
$L_{min} = T/2 = 24.22[in]/2 = \mathbf{12.11}[in]$						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 26.7[in] - max(1.24[in], 1.5[in]) - max(1.24[in], 4.5[in]) = **20.7**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.00	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.16	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	63.65	60.00	DL	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6*10.61$[kip]$*1$ = **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	140.19	60.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.5*1.09$[in]$, 3*0.75$[in]$) + \min(1.5*2.19$[in]$, 3*0.75$[in]$)*(6 - 1))*0.375$[in]$*$ 58000[lb/in2]$*1$ = **140.19**[kip]						Eq. J3-6
Shear yielding	[Kip]	97.20	60.00	DL	0.62	Eq. J4-3
$A_g = L_p*t_p = 18$[in]$*0.375$[in] = **6.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*6.75$[in2] = **97.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	83.19	60.00	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 18$[in] $- 6*0.875$[in] = **12.75**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 12.75$[in]$*0.375$[in] = **4.78**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*4.78$[in2] = **83.19**[kip]						Eq. J4-4
Block shear	[Kip]	77.36	60.00	DL	0.78	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (6 - 1)*3$[in]$)*0.375$[in] = **6.19**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (6 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **4.38**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*4.38$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*6.19$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **77.36**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	133.64	60.00	DL	0.45	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*18$[in] = **133.64**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	201.83	60.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in]$ - 0.813$[in]$/2)$ = **1.59**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.5*1.59$[in]$, 3*0.75$[in]$) + \min(1.5*2.19$[in]$, 3*0.75$[in]$)*(6 - 1))*0.46$[in]$*$ 65000[lb/in2]$*1$ = **201.83**[kip]						Eq. J3-6
Shear yielding	[Kip]	190.44	60.00	DL	0.32	Eq. J4-3
$A_g = L_p*t_p = 20.7$[in]$*0.46$[in] = **9.52**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*9.52$[in2] = **190.44**[kip]						Eq. J4-3
Shear rupture	[Kip]	138.59	60.00	DL	0.43	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2

$L_e = L - n*L_h = 20.7$[in] - 6*0.875[in] = **15.45**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 15.45$[in]*0.46[in] = **7.11**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]*7.11[in2] = **138.59**[kip] Eq. J4-4

Flexural yielding	[Kip]	245.89	60.00	DL	0.24	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]*32.85[in3]/4[in] = **245.89**[kip] p. 9-6

Local web buckling	[Kip]	245.89	60.00	DL	0.24	p. 9-8, p. 9-7

$h_o = d - d_c = 26.7$[in] - 6[in] = **20.7**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3.5[in]<=2*26.7[in]) and (1.5[in]<=0.2*26.7[in]) and (3.5[in]<=2*26.7[in]) and (4.5[in]<=0.2*26.7[in]) = **True** p. 9-8

$f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(4.5$[in]$/26.7$[in]$) =$ **2.24** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d = 0.62*\pi*2.90E+07$[lb/in2]*0.46[in]^2/(3.5[in]*20.7[in])*2.24 = **3.69E+05**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2], 3.69E+05[lb/in2])*32.85[in3]/4[in] = **245.89**[kip] p. 9-7

Block shear	[Kip]	135.07	60.00	DL	0.44	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.16$[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.46[in] = **0.792**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2$[in] + (6 - 1)*3[in])*0.46[in] = **7.82**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2$[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.46[in] = **5.61**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
0.5*min(0.6*65000[lb/in2]*5.61[in2] + 1*65000[lb/in2]*0.792[in2], 0.6*50000[lb/in2]*7.82[in2] + 1*65000[lb/in2]*0.792[in2]) = **135.07**[kip] Eq. J4-5

Flexural rupture	[Kip]	266.91	60.00	DL	0.22	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]*32.85[in3]/4[in] = **266.91**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	184.86	40.00	DL	0.22	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]*0.395[in] = **15.41**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 60$[kip]/(0.5*3.71[kip/in]*1*18[in]) = **1.8** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.8/16 [in] = **3.33**[kip/in] p. 9-5

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-25 3:44 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-07 Beam to Girder Skewed Shear Tab Connection\SHEAR TAB\L3&L2.cnx\

Steel connections

Results

Connection name : SP BG
Connection ID : SC-07-45

Family: Beam - Girder (BG)
Type: Single plate
Description: W27X84

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	60.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	18.00	12.11	20.70	✔	p. 10-104
$L_{min} = T/2 = 24.22[in]/2 = \mathbf{12.11}[in]$						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 26.7[in] - max(1.24[in], 1.5[in]) - max(1.24[in], 4.5[in]) = **20.7**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow$ **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.00	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = \mathbf{1}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.16	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	63.65	60.00	DL	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6*10.61$[kip]$*1$ = **63.65**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	140.19	60.00	DL	0.43	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 0.813$[in]$/2)$ = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.5*1.09$[in]$, 3*0.75$[in]$) + \min(1.5*2.19$[in]$, 3*0.75$[in]$)*(6 - 1))*0.375$[in]$*$ 58000[lb/in2]$*1$ = **140.19**[kip]						Eq. J3-6
Shear yielding	[Kip]	97.20	60.00	DL	0.62	Eq. J4-3
$A_g = L_p*t_p = 18$[in]$*0.375$[in] = **6.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*6.75$[in2] = **97.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	83.19	60.00	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 18$[in] $- 6*0.875$[in] = **12.75**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 12.75$[in]$*0.375$[in] = **4.78**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*4.78$[in2] = **83.19**[kip]						Eq. J4-4
Block shear	[Kip]	77.36	60.00	DL	0.78	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5$[in]$ + (1 - 1)*3$[in]$ - (1 - 0.5)*$ 1.06[in]$)*0.375$[in] = **0.363**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in]$ + (6 - 1)*3$[in]$)*0.375$[in] = **6.19**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in]$ + (6 - 1)*(3$[in]$ - 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **4.38**[in2]						Sec. J4-3
IsStressUniform → **True**						
$U_{bs} = 1$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*4.38$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$, 0.6*36000$[lb/in2]$*6.19$[in2]$ + 1*58000$[lb/in2]$*0.363$[in2]$) = **77.36**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	133.64	60.00	DL	0.45	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*18$[in] = **133.64**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	201.83	60.00	DL	0.30	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in]$ - 0.813$[in]$/2)$ = **1.59**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$)$ = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.5*1.59$[in]$, 3*0.75$[in]$) + \min(1.5*2.19$[in]$, 3*0.75$[in]$)*(6 - 1))*0.46$[in]$*$ 65000[lb/in2]$*1$ = **201.83**[kip]						Eq. J3-6
Shear yielding	[Kip]	190.44	60.00	DL	0.32	Eq. J4-3
$A_g = L_p*t_p = 20.7$[in]$*0.46$[in] = **9.52**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*9.52$[in2] = **190.44**[kip]						Eq. J4-3
Shear rupture	[Kip]	138.59	60.00	DL	0.43	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2

$L_e = L - n*L_h = 20.7$[in] - 6*0.875[in] = **15.45**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 15.45$[in]*0.46[in] = **7.11**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]*7.11[in2] = **138.59**[kip] Eq. J4-4

Flexural yielding	[Kip]	245.89	60.00	DL	0.24	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]*32.85[in3]/4[in] = **245.89**[kip] p. 9-6

Local web buckling	[Kip]	245.89	60.00	DL	0.24	p. 9-8, p. 9-7

$h_o = d - d_c = 26.7$[in] - 6[in] = **20.7**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3.5[in]<=2*26.7[in]) and (1.5[in]<=0.2*26.7[in]) and (3.5[in]<=2*26.7[in]) and (4.5[in]<=0.2*26.7[in]) = **True** p. 9-8

$f_d = 3.5 - 7.5*(d_c/d) = 3.5 - 7.5*(4.5$[in]$/26.7$[in]$) =$ **2.24** p. 9-8

$F_{cr} = 0.62*\pi*E*t_w^2/(c*h_o)*f_d = 0.62*\pi*2.90E+07$[lb/in2]*0.46[in]^2/(3.5[in]*20.7[in])*2.24 = **3.69E+05**[lb/in2] p. 9-8

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2], 3.69E+05[lb/in2])*32.85[in3]/4[in] = **245.89**[kip] p. 9-7

Block shear	[Kip]	135.07	60.00	DL	0.44	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.16$[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.46[in] = **0.792**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2$[in] + (6 - 1)*3[in])*0.46[in] = **7.82**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2$[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.46[in] = **5.61**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
0.5*min(0.6*65000[lb/in2]*5.61[in2] + 1*65000[lb/in2]*0.792[in2], 0.6*50000[lb/in2]*7.82[in2] + 1*65000[lb/in2]*0.792[in2]) = **135.07**[kip] Eq. J4-5

Flexural rupture	[Kip]	266.91	60.00	DL	0.22	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]*32.85[in3]/4[in] = **266.91**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	184.86	40.00	DL	0.22	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]*0.395[in] = **15.41**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 60$[kip]/(0.5*3.71[kip/in]*1*18[in]) = **1.8** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.8/16 [in] = **3.33**[kip/in] p. 9-5

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
F_{cr}: Critical stress, flexural stress buckling
f_d: Plate buckling model adjustment factor for beam coped at both flanges
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

SC-08 Beam to Girder Reinforced Shear Tab Connection

Conn. ID	Location	Beam	Girder	Design Reaction	No. of Bolts	Bolt Space (inch)	Bolt Edge Horizontal	Skewed Angle	Max. Bolt to Weld	A36 Full Depth	Weld Size[a] (inch)	Max. Top Flange
SC-08-1[b]	L3, A.5-A.2/1-1.8	W10x17	W36x487	18	(4) 3/4" Dia. A325N	3	1.5	26	2	3/8	1/4	3.65
	L3, A.5-A.2/1-1.9	W10x17	W36x302	18	(4) 3/4" Dia. A325N	3	1.5	0	3	3/8	1/4	
	L3	W10x17	W36x487	10	(4) 3/4" Dia. A325N	3	1.5	26	4	3/8	1/4	
SC-08-2[c]	L3, A.5-A.2/1-1.9	W12x19	W36x487	18	(4) 3/4" Dia. A325N	3	1.5	26	4	3/8	1/4	3.65
SC-08-3[d]	L3, A.5-A.2/1-1.9	W14x22	W36x487	25	(4) 3/4" Dia. A325N	3	1.5	26	4	3/8	1/4	3.65

a. For skewed shear tab plate, use 7/16" weld size at obtuse angle side .

b. Web Plate Depth for W10x17 not less than 6 3/8"; Length to match the cope length

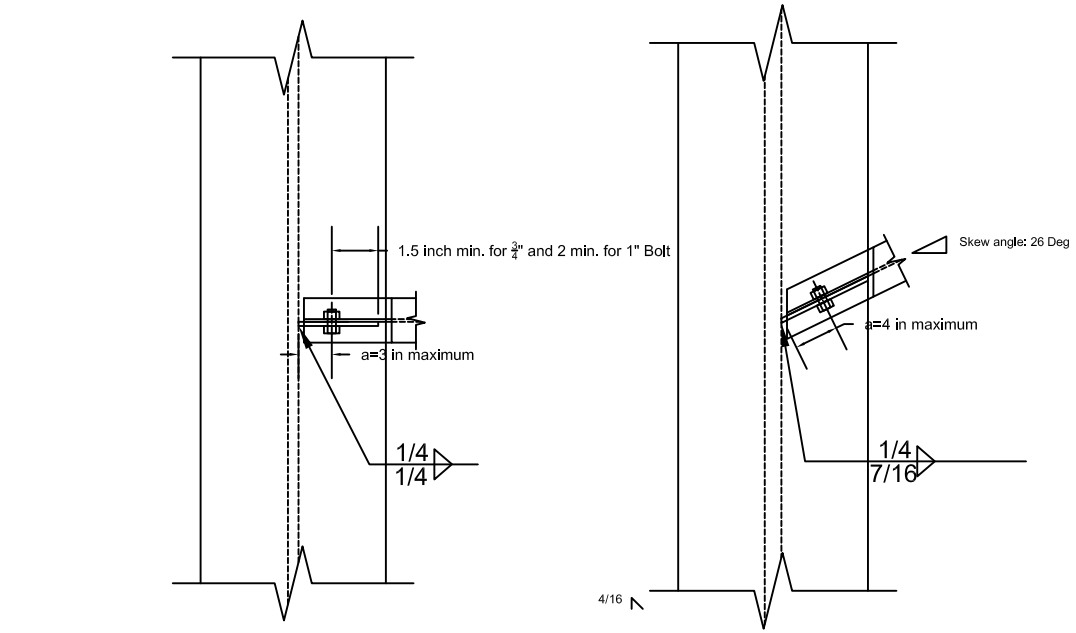
c. Web Plate Depth for W12x19 not less than 8 1/4"; Length to match the cope length

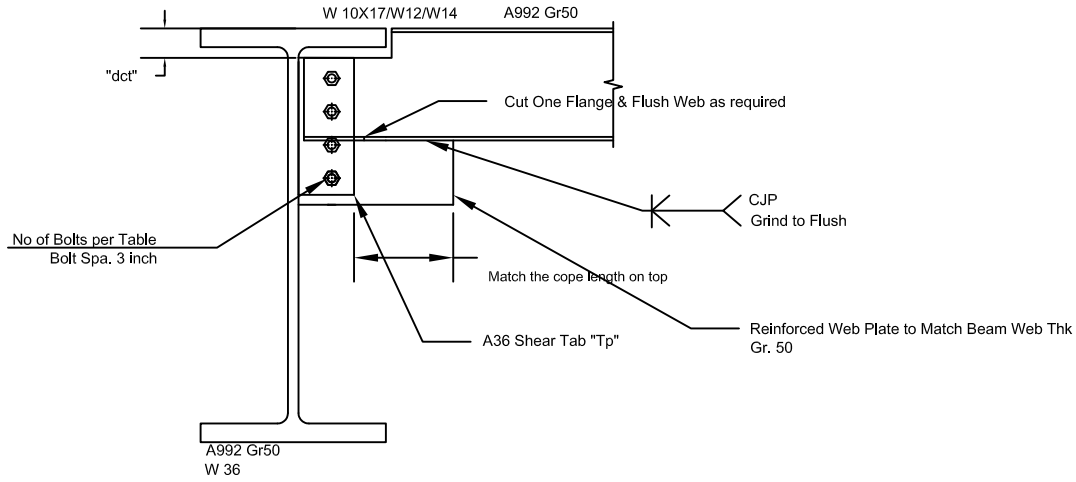
d. Web Plate Depth for W14x22 not less than 9 3/4"; Length to match the cope length

See manual calculation attached for reinforced section check after software output

SC-08 | Beam to Girder Reinforced Shear Tab Connection

Top view





Current Date: 5/12/2016 10:05 PM

Units system: English

File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-08 Beam to Girder Shear Tab Connection\SC-08.cnx\

Steel connections

Results

Connection name : **SP_BG**

Connection ID : **SC-08-1**

Family: Beam - Girder (BG)

Type: Single plate

Description: W10X17

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	18.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	4.42	6.82	✗	p. 10-104
$L_{min} = T/2 = 8.84[in]/2 =$ **4.42**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 10.1[in] - max(0.63[in], 2.65[in]) - max(0.63[in], 0[in]) = **6.82**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] =$ **1.25**[in]						Tables J3.4,

						J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
L_{emin} = 2*d = 2*0.75[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.76	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.24[in], 12 [in]) = **5.76**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	1.85	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	1.50	--	✔	p. 10-102
L_{emin} = 2*d = 2*0.75[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

WARNINGS

- Connector does not fit on beam

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	29.85	18.00	DL	0.60	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 2.81*10.61[kip]*1 = **29.85**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	51.35	18.00	DL	0.35	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)* (n - 1))*t_p*F_u*n_c = 0.5*(2.81/(1*4))*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(4 - 1))*0.375[in]*58000[lb/in2]*1 = **51.35**[kip]						p. 7-18, Sec. J3.10

Shear yielding	[Kip]	64.80	18.00	DL	0.28	Eq. J4-3
$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip]						Eq. J4-3
Shear rupture	[Kip]	55.46	18.00	DL	0.32	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12[in] - 4*0.875[in] = **8.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 8.5[in]*0.375[in] = **3.19**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip]						Eq. J4-4
Block shear	[Kip]	54.08	18.00	DL	0.33	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/in2]*0.398[in2]) = **54.08**[kip]						Eq. J4-5
Flexural rupture	[Kip]	94.82	18.00	DL	0.19	p. 9-6
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(12[in]^2 - 3[in]^2*4*(4^2 - 1)* 0.875[in]/12[in]) = **9.81**[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*58000[lb/in2]*9.81[in3]/3[in] = **94.82**[kip]						p. 9-6

Plate (support side)

Weld capacity	[Kip]	89.10	18.00	DL	0.20	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*12[in] = **89.1**[kip]						Tables 8-4 .. 8-11
Flexure with the Von-Mises shear reduction	[Kip*ft]	22.96	4.50	DL	0.20	p. 10-103
$A_g = L_p*t_p$ = 12[in]*0.375[in] = **4.5**[in2]						Sec. D3-1
$f_v = V/A_g$ = 18[kip]/4.5[in2] = **4000**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*36000[lb/in2])^2 - 3*4000[lb/in2]^2))^{1/2}$ = **20413.21**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.375[in]*12[in]^2/4 = **13.5**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 20413.21[lb/in2]*13.5[in3] = **22.96**[kip*ft]						p. 10-103

Beam

Bolt bearing under shear load	[Kip]	39.14	18.00	DL	0.46	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.85[in] - 0.813[in]/2) = **1.44**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*
(n - 1))*t_p*F_u*n_c = 0.5*(2.81/(1*4))*(min(1.2*1.44[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*
0.75[in])*(4 - 1))*0.24[in]*65000[lb/in2]*1 = **39.14**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	35.76	18.00	DL	0.50	Eq. J4-3

A_g = L_p*t_p = 7.45[in]*0.24[in] = **1.79**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*1.79[in2] = **35.76**[kip] Eq. J4-3

Shear rupture	[Kip]	18.49	18.00	DL	0.97	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 7.45[in] - 4*0.875[in] = **3.95**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.95[in]*0.24[in] = **0.948**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*0.948[in2] = **18.49**[kip] Eq. J4-4

Flexural yielding	[Kip]	12.13	18.00	DL	1.48	p. 9-6

(1/Ω)R_n = *(1/Ω)**F_y*S_{net}/e = 0.599*50000[lb/in2]*3.4[in3]/8.4[in] = **12.13**[kip] p. 9-6

Local web buckling	[Kip]	12.13	18.00	DL	1.48	p. 9-7

h_o = d - d_c = 10.1[in] - 2.65[in] = **7.45**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=2*d) and (d_c<=d/2) = (7.9[in]<=2*10.1[in]) and (2.65[in]<=10.1[in]/2) = **True** p. 9-7

c/d<=1 → 7.9[in]/10.1[in]<=1 → **True**

f = 2*c/d = 2*7.9[in]/10.1[in] = **1.56** p. 9-7

c/h_o<=1 → 7.9[in]/7.45[in]<=1 → **False**

k = 2.2*h_o/c = 2.2*7.45[in]/7.9[in] = **2.07** p. 9-7

F_{cr} = π^2*E/(12*(1 - ν^2))*(t_w/h_o)^2*f*k = π^2*2.90E+07[lb/in2]/(12*(1 - 0.3^2))*
(0.24[in]/7.45[in])^2*1.56*2.07 = **88282.09**[lb/in2] p. 9-7

(1/Ω)R_n = *(1/Ω)**min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 88282.09[lb/in2])*3.4[in3]/
8.4[in] = **12.13**[kip] p. 9-7

Block shear	[Kip]	52.53	18.00	DL	0.34	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 0.5)*spa - (n_c - 0.5)*dh_h)*t_p = (2.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
0.875[in])*0.24[in] = **0.495**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.85[in] + (4 - 1)*3[in])*0.24[in] = **2.6**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.85[in] + (4 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.24[in] = **1.87**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.87[in2] + 1*65000[lb/in2]*0.495[in2], 0.6*50000[lb/in2]*2.6[in2] + 1*65000[lb/
in2]*0.495[in2]) = **52.53**[kip] Eq. J4-5

Flexural rupture	[Kip]	13.17	18.00	DL	1.37	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*3.4$[in3]$/8.4$[in] = **13.17**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	442.26	18.00	DL	0.04	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.945$[in] = **36.86**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 18$[kip]$/(0.5*3.71$[kip/in]$*1*12$[in]$) =$ **0.808** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.808/16$ [in] = **1.5**[kip/in] p. 9-5

Global critical strength ratio **1.48**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

f: Plate buckling model adjustment factor

F_{cr}: Critical stress, flexural stress buckling

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

IsTopFlangeBeamCoped: Is the top beam flange coped

k: Plate buckling coefficient

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

ν: Poisson's ratio

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

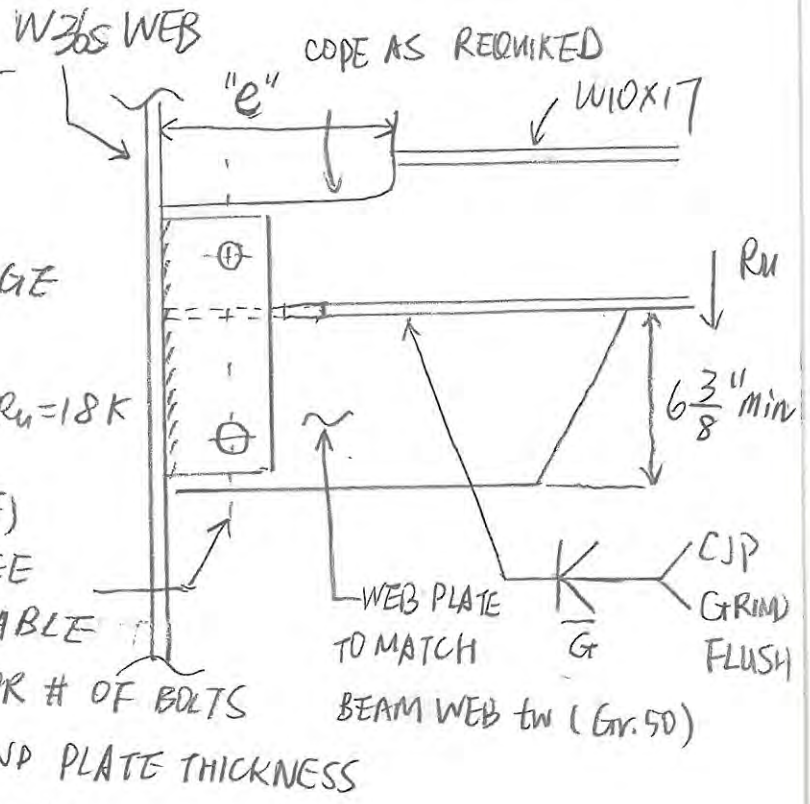
Strengthening W10X17

COPE BEAM CAPACITY CHECK

SEE SECTION PROPERTIES NEXT PAGE

GOOD FOR $e \leq 9.25"$ FROM COPE, $R_u = 18K$

$S_{net} = 6.362 in^3$ (SEE NEXT PAGE)



SHEAR RUPTURE CHECK

$L = 12.61"$

$L_e = L - nL_h = 12.61" - 4 \times 0.875" = 9.11"$

$A_e = 9.11 \times 0.24 = 2.19 in^2$

$$\frac{R_n}{\Omega} = \frac{0.6 \times 65 \times 2.19}{2} = 42.6^K > 18^K$$

OKAY!

FLEXURAL CHECK

$$\frac{R_n}{\Omega} = \frac{F_y S_{net}}{\Omega \cdot e} = \frac{50 \times 6.362}{1.67 \times 9.25} = 20.6^K > 18^K \quad \text{OKAY!}$$

LOCAL WEB BUCKLING:

$$\lambda = \frac{h_o \sqrt{F_y}}{10 t_w \sqrt{475 + 280\left(\frac{h_o}{c}\right)^2}} = \frac{6.47\sqrt{50}}{10 \times 0.24 \sqrt{475 + 280\left(\frac{6.47}{9.25 - 0.5}\right)^2}} = 0.76$$

$$Q = (1.34 - 0.486 \times 0.76) = 0.97$$

$$\frac{R_n}{\Omega} = \frac{0.97 \times 50 \times 6.362}{1.67 \times 9.25} = 19.98^K > 18^K \quad \text{OKAY!}$$

FLEXURAL RUPTURE:

$$\frac{R_n}{\Omega} = \frac{65 \times \frac{1}{4} \cdot 0.24 \times 12.61^2}{2 \times 9.25} = 33.5^K > 18^K \quad \text{OKAY!}$$

Section Properties: Section1

Section Information:

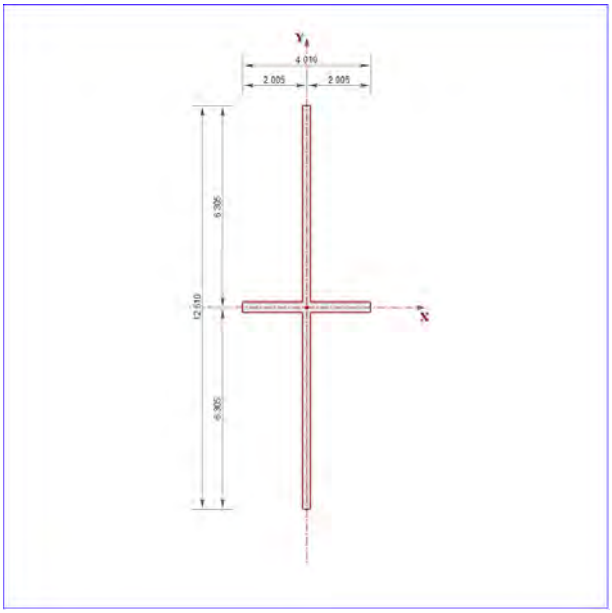
Material Type	=	General
Shape Type	=	Arbitrary
Number of Shapes	=	1

Basic Properties:

Total Width	=	4.010	in
Total Height	=	12.610	in
Centroid, Xo	=	-0.000	in
Centroid, Yo	=	-0.000	in
X-Bar (Right)	=	2.005	in
X-Bar (Left)	=	2.005	in
Y-Bar (Top)	=	6.305	in
Y-Bar (Bot)	=	6.305	in
Max Thick	=	12.610	in

Equivalent Properties:

Area, Ax	=	4.270	in^2
Inertia, Ixx	=	40.110	in^4
Inertia, Iyy	=	1.787	in^4
Inertia, Ixy	=	0.000	in^4
Sx (Top)	=	6.362	in^3
Sx (Bot)	=	6.362	in^3
Sy (Left)	=	0.891	in^3
Sy (Right)	=	0.891	in^3
rx	=	3.065	in
ry	=	0.647	in
Plastic Zx	=	9.643	in^3
Plastic Zy	=	1.503	in^3
Torsional J	=	0.106	in^4
As-xx Def	=	1.000	
As-yy Def	=	1.000	
As-xx Stress	=	1.000	
As-yy Stress	=	1.000	



Section Diagram

Current Date: 5/12/2016 10:21 PM

Units system: English

File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-08 Beam to Girder Shear Tab Connection\SC-08.cnx\

Steel connections

Results

Connection name : **SP BG**
Connection ID : **SC-08-2**

Family: Beam - Girder (BG)

Type: Single plate

Description: W12X19

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	18.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	5.45	7.92	✗	p. 10-104
$L_{min} = T/2 = 10.9[in]/2 = \mathbf{5.45}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 12.2[in] - \max(0.65[in], 3.63[in]) - \max(0.65[in], 0[in]) = \mathbf{7.92}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4,

						J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
L_{emin} = 2*d = 2*0.75[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.64	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.235[in], 12 [in]) = **5.64**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.24	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.87	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	3.26	1.50	--	✔	p. 10-102
L_{emin} = 2*d = 2*0.75[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

WARNINGS

- Connector does not fit on beam

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	25.08	18.00	DL	0.72	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = C*$(1/\Omega)R_n$**BoltFactor* = 2.36*10.61[kip]*1 = **25.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	43.15	18.00	DL	0.42	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*
(n - 1))*t_p*F_u*n_c = 0.5*(2.36/(1*4))*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*
0.75[in])*(4 - 1))*0.375[in]*58000[lb/in2]*1 = **43.15**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	64.80	18.00	DL	0.28	Eq. J4-3

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip] Eq. J4-3

Shear rupture	[Kip]	55.46	18.00	DL	0.32	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 12[in] - 4*0.875[in] = **8.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8.5[in]*0.375[in] = **3.19**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip] Eq. J4-4

Block shear	[Kip]	54.08	18.00	DL	0.33	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*
0.875[in])*0.375[in] = **0.398**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) -
0.875[in]/2)*0.375[in] = **2.79**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/
in2]*0.398[in2]) = **54.08**[kip] Eq. J4-5

Flexural rupture	[Kip]	71.11	18.00	DL	0.25	p. 9-6

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375[in]/4*(12[in]^2 - 3[in]^2*4*(4^2 - 1)*
0.875[in]/12[in]) = **9.81**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*58000[lb/in2]*9.81[in3]/4[in] = **71.11**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	89.10	18.00	DL	0.20	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.71[kip/in]*1*4*12[in] = **89.1**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	22.96	6.00	DL	0.26	p. 10-103

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

f_v = V/A_g = 18[kip]/4.5[in2] = **4000**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*4000[lb/
in2]^2))$^{1/2}$ = **20413.21**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.375$[in]$*12$[in]$^2/4 =$ **13.5**[in3] T. 17-27

(1/Ω)$M_n = (1/\Omega)F_{cr}*Z = 20413.21$[lb/in2]$*13.5$[in3] = **22.96**[kip*ft] p. 10-103

Beam

Bolt bearing under shear load	[Kip]	32.31	18.00	DL	0.56	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.87$[in] $- 0.813$[in]$/2) =$ **1.46**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(2.36/(1*4))*(\min(1.2*1.46$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$
0.75[in]$)*(4 - 1))*0.235$[in]$*65000$[lb/in2]$*1 =$ **32.31**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	40.28	18.00	DL	0.45	Eq. J4-3

$A_g = L_p*t_p = 8.57$[in]$*0.235$[in]$=$ **2.01**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.01$[in2] = **40.28**[kip] Eq. J4-3

Shear rupture	[Kip]	23.23	18.00	DL	0.77	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$L_e = L - n*L_h = 8.57$[in] $- 4*0.875$[in] $=$ **5.07**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 5.07$[in]$*0.235$[in]$=$ **1.19**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*1.19$[in2] = **23.23**[kip] Eq. J4-4

Flexural yielding	[Kip]	15.81	18.00	DL	1.14	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*4.38$[in3]$/8.3$[in] $=$ **15.81**[kip] p. 9-6

Local web buckling	[Kip]	15.81	18.00	DL	1.14	p. 9-7

$h_o = d - d_c = 12.2$[in] $- 3.63$[in] $=$ **8.57**[in] p. 9-7

IsTopFlangeBeamCoped = $(c<=2*d)$ and $(d_c<=d/2) = (7.8$[in]$<=2*12.2$[in]$)$ and $(3.63$[in]$<=12.2$[in]$/2) =$ **True** p. 9-7

$c/d<=1 \rightarrow 7.8$[in]$/12.2$[in]$<=1 \rightarrow$ **True**

$f = 2*c/d = 2*7.8$[in]$/12.2$[in] $=$ **1.28** p. 9-7

$c/h_o<=1 \rightarrow 7.8$[in]$/8.57$[in]$<=1 \rightarrow$ **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(8.57$[in]$/7.8$[in]$)^{1.65} =$ **2.57** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*$
$(0.235$[in]$/8.57$[in]$)^2*1.28*2.57 =$ **64758.82**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 64758.82$[lb/in2]$)*4.38$[in3]$/$
8.3[in] $=$ **15.81**[kip] p. 9-7

Block shear	[Kip]	57.32	18.00	DL	0.31	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (3.26$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$
0.875[in]$)*0.235$[in] $=$ **0.663**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.87$[in] $+ (4 - 1)*3$[in]$)*0.235$[in] $=$ **2.55**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.87$[in] $+ (4 - 1)*(3$[in] $- 0.875$[in]$) -$

0.875[in]/2)*0.235[in] = **1.83**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.83[in2] + 1*65000[lb/in2]*0.663[in2], 0.6*50000[lb/in2]*2.55[in2] + 1*65000[lb/in2]*0.663[in2]) = **57.32**[kip] Eq. J4-5

Flexural rupture	[Kip]	17.17	18.00	DL	1.05	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*4.38[in3]/8.3[in] = **17.17**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	702.00	18.00	DL	0.03	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*1.5[in] = **58.5**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 18[kip]/(0.5*3.71[kip/in]*1*12[in]) = **0.808** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.808/16 [in] = **1.5**[kip/in] p. 9-5

Global critical strength ratio **1.14**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

f: Plate buckling model adjustment factor

F_{cr}: Critical stress, flexural stress buckling

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

IsTopFlangeBeamCoped: Is the top beam flange coped

k: Plate buckling coefficient

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

ν: Poisson's ratio

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

$\sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

STRENGTHENING W14X22

COPED BEAM CAPACITY CHECK

SEE SECTION PROPERTIES ON THE NEXT PAGE

GOOD FOR $e_{cope} \leq 9.25$" FROM COPE LINE

$S_{net} = 15.038 in^3$

FLEXURAL YIELDING CHECK

$$\frac{R_n}{\Omega} = \frac{F_y S_{net}}{\Omega e} = \frac{50 \times 15.038}{1.67 \times 9.25} = 48.7^k > 25^k \quad \text{OKAY!}$$

LOCAL WEB BUCKLING

$$\lambda = \frac{h_o \sqrt{F_y}}{10 t_w \sqrt{475 + 280\left(\frac{h_o}{c}\right)^2}} = \frac{10.07 \cdot \sqrt{50}}{10 \times 0.23 \sqrt{475 + 280\left(\frac{10.07}{9.5 - 0.5}\right)^2}} = 1.064$$

$$Q = 1.34 - 0.486 \times 1.064 = 0.823$$

$$\frac{R_n}{\Omega} = \frac{0.823 \times 50 \times 15.038}{1.67 \times 9.25} = 40.1^k > 25^k \quad \text{OKAY!}$$

FLEXURAL RUPTURE

$$\frac{R_n}{\Omega} = \frac{F_u Z_{net}}{\Omega e} = \frac{65 \times \frac{1}{4} \times 15.038^2 \times 0.23}{2 \times 9.25} = 45.7^k > 25^k$$

OKAY!!!

Section Properties: Section3

Section Information:

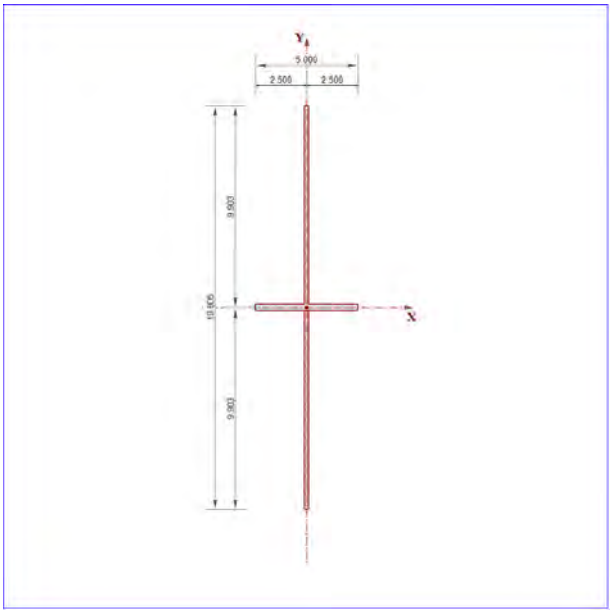
Material Type	=	General
Shape Type	=	Arbitrary
Number of Shapes	=	2

Basic Properties:

Total Width	=	5.000	in
Total Height	=	19.805	in
Centroid, Xo	=	0.000	in
Centroid, Yo	=	0.000	in
X-Bar (Right)	=	2.500	in
X-Bar (Left)	=	2.500	in
Y-Bar (Top)	=	9.903	in
Y-Bar (Bot)	=	9.903	in
Max Thick	=	0.335	in

Equivalent Properties:

Area, Ax	=	6.153	in^2
Inertia, Ixx	=	148.91	in^4
Inertia, Iyy	=	3.509	in^4
Inertia, Ixy	=	0.000	in^4
Sx (Top)	=	15.038	in^3
Sx (Bot)	=	15.038	in^3
Sy (Left)	=	1.404	in^3
Sy (Right)	=	1.404	in^3
rx	=	4.919	in
ry	=	0.755	in
Plastic Zx	=	22.688	in^3
Plastic Zy	=	2.351	in^3
Torsional J	=	0.140	in^4
As-xx Def	=	1.000	
As-yy Def	=	1.000	
As-xx Stress	=	1.000	
As-yy Stress	=	1.000	



Section Diagram

Current Date: 5/12/2016 10:26 PM

Units system: English

File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-08 Beam to Girder Shear Tab Connection\SC-08.cnx\

Steel connections

Results

Connection name : **SP BG**
Connection ID : **SC-08-3**

Family: Beam - Girder (BG)

Type: Single plate

Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	25.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.00	6.11	9.33	✗	p. 10-104
$L_{min} = T/2 = 12.23$[in]$/2 =$ **6.12**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 13.7[in] - max(0.735[in], 3.63[in]) - max(0.735[in], 0[in]) = **9.34**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✓	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 0.75$[in]$/2 + 1/16$ [in] $=$ **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4,

						J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
L_{emin} = 2*d = 2*0.75[in] = **1.5**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Thickness	[in]	0.23	--	0.43	✔	p. 10-151, p. 10-102
t_{pmax} = (3/16 [in])/$sin\alpha$ = (3/16 [in])/0.438 = **0.428**[in]						p. 10-151
t_{pmax} = d/2 + 1/16 [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	3.26	1.50	--	✔	p. 10-102
L_{emin} = 2*d = 2*0.75[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

WARNINGS

- Connector does not fit on beam

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	25.08	25.00	DL	1.00	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n$ = $(1/\Omega)$*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n$ = C*$(1/\Omega)R_n$**BoltFactor* = 2.36*10.61[kip]*1 = **25.08**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	43.15	25.00	DL	0.58	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)* (n - 1))*t_p*F_u*n_c = 0.5*(2.36/(1*4))*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4* 0.75[in])*(4 - 1))*0.375[in]*58000[lb/in2]*1 = **43.15**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	64.80	25.00	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*4.5[in2] = **64.8**[kip] Eq. J4-3

Shear rupture	[Kip]	55.46	25.00	DL	0.45	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 12[in] - 4*0.875[in] = **8.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8.5[in]*0.375[in] = **3.19**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*3.19[in2] = **55.46**[kip] Eq. J4-4

Block shear	[Kip]	54.08	25.00	DL	0.46	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **2.79**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*58000[lb/in2]*2.79[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*3.94[in2] + 1*58000[lb/ in2]*0.398[in2]) = **54.08**[kip] Eq. J4-5

Flexural rupture	[Kip]	71.11	25.00	DL	0.35	p. 9-6

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375[in]/4*(12[in]^2 - 3[in]^2*4*(4^2 - 1)* 0.875[in]/12[in]) = **9.81**[in3] 4

(1/Ω)R_n = *(1/Ω)**F_u*Z_{net}/e = 0.5*58000[lb/in2]*9.81[in3]/4[in] = **71.11**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	89.10	25.00	DL	0.28	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*3.71[kip/in]*1*4*12[in] = **89.1**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	21.70	8.33	DL	0.38	p. 10-103

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

f_v = V/A_g = 25[kip]/4.5[in2] = **5555.56**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)**F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*5555.56[lb/ in2]^2))$^{1/2}$ = **19290.07**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.375$[in]$*12$[in]$^2/4 =$ **13.5**[in3] T. 17-27

(1/Ω)$M_n = (1/\Omega)F_{cr}*Z = 19290.07$[lb/in2]$*13.5$[in3] = **21.7**[kip*ft] p. 10-103

Beam

Bolt bearing under shear load	[Kip]	29.66	25.00	DL	0.84	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in] $- 0.813$[in]$/2) =$ **1.09**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c = 0.5*(2.36/(1*4))*(\min(1.2*1.09$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$
0.75[in]$)*(4 - 1))*0.23$[in]$*65000$[lb/in2]$*1 =$ **29.66**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	46.32	25.00	DL	0.54	Eq. J4-3

$A_g = L_p*t_p = 10.07$[in]$*0.23$[in]$ =$ **2.32**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.32$[in2] = **46.32**[kip] Eq. J4-3

Shear rupture	[Kip]	29.47	25.00	DL	0.85	Eq. J4-4

$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$L_e = L - n*L_h = 10.07$[in] $- 4*0.875$[in] $=$ **6.57**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 6.57$[in]$*0.23$[in]$ =$ **1.51**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*1.51$[in2] = **29.47**[kip] Eq. J4-4

Flexural yielding	[Kip]	21.64	25.00	DL	1.16	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*6$[in3]$/8.3$[in] = **21.64**[kip] p. 9-6

Local web buckling	[Kip]	21.64	25.00	DL	1.16	p. 9-7

$h_o = d - d_c = 13.7$[in] $- 3.63$[in] $=$ **10.07**[in] p. 9-7

IsTopFlangeBeamCoped = (c<=$2*d$) and (d_c<=$d/2$) = (7.8[in]<=2*13.7[in]) and (3.63[in]<=13.7[in]/2) = **True** p. 9-7

c/d<=1 → 7.8[in]/13.7[in]<=1 → **True**

$f = 2*c/d = 2*7.8$[in]$/13.7$[in] $=$ **1.14** p. 9-7

c/h_o<=1 → 7.8[in]/10.07[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(10.07$[in]$/7.8$[in]$)^{1.65} =$ **3.35** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90\text{E+}07$[lb/in2]$/(12*(1 - 0.3^2))*$
$(0.23$[in]$/10.07$[in]$)^2*1.14*3.35 =$ **52208.48**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2]$, 52208.48$[lb/in2]$)*6$[in3]$/$
8.3[in] $=$ **21.64**[kip] p. 9-7

Block shear	[Kip]	54.46	25.00	DL	0.46	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] $=$ **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (3.26$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$
0.875[in]$)*0.23$[in] $=$ **0.649**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] $+ (4 - 1)*3$[in]$)*0.23$[in] $=$ **2.42**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] $+ (4 - 1)*(3$[in] $- 0.875$[in]$) -$

0.875[in]/2)*0.23[in] = **1.71**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.71[in2] + 1*65000[lb/in2]*0.649[in2], 0.6*50000[lb/in2]*2.42[in2] + 1*65000[lb/in2]*0.649[in2]) = **54.46**[kip] Eq. J4-5

Flexural rupture	[Kip]	23.49	25.00	DL	1.06	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*6[in3]/8.3[in] = **23.49**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	702.00	25.00	DL	0.04	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*1.5[in] = **58.5**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 25[kip]/(0.5*3.71[kip/in]*1*12[in]) = **1.12** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.12/16 [in] = **2.08**[kip/in] p. 9-5

Global critical strength ratio **1.16**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_c: Coped depth

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

f: Plate buckling model adjustment factor

F_{cr}: Critical stress, flexural stress buckling

F_{EXX}: Electrode classification number

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

IsTopFlangeBeamCoped: Is the top beam flange coped

k: Plate buckling coefficient

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

ν: Poisson's ratio

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

$sin\alpha$: Sine of the skew angle

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Strengthening W12X19

COPED BEAM CAPACITY CHECK

SEE SECTION PROPERTIES NEXT PAGE

GOOD FOR $e \leq 9.25$" FROM COPE CUT $R_u = 18^k$

$S_{net} = 11.043\ in^3$ (SEE NEXT PAGE)

FLEXURAL YIELDING

$F_y/50 = 50/2 = 25\ ksi < 0.75 F_u = 0.75 \times 65 = 48.8\ ksi$ ← controls

$$\frac{R_n}{\Omega} = \frac{F_y S_{net}}{\Omega e} = \frac{50 \times 11.043}{1.67 \times 9.25} = 35.74^k > 18^k$$ Okay!

LOCAL WEB BUCKLING

$$\lambda = \frac{h_o\sqrt{F_y}}{10 t_w \sqrt{\frac{475+280}{(h_o/c)^2}}} = \frac{8.57\sqrt{50}}{10 \times 0.235 \sqrt{\frac{475+280}{(\frac{8.57}{9.37-0.5})^2}}} = 0.946$$

$$Q = (1.34 - 0.486 \times 0.946) = 0.88$$

$$\frac{R_n}{\Omega} = \frac{0.88 \times 50 \times 11.043}{1.67 \times 9.25} = 31.47^k > 18^k$$ Okay!

FLEXURAL RUPTURE:

$$\frac{R_n}{\Omega} = \frac{F_u \cdot Z_{net}}{\Omega e} = \frac{65 \times 11.043^2 \times \frac{0.235}{4}}{2 \times 9.25} = 25.1^k > 18^k$$ OKAY!

Section Properties: Section2

Section Information:

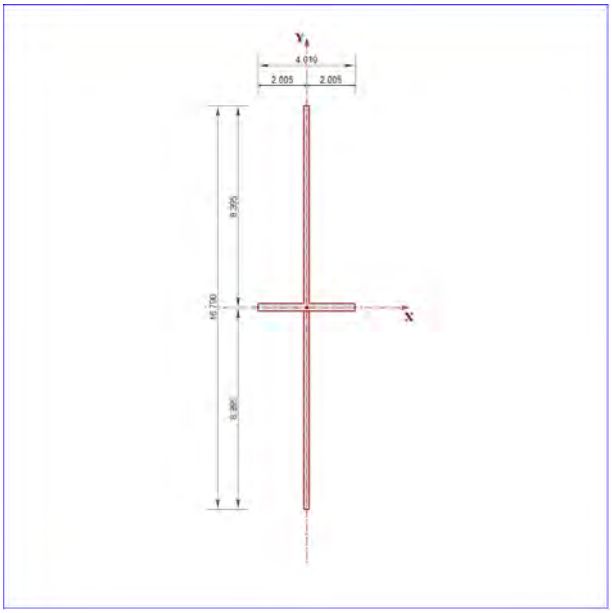
Material Type	=	General
Shape Type	=	Arbitrary
Number of Shapes	=	2

Basic Properties:

Total Width	=	4.010	in
Total Height	=	16.790	in
Centroid, Xo	=	-0.000	in
Centroid, Yo	=	0.000	in
X-Bar (Right)	=	2.005	in
X-Bar (Left)	=	2.005	in
Y-Bar (Top)	=	8.395	in
Y-Bar (Bot)	=	8.395	in
Max Thick	=	0.350	in

Equivalent Properties:

Area, Ax	=	5.267	in^2
Inertia, Ixx	=	92.708	in^4
Inertia, Iyy	=	1.898	in^4
Inertia, Ixy	=	0.000	in^4
Sx (Top)	=	11.043	in^3
Sx (Bot)	=	11.043	in^3
Sy (Left)	=	0.947	in^3
Sy (Right)	=	0.947	in^3
rx	=	4.195	in
ry	=	0.600	in
Plastic Zx	=	16.678	in^3
Plastic Zy	=	1.634	in^3
Torsional J	=	0.127	in^4
As-xx Def	=	1.000	
As-yy Def	=	1.000	
As-xx Stress	=	1.000	
As-yy Stress	=	1.000	



Section Diagram

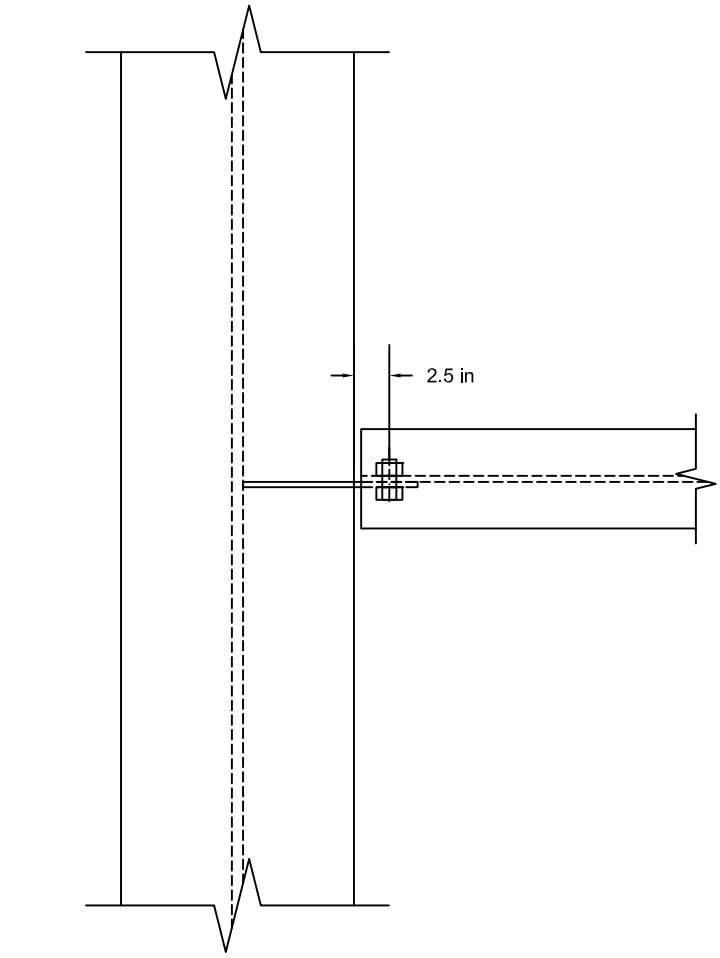
SC-09 BEAM TO GIRDER EXTENDED SHEAR TAB CONNECTION

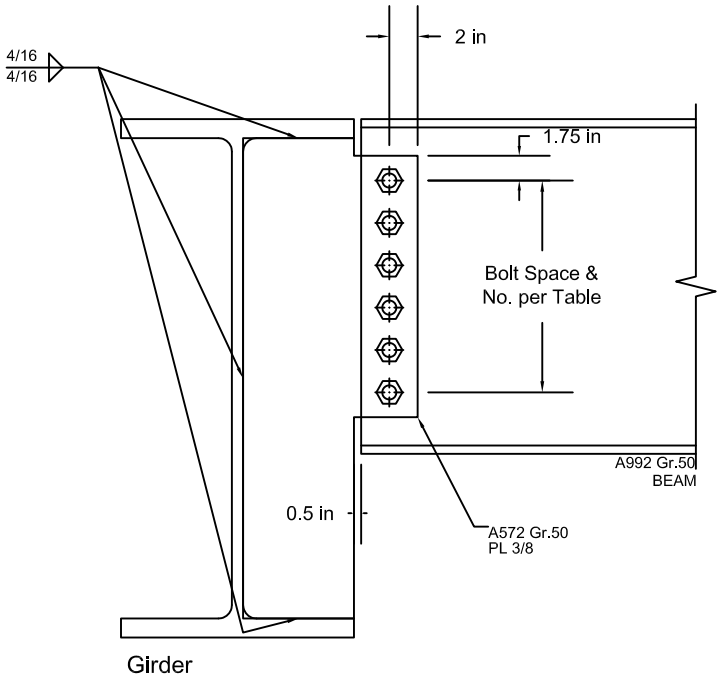
Connection ID	**Location**	Beam	Girder	Shear Load (kips) "R"	No.of Bolts (Row X Col.)	Bolts Type	Shear Tab to Girder Weld Size (inch) "w"	Bolt Spacing (inch) "Spa."	A36 Plate Thk. (inch) "tp"	Distance between Weld and Bolt group (inch) "a"	Bolt Edge Distance Horizontal (inch) "L_{eh}"	Bolt Edge Distance Vertical (inch) "L_{ev}"
SC-09-01	**L3 1-B.2**	W24x62	W36x247	35	6x1	1" Dia. A490N	1/4"	3"	3/8"	2.5"	2"	1.75"
SC-09-02	**L3 1-B.3/1-A.5**	W16x31	W36x247 W36x302	20	4x1	1" Dia. A490N	1/4"	3"	3/8"	2.5"	2"	1.75"
SC-09-03	**L3 1-A.5**	W24x68	W36x302	35	6x1	1" Dia. A490N	1/4"	3"	3/8"	2.5"	2"	1.75"
SC-09-04	**L3 1-C.3**	W14x22	W24x62	20	4x1	1" Dia. A490N	1/4"	2.75"	3/8"	2.5"	2"	1.75"

SC-09

BEAM TO GIRDER EXTENDED SHEAR TAB CONNECTION

Top view





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Units system: English

File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-09 Beam to Girder Extended Shear Tab\Extended shear tab.cnx\

Steel connections

Results

Connection name : **SP_BG**
Connection ID : **SC-09-1**

Family: Beam - Girder (BG)

Type: Single plate

Description: W 24X62

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	35.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3,

						Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.35	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	53.95	35.00	DL	0.65	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 2.29*23.55[kip]*1 = **53.95**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	76.57	30.19	DL	0.39	p. 10-103
A_g = L_p*t_p = 18.5[in]*0.375[in] = **6.94**[in2]						Sec. D3-1
f_v = V/A_g = 35[kip]/6.94[in2] = **5045.05**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*5045.05[lb/in2^2]))$^{1/2}$ = **28636.57**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.375[in]*18.5[in]^2/4 = **32.09**[in3]						T. 17-27
(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 28636.57[lb/in2]*32.09[in3] = **76.57**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	60.90	35.00	DL	0.57	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*						
(n - 1))*t_p*F_u*n_c = 0.5*(2.29/(1*6))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*						

1[in])*(6 - 1))*0.375[in]*65000[lb/in2]*1 = **60.9**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	138.75	35.00	DL	0.25	Eq. J4-3

$A_g = L_p*t_p$ = 18.5[in]*0.375[in] = **6.94**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*6.94[in2] = **138.75**[kip] Eq. J4-3

Shear rupture	[Kip]	85.92	35.00	DL	0.41	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 18.5[in] - 6*1.13[in] = **11.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 11.75[in]*0.375[in] = **4.41**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*4.41[in2] = **85.92**[kip] Eq. J4-4

Block shear	[Kip]	94.76	35.00	DL	0.37	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (6 - 1)*3[in])*0.375[in] = **6.28**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **3.96**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*3.96[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*6.28[in2] + 1*65000[lb/in2]*0.539[in2]) = **94.76**[kip] Eq. J4-5

Flexural rupture	[Kip]	66.92	35.00	DL	0.52	p. 9-6

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(18.5[in]^2 - 3[in]^2*6*(6^2 -
1)*1.13[in]/18.5[in]) = **21.31**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*21.31[in3]/10.35[in] = **66.92**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	252.44	35.00	DL	0.14	Tables 8-4 .. 8-11

e = 0 p. 10-135

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)*C*C_1*D*L$) = 2 * (0.5*1.86[kip/in]*1*4*34[in]) = **252.44**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	74.84	35.00	DL	0.47	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 4.35[in] - 1.06[in]/2) = **3.82**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c$ = 0.5*(2.29/(1*6))*(min(1.2*3.82[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*
1[in])*(6 - 1))*0.43[in]*65000[lb/in2]*1 = **74.84**[kip] p. 7-18,

						Sec. J3.10
Shear yielding	[Kip]	203.82	35.00	DL	0.17	Eq. J4-3
$A_g = L_p * t_p = 23.7$[in]$*0.43$[in] = **10.19**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*10.19$[in2] = **203.82**[kip]						Eq. J4-3
Support						
Welds rupture	[Kip/ft]	374.40	12.35	DL	0.03	p. 9-5
$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.8$[in] = **31.2**[kip/in]						p. 9-5
$e = 0$						p. 10-135
$D_{min} = P/((1/\Omega)*C*C_1*L) = 17.5$[kip]$/(0.5*1.86$[kip/in]$*1*34$[in]$) =$ **0.555**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.555/16$ [in] = **1.03**[kip/in]						p. 9-5

Global critical strength ratio **0.65**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 5/25/2016 8:09 PM

Units system: English

File name: U:\Webster Connection Design Folder\Reports and Calculations\SC-09 Beam to Girder Extended Shear Tab\Extended shear tab.cnx\

Steel connections

Results

Connection name : SP BG

Connection ID : SC-09-2

Family: Beam - Girder (BG)

Type: Single plate

Description: W 16X31

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	6.60	✔	Sec. J3.3,

						Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.275[in], 12 [in]) = **6.6**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.45	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	24.85	20.00	DL	0.80	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 1.06*23.55[kip]*1 = **24.85**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	24.72	17.30	DL	0.70	p. 10-103
A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2]						Sec. D3-1
f_v = V/A_g = 20[kip]/4.69[in2] = **4266.67**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*36000[lb/in2])^2 - 3*4266.67[lb/in2^2]))$^{1/2}$ = **20250.58**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.375[in]*12.5[in]^2/4 = **14.65**[in3]						T. 17-27
(1/Ω)M_n = *(1/Ω)*F_{cr}**Z* = 20250.58[lb/in2]*14.65[in3] = **24.72**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	24.20	20.00	DL	0.83	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)* (n - 1))*t_p*F_u*n_c = 0.5*(1.06/(1*4))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*						

1[in])*(4 - 1))*0.375[in]*58000[lb/in2]*1 = **24.2**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	67.50	20.00	DL	0.30	Eq. J4-3

$A_g = L_p*t_p$ = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*4.69[in2] = **67.5**[kip] Eq. J4-3

Shear rupture	[Kip]	52.20	20.00	DL	0.38	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 12.5[in] - 4*1.13[in] = **8**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 8[in]*0.375[in] = **3**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*3[in2] = **52.2**[kip] Eq. J4-4

Block shear	[Kip]	59.17	20.00	DL	0.34	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (4 - 1)*3[in])*0.375[in] = **4.03**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.375[in] = **2.55**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*58000[lb/in2]*2.55[in2] + 1*58000[lb/in2]*0.539[in2], 0.6*36000[lb/in2]*4.03[in2] + 1*58000[lb/in2]*0.539[in2]) = **59.17**[kip] Eq. J4-5

Flexural rupture	[Kip]	28.20	20.00	DL	0.71	p. 9-6

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(12.5[in]^2 - 3[in]^2*4*(4^2 - 1)*1.13[in]/12.5[in]) = **10.09**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*58000[lb/in2]*10.09[in3]/10.38[in] = **28.2**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	251.99	20.00	DL	0.08	Tables 8-4 .. 8-11

e = 0 p. 10-135

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)*C*C_1*D*L$) = 2 * (0.5*1.86[kip/in]*1*4*33.94[in]) = **251.99**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	22.10	20.00	DL	0.91	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 3.45[in] - 1.06[in]/2) = **2.92**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(1.06/(1*4))*(min(1.2*2.92[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.275[in]*65000[lb/in2]*1 = **22.1**[kip] p. 7-18,

						Sec. J3.10
Shear yielding	[Kip]	87.45	20.00	DL	0.23	Eq. J4-3
$A_g = L_p * t_p$ = 15.9[in]*0.275[in] = **4.37**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*4.37[in2] = **87.45**[kip]						Eq. J4-3
Support						
Welds rupture	[Kip/ft]	442.26	7.07	DL	0.02	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.945[in] = **36.86**[kip/in]						p. 9-5
$e = 0$						p. 10-135
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 10[kip]/(0.5*1.86[kip/in]*1*33.94[in]) = **0.317**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.317/16 [in] = **0.589**[kip/in]						p. 9-5

Global critical strength ratio **0.91**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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Steel connections

Results

Connection name : **SP_BG**
Connection ID : **SC-09-3**

Family: Beam - Girder (BG)

Type: Single plate

Description: W 24X68

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	35.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3,

						Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.35	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	53.83	35.00	DL	0.65	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 2.29*23.55[kip]*1 = **53.83**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	76.57	30.27	DL	0.40	p. 10-103
A_g = L_p*t_p = 18.5[in]*0.375[in] = **6.94**[in2]						Sec. D3-1
f_v = V/A_g = 35[kip]/6.94[in2] = **5045.05**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*5045.05[lb/in2^2]))$^{1/2}$ = **28636.57**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.375[in]*18.5[in]^2/4 = **32.09**[in3]						T. 17-27
(1/Ω)M_n = *(1/Ω)*F_{cr}**Z* = 28636.57[lb/in2]*32.09[in3] = **76.57**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	60.76	35.00	DL	0.58	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)* (n - 1))*t_p*F_u*n_c = 0.5*(2.29/(1*6))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*						

1[in])*(6 - 1))*0.375[in]*65000[lb/in2]*1 = **60.76**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	138.75	35.00	DL	0.25	Eq. J4-3

$A_g = L_p*t_p$ = 18.5[in]*0.375[in] = **6.94**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*6.94[in2] = **138.75**[kip] Eq. J4-3

Shear rupture	[Kip]	85.92	35.00	DL	0.41	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 18.5[in] - 6*1.13[in] = **11.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 11.75[in]*0.375[in] = **4.41**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*4.41[in2] = **85.92**[kip] Eq. J4-4

Block shear	[Kip]	94.76	35.00	DL	0.37	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (6 - 1)*3[in])*0.375[in] = **6.28**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **3.96**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*3.96[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*6.28[in2] + 1*65000[lb/in2]*0.539[in2]) = **94.76**[kip] Eq. J4-5

Flexural rupture	[Kip]	66.74	35.00	DL	0.52	p. 9-6

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(18.5[in]^2 - 3[in]^2*6*(6^2 -
1)*1.13[in]/18.5[in]) = **21.31**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*21.31[in3]/10.38[in] = **66.74**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	251.99	35.00	DL	0.14	Tables 8-4 .. 8-11

e = 0 p. 10-135

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)*C*C_1*D*L$) = 2 * (0.5*1.86[kip/in]*1*4*33.94[in]) = **251.99**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	72.06	35.00	DL	0.49	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 4.35[in] - 1.06[in]/2) = **3.82**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c$ = 0.5*(2.29/(1*6))*(min(1.2*3.82[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*
1[in])*(6 - 1))*0.415[in]*65000[lb/in2]*1 = **72.06**[kip] p. 7-18,

						Sec. J3.10
Shear yielding	[Kip]	196.71	35.00	DL	0.18	Eq. J4-3
$A_g = L_p * t_p$ = 23.7[in]*0.415[in] = **9.84**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*9.84[in2] = **196.71**[kip]						Eq. J4-3
Support						
Welds rupture	[Kip/ft]	442.26	12.37	DL	0.03	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.945[in] = **36.86**[kip/in]						p. 9-5
$e = 0$						p. 10-135
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 17.5[kip]/(0.5*1.86[kip/in]*1*33.94[in]) = **0.556**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.556/16 [in] = **1.03**[kip/in]						p. 9-5

Global critical strength ratio **0.65**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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Steel connections

Results

Connection name : **SP_BG_1/4PL_3B3/4**
Connection ID : **SC-09-4**

Family: Beam - Girder (BG)

Type: Single plate

Description: W 14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	20.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.87	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0.125[in] = **1.88**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	2.75	2.67	5.52	✔	Sec. J3.3,

						Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.23[in], 12 [in]) = **5.52**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.72	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Plate (beam side)						
Bolts shear	[Kip]	38.91	20.00	DL	0.51	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 1.65*23.55[kip]*1 = **38.91**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	31.16	9.67	DL	0.31	p. 10-103
A_g = L_p*t_p = 11.75[in]*0.375[in] = **4.41**[in2]						Sec. D3-1
f_v = V/A_g = 20[kip]/4.41[in2] = **4539.01**[lb/in2]						p. 10-103
(1/Ω)F_{cr} = (max(0, ((1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*4539.01[lb/in2^2]))$^{1/2}$ = **28889.5**[lb/in2]						p. 10-103
Z_x = t_p*L^2/4 = 0.375[in]*11.75[in]^2/4 = **12.94**[in3]						T. 17-27
(1/Ω)M_n = *(1/Ω)*F_{cr}**Z* = 28889.5[lb/in2]*12.94[in3] = **31.16**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	37.95	20.00	DL	0.53	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 2.75[in] - 1.06[in]) = **1.69**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*						
(n - 1))*t_p*F_u*n_c = 0.5*(1.65/(1*4))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.69[in], 2.4*						

1[in])*(4 - 1))*0.375[in]*65000[lb/in2]*1 = **37.95**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	88.13	20.00	DL	0.23	Eq. J4-3

$A_g = L_p*t_p$ = 11.75[in]*0.375[in] = **4.41**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*4.41[in2] = **88.13**[kip] Eq. J4-3

Shear rupture	[Kip]	53.02	20.00	DL	0.38	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 11.75[in] - 4*1.13[in] = **7.25**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 7.25[in]*0.375[in] = **2.72**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*2.72[in2] = **53.02**[kip] Eq. J4-4

Block shear	[Kip]	60.33	20.00	DL	0.33	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.31[in] + 1/16 [in] = **1.38**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*5.5[in] - (1 - 0.5)*
1.38[in])*0.375[in] = **0.492**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (4 - 1)*2.75[in])*0.375[in] = **3.75**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (4 - 1)*(2.75[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **2.27**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*2.27[in2] + 1*65000[lb/in2]*0.492[in2], 0.6*50000[lb/in2]*3.75[in2] + 1*65000[lb/
in2]*0.492[in2]) = **60.33**[kip] Eq. J4-5

Flexural rupture	[Kip]	49.66	20.00	DL	0.40	p. 9-6

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(11.75[in]^2 - 2.75[in]^2*4*
(4^2 - 1)*1.13[in]/11.75[in]) = **8.87**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*8.87[in3]/5.81[in] = **49.66**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	167.20	20.00	DL	0.12	Tables 8-4 .. 8-11

$e = 0$ p. 10-135

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)*C*C_1*D*L$) = 2 * (0.5*1.86[kip/in]*1*4*22.52[in]) = **167.2**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	26.17	20.00	DL	0.76	p. 7-18, Sec. J3.10

$L_{c\text{-}end} = \max(0.0, L_e - dh_h/2)$ = Max(0.0, 2.73[in] - 1.06[in]/2) = **2.19**[in] Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - dh_h)$ = Max(0.0, 2.75[in] - 1.06[in]) = **1.69**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$
$(n - 1))*t_p*F_u*n_c$ = 0.5*(1.65/(1*4))*(min(1.2*2.19[in], 2.4*1[in]) + min(1.2*1.69[in], 2.4*
1[in])*(4 - 1))*0.23[in]*65000[lb/in2]*1 = **26.17**[kip] p. 7-18,

Sec. J3.10

Shear yielding	[Kip]	63.02	20.00	DL	0.32	Eq. J4-3

$A_g = L_p * t_p$ = 13.7[in]*0.23[in] = **3.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*3.15[in2] = **63.02**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	201.24	10.66	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.43[in] = **16.77**[kip/in] p. 9-5

e = 0 p. 10-135

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 10[kip]/(0.5*1.86[kip/in]*1*22.52[in]) = **0.478** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.478/16 [in] = **0.888**[kip/in] p. 9-5

Global critical strength ratio **0.76**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_h: Nominal hole dimension

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_{nv}:Nominal shear stress

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_y: Specified minimum yield stress

h_o: Reduced beam depth

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_p: Plate length

L: Length of weld

λ: Slenderness

e_{dmin}: Minimum edge distance

n: Bolts rows number

n_c: Number of bolt columns

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

t_p: Plate thickness

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

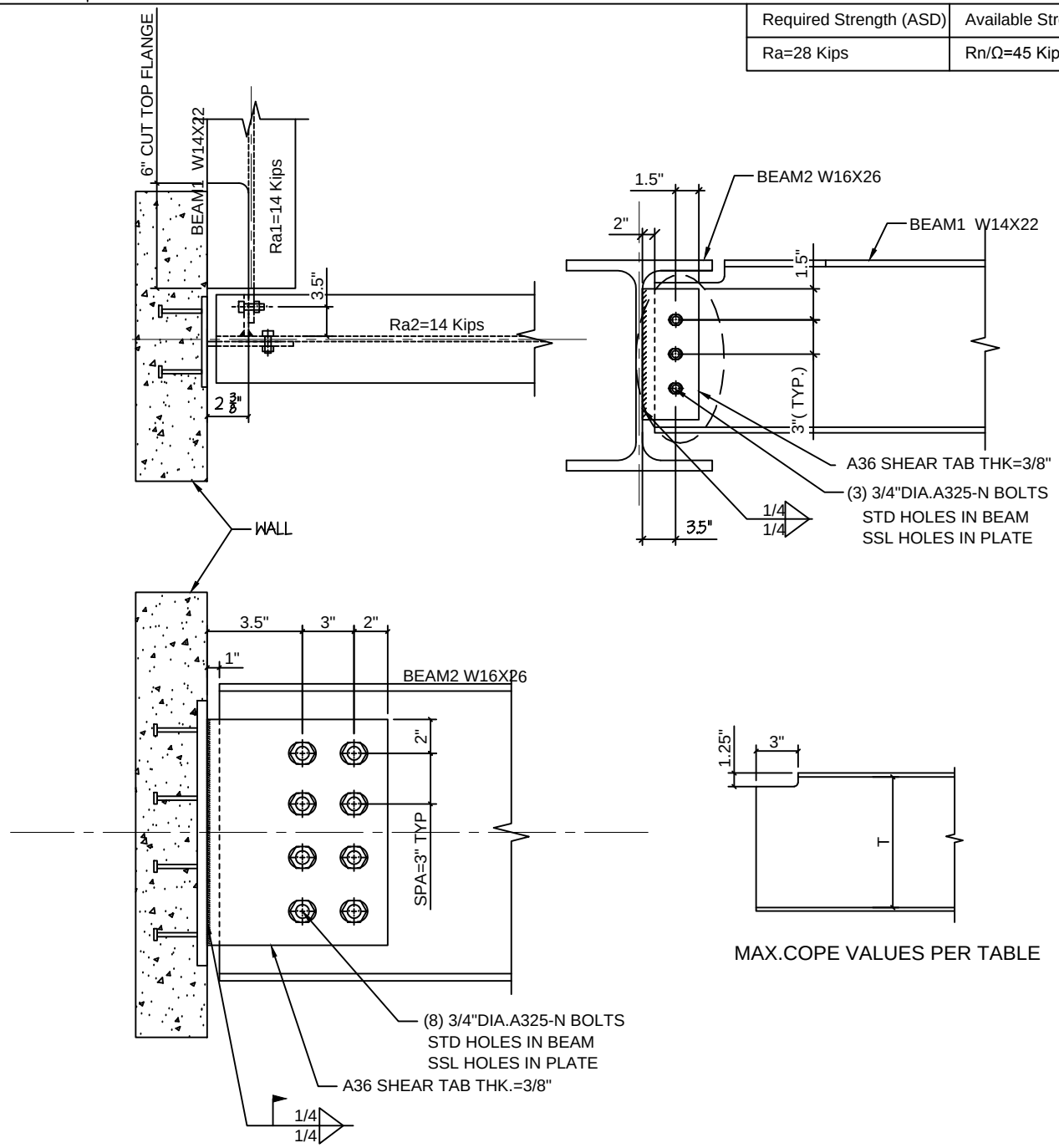
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

NS-01a/b Beam-Wall Connection Location Floor 2(Axis 3-W,V)

Required Strength (ASD)	Available Strength (ASD)
Ra=28 Kips	Rn/Ω=45 Kips



Current Date: 2016-05-25 5:39 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\NS Nonstandard Connection\NS.cnx\

Steel connections

Results

Connection name : **Beam Connection To Wall**
Connection ID : **NS-01a**

Family: Beam - Column flange (BCF)
Type: Single plate
Description: W16X26

Design code: AISC 360-05 ASD

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	40.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	13.00	7.10	14.21	✔	p. 10-104
$L_{min} = T/2 = 14.21[in]/2 = \mathbf{7.1}[in]$						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 15.7[in] - max(0.747[in], 0[in]) - max(0.747[in], 0[in]) = **14.21**[in]						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] = 0.75[in]/2 + 1/16 [in] = **0.438**[in]						p. 10-102
Vertical edge distance	[in]	2.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25[in], 12$ [in]$) = \mathbf{6}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.25[in], 12$ [in]$) = \mathbf{6}[in]$						Sec. J3.5
Eccentricity	[in]	5.00	5.00	--	✔	
Min. eb=5 [in]						
Beam						
Vertical edge distance	[in]	3.35	1.25	--	✔	Tables J3.4,

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						J3.5 Tables J3.4, J3.5
Horizontal edge distance	[in]	3.00	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75$[in] = **1.5**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	44.63	40.00	DL	0.90	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b = 0.5*48000$[lb/in2]$*0.442$[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4.21*10.61$[kip]$*1$ = **44.63**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	82.35	40.00	DL	0.49	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in] $- 0.813$[in]$/2) =$ **1.59**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*$ $(n - 1))*t_p*F_u*n_c = 0.5*(4.21/(2*4))*(\min(1.2*1.59$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*$ 0.75[in]$)*(4 - 1))*0.375$[in]$*58000$[lb/in2]$*2$ = **82.35**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	70.20	40.00	DL	0.57	Eq. J4-3
$A_g = L_p*t_p = 13$[in]$*0.375$[in] = **4.88**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*36000$[lb/in2]$*4.88$[in2] = **70.2**[kip]						Eq. J4-3
Shear rupture	[Kip]	61.99	40.00	DL	0.65	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h = 13$[in] $- 4*0.875$[in] = **9.5**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 9.5$[in]$*0.375$[in] = **3.56**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*3.56$[in2] = **61.99**[kip]						Eq. J4-4
Block shear	[Kip]	63.07	40.00	DL	0.63	Eq. J4-5
$dh_h = d_h + 1/16$ [in] $= 1$[in] $+ 1/16$ [in] = **1.06**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] $+ (2 - 1)*3$[in] $- (2 - 0.5)*$ 1.06[in]$)*0.375$[in] = **1.28**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2$[in] $+ (4 - 1)*3$[in]$)*0.375$[in] = **4.13**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2$[in] $+ (4 - 1)*(3$[in] $- 0.875$[in]$) -$ 0.875[in]$/2)*0.375$[in] = **2.98**[in2]						Sec. J4-3
IsStressUniform → **False**						
$U_{bs} = 0.5$						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*2.98$[in2] $+ 0.5*58000$[lb/in2]$*1.28$[in2]$, 0.6*36000$[lb/in2]$*4.13$[in2] $+ 0.5*$ 58000[lb/in2]$*1.28$[in2]$)$ = **63.07**[kip]						Eq. J4-5
Flexural rupture	[Kip]	103.04	40.00	DL	0.39	p. 9-6
$L_h = d_h + 1/16$ [in] $= 0.813$[in] $+ 1/16$ [in] = **0.875**[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.375$[in]$/4*(13$[in]$^2 - 3$[in]$^2*4*(4^2 - 1)*$ 0.875[in]$/13$[in]$) =$ **12.44**[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*58000$[lb/in2]$*12.44$[in3]$/3.5$[in] = **103.04**[kip]						p. 9-6
Plate (support side)						

Weld capacity	[Kip]	96.52	40.00	DL	0.41	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*3.71$[kip/in]$*1*4*13$[in] $=$ **96.52**[kip]						Tables 8-4 .. 8-11
Flexure with the Von-Mises shear reduction	[Kip*ft]	21.40	11.67	DL	0.55	p. 10-103
$A_g = L_p*t_p = 13$[in]$*0.375$[in] $=$ **4.88**[in2]						Sec. D3-1
$f_v = V/A_g = 40$[kip]$/4.88$[in2] $=$ **8205.13**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*36000$[lb/in2]$)^2 - 3*8205.13$[lb/in2]$^2))^{1/2} =$ **16208.85**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4 = 0.375$[in]$*13$[in]$^2/4 =$ **15.84**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 16208.85$[lb/in2]$*15.84$[in3] $=$ **21.4**[kip*ft]						p. 10-103
Beam						
Bolt bearing under shear load	[Kip]	61.53	40.00	DL	0.65	p. 7-18, Sec. J3.10
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.35$[in]$ - 0.813$[in]$/2) =$ **2.94**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 0.813$[in]$) =$ **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(4.21/(2*4))*(\min(1.2*2.94$[in]$, 2.4*0.75$[in]$) + \min(1.2*2.19$[in]$, 2.4*0.75$[in]$)*(4 - 1))*0.25$[in]$*65000$[lb/in2]$*2 =$ **61.53**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	78.50	40.00	DL	0.51	Eq. J4-3
$A_g = L_p*t_p = 15.7$[in]$*0.25$[in] $=$ **3.93**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*3.93$[in2] $=$ **78.5**[kip]						Eq. J4-3
Support						
Welds rupture	[Kip/ft]	248.04	36.92	DL	0.15	p. 9-5
$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.53$[in] $=$ **20.67**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L) = 40$[kip]$/(0.5*3.71$[kip/in]$*1*13$[in]$) =$ **1.66**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.66/16$ [in] $=$ **3.08**[kip/in]						p. 9-5

Global critical strength ratio **0.90**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor

k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
λ: Slenderness
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling
$(1/\Omega)M_n$: Design or allowable strength
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
V: Shear load
w_{min}: Minimum weld size required
Z: Plastic modulus
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 5:40 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\NS Nonstandard Connection\NS.cnx\

Steel connections

Results

Connection name : SP_BG
Connection ID : NS-01b

Family: Beam - Girder (BG)
Type: Single plate
Description: W14X22

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	14.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.00	6.11	11.71	✔	p. 10-104
$L_{min} = T/2 = 12.23[in]/2 = \mathbf{6.12}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 13.7[in] - \max(0.735[in], 1.25[in]) - \max(0.735[in], 0[in]) = \mathbf{11.72}[in]$						p. 10-49
Thickness	[in]	0.38	--	0.44	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 0.75[in]/2 + 1/16\ [in] = \mathbf{0.438}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	5.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75[in] = \mathbf{2}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.23[in], 12\ [in]) = \mathbf{5.52}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.60	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	3.00	1.50	--	✔	p. 10-102
$L_{emin} = 2*d = 2*0.75[in] = \mathbf{1.5}[in]$						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375[in] = \mathbf{0.0195}$						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	31.82	14.00	DL	0.44	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3*10.61[kip]*1 = **31.82**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	53.42	14.00	DL	0.26	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.375[in]*58000[lb/in2]*1 = **53.42**[kip]						Eq. J3-6
Shear yielding	[Kip]	48.60	14.00	DL	0.29	Eq. J4-3
$A_g = L_p*t_p$ = 9[in]*0.375[in] = **3.38**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*3.38[in2] = **48.6**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.60	14.00	DL	0.34	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 9[in] - 3*0.875[in] = **6.38**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 6.38[in]*0.375[in] = **2.39**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*58000[lb/in2]*2.39[in2] = **41.6**[kip]						Eq. J4-4
Block shear	[Kip]	41.93	14.00	DL	0.33	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.5[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.375[in] = **0.398**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (3 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.375[in] = **1.99**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*58000[lb/in2]*1.99[in2] + 1*58000[lb/in2]*0.398[in2], 0.6*36000[lb/in2]*2.81[in2] + 1*58000[lb/in2]*0.398[in2]) = **41.93**[kip]						Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	66.82	14.00	DL	0.21	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*4*9[in] = **66.82**[kip]						Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	40.37	14.00	DL	0.35	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.6[in] - 0.813[in]/2) = **2.19**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*2.19[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(3 - 1))* 0.23[in]*65000[lb/in2]*1 = **40.37**[kip]						Eq. J3-6
Shear yielding	[Kip]	57.27	14.00	DL	0.24	Eq. J4-3
$A_g = L_p*t_p$ = 12.45[in]*0.23[in] = **2.86**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*2.86[in2] = **57.27**[kip]						Eq. J4-3
Shear rupture	[Kip]	44.07	14.00	DL	0.32	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 12.45[in] - 3*0.875[in] = **9.83**[in]						DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 9.83$[in]$*0.23$[in]$ =$ **2.26**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*2.26$[in2]$ =$ **44.07**[kip] Eq. J4-4

Flexural yielding	[Kip]	41.10	14.00	DL	0.34	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_y*S_{net}/e = 0.599*50000$[lb/in2]$*8.92$[in3]$/6.5$[in]$ =$ **41.1**[kip] p. 9-6

Local web buckling	[Kip]	41.10	14.00	DL	0.34	p. 9-7

$h_o = d - d_c = 13.7$[in]$ - 1.25$[in]$ =$ **12.45**[in] p. 9-7

$IsTopFlangeBeamCoped$ = (c<=2*d) and (d_c<=d/2) = (6[in]<=2*13.7[in]) and (1.25[in]<=13.7[in]/2) = **True** p. 9-7

c/d<=1 → 6[in]/13.7[in]<=1 → **True**

$f = 2*c/d = 2*6$[in]$/13.7$[in]$ =$ **0.876** p. 9-7

c/h_o<=1 → 6[in]/12.45[in]<=1 → **True**

$k = 2.2*(h_o/c)^{1.65} = 2.2*(12.45$[in]$/6$[in]$)^{1.65} =$ **7.34** p. 9-7

$F_{cr} = \pi^2*E/(12*(1 - \nu^2))*(t_w/h_o)^2*f*k = \pi^2*2.90E+07$[lb/in2]$/(12*(1 - 0.3^2))*$
$(0.23$[in]$/12.45$[in]$)^2*0.876*7.34 =$ **57485.1**[lb/in2] p. 9-7

$(1/\Omega)R_n = (1/\Omega)*\min(F_y, F_{cr})*S_{net}/e = 0.599*\min(50000$[lb/in2], 57485.1[lb/in2]$)*8.92$[in3]$/$
6.5[in]$ =$ **41.1**[kip] p. 9-7

Block shear	[Kip]	47.21	14.00	DL	0.30	Eq. J4-5

$dh_h = d_h + 1/16$ [in]$ = 1$[in]$ + 1/16$ [in]$ =$ **1.06**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in]$ = 0.813$[in]$ + 1/16$ [in]$ =$ **0.875**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (3$[in]$ + (1 - 1)*5.5$[in]$ - (1 - 0.5)*$
1.06[in]$)*0.23$[in]$ =$ **0.568**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (2.6$[in]$ + (3 - 1)*3$[in]$)*0.23$[in]$ =$ **1.98**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (2.6$[in]$ + (3 - 1)*(3$[in]$ - 0.875$[in]$) -$
0.875[in]$/2)*0.23$[in]$ =$ **1.47**[in2] Sec. J4-3

$IsStressUniform$ → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*1.47$[in2]$ + 1*65000$[lb/in2]$*0.568$[in2]$, 0.6*50000$[lb/in2]$*1.98$[in2]$ + 1*65000$[lb/in2]$*0.568$[in2]$) =$ **47.21**[kip] Eq. J4-5

Flexural rupture	[Kip]	44.61	14.00	DL	0.31	p. 9-6

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*8.92$[in3]$/6.5$[in]$ =$ **44.61**[kip] p. 9-6

Support

Welds rupture	[Kip/ft]	117.00	18.67	DL	0.16	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.25$[in]$ =$ **9.75**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 14$[kip]$/(0.5*3.71$[kip/in]$*1*9$[in]$) =$ **0.838** tables 8-4..11

$HasWeldsOnBothSides$ → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in]$ = 0.6*70000$[lb/in2]$*(2)^{1/2}/2*0.838/16$ [in]$ =$ **1.56**[kip/in] p. 9-5

Global critical strength ratio **0.44**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
$(1/\Omega)R_n$: Available shear strength per bolt
$BoltFactor$: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{ct}: Top cope depth
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
E: Elastic modulus
f: Plate buckling model adjustment factor
F_{cr}: Critical stress, flexural stress buckling
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
IsTopFlangeBeamCoped: Is the top beam flange coped
k: Plate buckling coefficient
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
L: Length of weld
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
ν: Poisson's ratio
P: Required axial force
$(1/\Omega)$: Design factors
$(1/\Omega)R_n$: Design or allowable strength
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
S_{net}: Net section modulus
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
U_{bs}: Stress index
w_{min}: Minimum weld size required
Z_{net}: Net plastic section modulus

Current Date: 2016-05-26 1:13 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\NS Nonstandard Connection\L3 NS.cnx\

Steel connections

Results

Connection name : **DA_BG_**
Connection ID : **NS-02**

Family: Beam - Girder (BG)
Type: Angle(s)
Description: W36X282

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	70.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	18.00	16.03	19.10	✔	p. 10-8
$L_{min} = T/2 = 32.06$[in]$/2 =$ **16.03**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 37.1[in] - max(2.52[in], 3[in]) - max(2.52[in], 15[in]) = **19.1**[in]						p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*0.75$[in] $=$ **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} =$ min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Thickness	[in]	0.31	--	0.63	✔	p. 10-9
$t_{pmax} = 5/8$ [in]						p. 10-9
Angle (Support side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0$[in] $=$ **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.13	1.13	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1$[in] $+ 0.125$[in] $=$ **1.13**[in]						Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*0.75[in] = **2**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5
Beam						
Top cope length	[in]	3.50	--	74.20	✔	
c_{max} = 2*d = 2*37.1[in] = **74.2**[in]						
Bottom cope length	[in]	3.50	--	74.20	✔	
c_{max} = 2*d = 2*37.1[in] = **74.2**[in]						
Top cope depth	[in]	3.00	--	3.00	✔	
d_{ctmax} = min(d/2, d_{top} - w) = min(37.1[in]/2, 3[in] - 0[in]) = **3**[in]						
Bottom cope depth	[in]	15.00	--	16.10	✔	
d_{cbmax} = min(d/2, d - L - d_{top} - w) = min(37.1[in]/2, 37.1[in] - 18[in] - 3[in] - 0[in]) = **16.1**[in]						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	1.00	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1[in] + 0[in] = **1**[in]						Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	127.30	70.00	DL	0.55	Tables (7-1..14)
(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip]						Eq. J3-1
(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (6*10.61[kip]) = **127.3**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	186.91	70.00	DL	0.37	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in]						Sec. J4.10
(1/Ω)R_n = 2 * (*(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])* (6 - 1))*0.313[in]*58000[lb/in2]*1) = **186.91**[kip]						Eq. J3-6
Shear yielding	[Kip]	162.00	70.00	DL	0.43	Eq. J4-3
A_g = L_p*t_p = 18[in]*0.313[in] = **5.63**[in2]						Sec. D3-1
(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.63[in2]) = **162**[kip]						Eq. J4-3
Shear rupture	[Kip]	138.66	70.00	DL	0.50	Eq. J4-4
L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
L_e = L - n*L_h = 18[in] - 6*0.875[in] = **12.75**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 12.75[in]*0.313[in] = **3.98**[in2]						Sec. J4-2
(1/Ω)R_n = 2 * (*(1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.98[in2]) = **138.66**[kip]						Eq. J4-4
Block shear	[Kip]	126.10	70.00	DL	0.56	Eq. J4-5
dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)* 0.875[in])*0.313[in] = **0.254**[in2]						Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.313[in] = **5.16**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **3.65**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((*1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.65[in2] + 1*58000[lb/in2]*0.254[in2], 0.6*36000[lb/in2]*5.16[in2] + 1*58000[lb/in2]*0.254[in2])) = **126.1**[kip] Eq. J4-5

Angle (Support side)

Bolts shear	[Kip]	127.30	70.00	DL	0.55	Tables (7-1..14)

(1/Ω)R_n = *(1/Ω)*F_{nv}*A_b = 0.5*48000[lb/in2]*0.442[in2] = **10.61**[kip] Eq. J3-1

(1/Ω)R_n = 2 * (*C*(1/Ω)*R_n) = 2 * (6*10.61[kip]) = **127.3**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	186.91	70.00	DL	0.37	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

(1/Ω)R_n = 2 * ((*1/Ω)*(*C*/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(6/(1*6))*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*0.313[in]*58000[lb/in2]*1) = **186.91**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	162.00	70.00	DL	0.43	Eq. J4-3

A_g = L_p*t_p = 18[in]*0.313[in] = **5.63**[in2] Sec. D3-1

(1/Ω)R_n = 2 * ((*1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*5.63[in2]) = **162**[kip] Eq. J4-3

Shear rupture	[Kip]	138.66	70.00	DL	0.50	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 18[in] - 6*0.875[in] = **12.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 12.75[in]*0.313[in] = **3.98**[in2] Sec. J4-2

(1/Ω)R_n = 2 * ((*1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*3.98[in2]) = **138.66**[kip] Eq. J4-4

Block shear	[Kip]	122.14	70.00	DL	0.57	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1[in] + 1/16 [in] = **1.06**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.13[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.06[in])*0.313[in] = **0.186**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.313[in] = **5.16**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.313[in] = **3.65**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((*1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.65[in2] + 1*58000[lb/in2]*0.186[in2], 0.6*36000[lb/in2]*5.16[in2] + 1*58000[lb/in2]*0.186[in2])) = **122.14**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	22.59	0.00	DL	0.00	p. 9-10

f_v = F/(A_b*N_{bolts}) = 70[kip]/(0.442[in2]*12) = **13197.59**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/(*(1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*13197.59[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **67509.05**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*67509.05[lb/in2]*0.442[in2] = **14.92**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 70[kip]/(0.442[in2]*12) = **13197.59**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/(*(1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*90000[lb/in2] - 90000[lb/in2]*13197.59[lb/in2]/(0.5*48000[lb/in2]), 0.0), 90000[lb/in2]) = **67509.05**[lb/in2] Eq. J3-3

(1/Ω)R_n = *(1/Ω)*F'_{nt}*A_b = 0.5*67509.05[lb/in2]*0.442[in2] = **14.92**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.13[in] + 0.75[in]/2, 1.25*2.72[in] + 0.75[in]/2) = **1.5**[in] p. 9-12

b' = b - d/2 = 2.72[in] - 0.75[in]/2 = **2.34**[in] p. 9-12

ρ = b'/a' = 2.34[in]/1.5[in] = **1.56** p. 9-12

δ = 1 - d'/p = 1 - 0.813[in]/3[in] = **0.729** p. 9-11

t_c = ((3.33*B*b')/(*(1/Ω)*p*F_u))$^{0.5}$ = ((3.33*14.92[kip]*2.34[in])/(0.5*3[in]*58000[lb/

in2]))$^{0.5}$ = **1.16**[in] p. 9-12

α' = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.729*(1 + 1.56)))*((1.16[in]/0.313[in])^2 - 1) = **6.8** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.16[in])^2*(1 + 0.729) = **0.126** p. 9-13

T_{avail} = 12 * (B*Q) = 12 * (14.92[kip]*0.126) = **22.59**[kip] p. 9-10

Beam

Bolt bearing under shear load	[Kip]	296.61	70.00	DL	0.24	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 0.813[in]/2) = **1.09**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.09[in], 2.4*0.75[in]) + min(1.2*2.19[in], 2.4*0.75[in])*(6 - 1))*0.885[in]*65000[lb/in2]*1 = **296.61**[kip] Eq. J3-6

Shear yielding	[Kip]	338.07	70.00	DL	0.21	Eq. J4-3

A_g = L_p*t_p = 19.1[in]*0.885[in] = **16.9**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*16.9[in2] = **338.07**[kip] Eq. J4-3

Shear rupture	[Kip]	239.02	70.00	DL	0.29	Eq. J4-4

L_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

L_e = L - n*L_h = 19.1[in] - 6*0.875[in] = **13.85**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 13.85[in]*0.885[in] = **12.26**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*12.26[in2] = **239.02**[kip] Eq. J4-4

Block shear	[Kip]	253.83	70.00	DL	0.28	Eq. J4-5

dh_h = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 0.813[in] + 1/16 [in] = **0.875**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.25[in] + (1 - 1)*5.5[in] - (1 - 0.5)*0.875[in])*0.885[in] = **1.6**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.885[in] = **14.6**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 0.875[in]) - 0.875[in]/2)*0.885[in] = **10.34**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*10.34[in2] + 1*65000[lb/in2]*1.6[in2], 0.6*50000[lb/in2]*14.6[in2] + 1*65000[lb/in2]*1.6[in2]) = **253.83**[kip] Eq. J4-5

Flexural yielding	[Kip]	402.77	70.00	DL	0.17	p. 9-6

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*S_{net}/e = 0.599*50000[lb/in2]*53.81[in3]/4[in] = **402.77**[kip] p. 9-6

Flexural rupture	[Kip]	437.20	70.00	DL	0.16	p. 9-6

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*Z_{net}/e = 0.5*65000[lb/in2]*53.81[in3]/4[in] = **437.2**[kip] p. 9-6

Local web buckling	[Kip]	402.77	70.00	DL	0.17	p. 9-8, p. 9-7

h_o = d - d_c = 37.1[in] - 18[in] = **19.1**[in] p. 9-7

IsBeamCopedAtBothFlanges = (c_t<=2*d) and (d_{ct}<=0.2*d) and (c_b<=2*d) and (d_{cb}<=0.2*d) = (3.5[in]<=2*37.1[in]) and (3[in]<=0.2*37.1[in]) and (3.5[in]<=2*37.1[in]) and (15[in]<=0.2*37.1[in]) = **False** p. 9-8

λ = h_o*(F_y/(1 [ksi]))$^{1/2}$/(10*t_w*(475 + 280*(h_o/c)^2)$^{1/2}$) = 19.1[in]*(50000[lb/in2]/(1 [ksi]))$^{1/2}$/(10*0.885[in]*(475 + 280*(19.1[in]/3.5[in])^2)$^{1/2}$) = **0.163** p. 9-9

λ*Limit* = λ<=0.7 = 0.163<=0.7 = **True** p. 9-9

Q = 1 p. 9-9

F_{cr} = F_y*Q = 50000[lb/in2]*1 = **50000**[lb/in2] p. 9-8

$(1/\Omega)R_n$ = $(1/\Omega)$*min(F_y, F_{cr})*S_{net}/e = 0.599*min(50000[lb/in2], 50000[lb/in2])*53.81[in3]/4[in] = **402.77**[kip] p. 9-7

Support

Bolt bearing under shear load	[Kip]	301.86	70.00	DL	0.23	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 0.813[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 0.813[in]) = **2.19**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31\text{[in]}, 2.4*0.75\text{[in]}) + \min(1.2*2.19\text{[in]}, 2.4*$
$0.75\text{[in]})*(6 - 1))*0.43\text{[in]}*65000\text{[lb/in2]}*1) = \mathbf{301.86}\text{[kip]}$ Eq. J3-6

Global critical strength ratio **0.57**

NOTATION

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
a': Distance for prying action
α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength
B: Available tensile strength per bolt
B: Available strength of all bolts
b': Distance for prying action
b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.
C: Bolt group coefficient
c: Coped length
C_2: Edge distance increment
c_b: Bottom cope length
c_t: Top cope length
c_{max}: Maximum coped length
d: Nominal bolt diameter
d_c: Coped depth
d_{cb}: Bottom cope depth
d_{cbmax}: Maximum bottom coped depth
d_{ct}: Top cope depth
d_{ctmax}: Maximum top coped depth
d_h: Nominal hole dimension
d_{top}: Beam top edge distance
d': Width of the hole along the length of the fitting
δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle
d: Beam depth
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
e: Load eccentricity
F: Required shear force for combined tension and shear
F_{cr}: Critical stress, flexural stress buckling
F_{nt}: Nominal tensile stress
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
F'_{nt}: Nominal tensile stress modified to include the effects of shear stress
h_o: Reduced beam depth
IsBeamCopedAtBothFlanges: Is beam coped at both flanges
IsCorrosionConsidered: Is corrosion considered
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
k: Outside corner radius
L: Length
L: Angle length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_{max}: Maximum length
L_{min}: Minimum length
L_p: Plate length
λ: Slenderness
$\lambda Limit$: Slenderness limit
e_{dmin}: Minimum edge distance
n: Bolts rows number
N_{bolts}: Number of bolts
n_c: Number of bolt columns

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q: Prying action coefficient

Q: Slenderness factor

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

S_{net}: Net section modulus

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

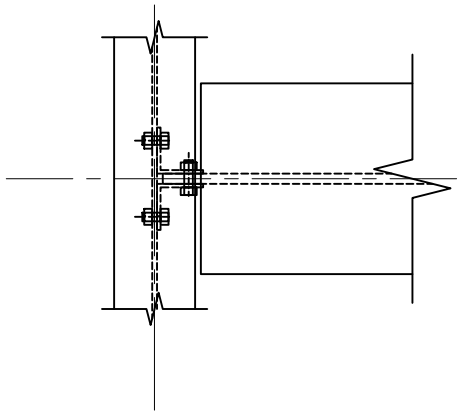
t_w: Web thickness

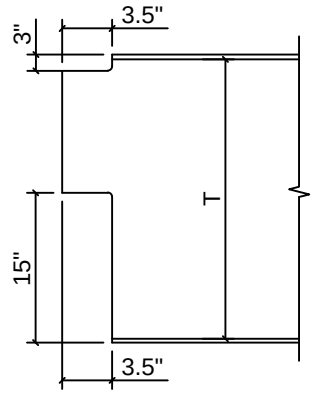
U_{bs}: Stress index

w: Weld size

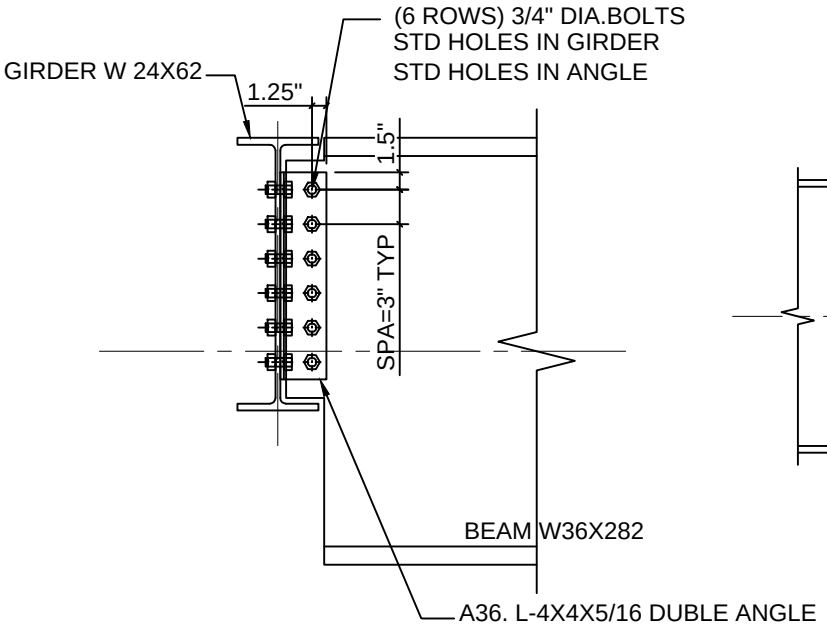
Z_{net}: Net plastic section modulus

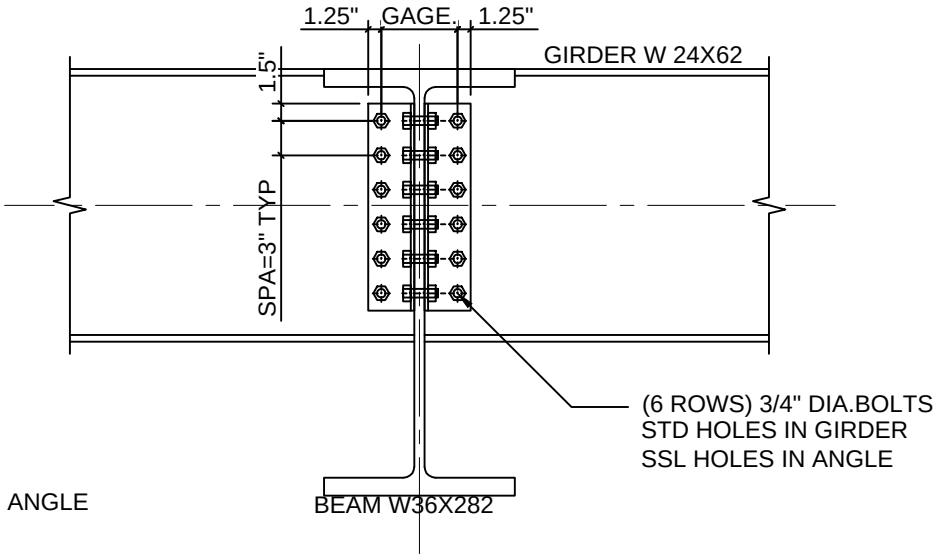
NS-02 Beam To Girder Connection Location Floor 2(Axis 1-C)



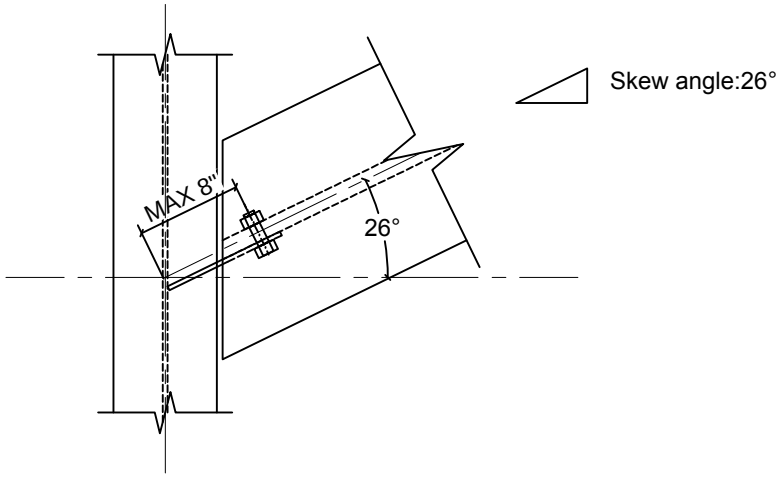


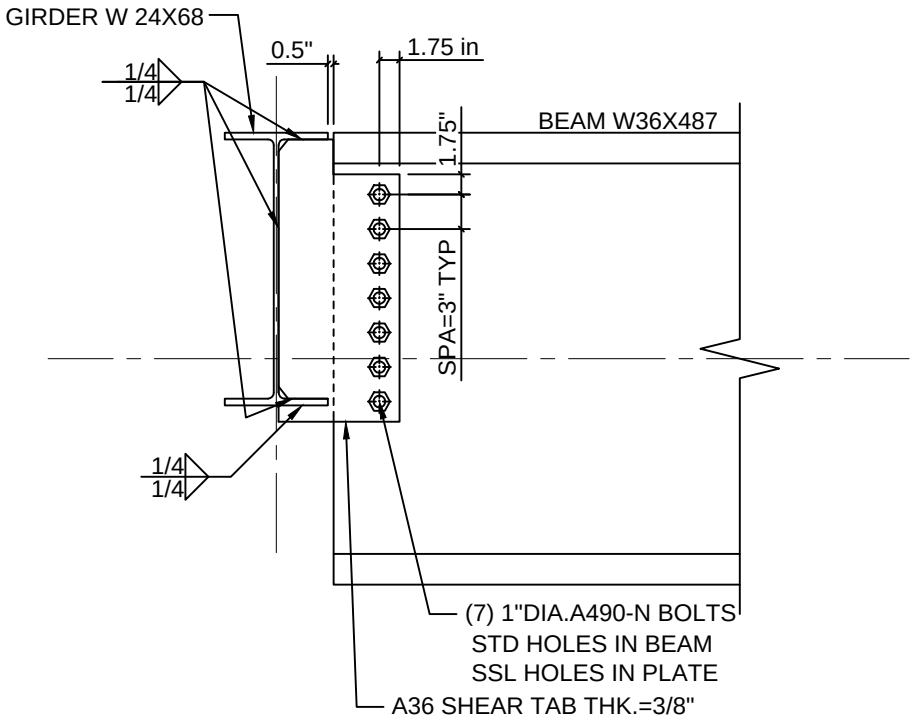
MAX. T&B COPE VALUES



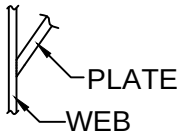


NS-03 Beam To Girder Connection Location Floor 2(Axis 1-A2)





IF 30°≤β≤45°
THE PLATE EDGES
BEVELED



β°	w1	w2
β≤30°	1/4	1/2
β≤45°	1/4	5/16

Current Date: 2016-05-25 5:43 PM
Units system: English
File name: U:\Webster Connection Design Folder\Reports and Calculations\NS Nonstandard Connection\L3 NS.cnx\

Steel connections

Results

Connection name : SP_BG_
Connection ID : NS-03

Family: Beam - Girder (BG)
Type: Single plate
Description: W36X487

Design code: AISC 360-05 ASD

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	65.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Plate (beam side)						
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in], 12 [in]$) =$ **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	5.38	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.70	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75$[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Plate (beam side)

Bolts shear	[Kip]	82.41	65.00	DL	0.79	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$(1/\Omega)R_n = (1/\Omega)*F_{nv}*A_b$ = 0.5*60000[lb/in2]*0.785[in2] = **23.55**[kip]						Eq. J3-1
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 3.5*23.55[kip]*1 = **82.41**[kip]						Tables (7-1..14)
Flexure with the Von-Mises shear reduction	[Kip*ft]	95.64	47.45	DL	0.50	p. 10-103
$A_g = L_p*t_p$ = 21.5[in]*0.375[in] = **8.06**[in2]						Sec. D3-1
$f_v = V/A_g$ = 65[kip]/8.06[in2] = **8062.02**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr}$ = (max(0, $((1/\Omega)*F_y)^2$ - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*8062.02[lb/in2]^2))$^{1/2}$ = **26484.38**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.375[in]*21.5[in]^2/4 = **43.34**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 26484.38[lb/in2]*43.34[in3] = **95.64**[kip*ft]						p. 10-103
Bolt bearing under shear load	[Kip]	93.91	65.00	DL	0.69	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(3.5/(1*7))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(7 - 1))*0.375[in]*65000[lb/in2]*1 = **93.91**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	161.25	65.00	DL	0.40	Eq. J4-3
$A_g = L_p*t_p$ = 21.5[in]*0.375[in] = **8.06**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*8.06[in2] = **161.25**[kip]						Eq. J4-3
Shear rupture	[Kip]	99.63	65.00	DL	0.65	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 21.5[in] - 7*1.13[in] = **13.63**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 13.63[in]*0.375[in] = **5.11**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*5.11[in2] = **99.63**[kip]						Eq. J4-4
Block shear	[Kip]	105.42	65.00	DL	0.62	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.75[in] + (1 - 1)*5.5[in] - (1 - 0.5)*1.13[in])*0.375[in] = **0.445**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (7 - 1)*3[in])*0.375[in] = **7.41**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (7 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.375[in] = **4.66**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*4.66[in2] + 1*65000[lb/in2]*0.445[in2], 0.6*50000[lb/in2]*7.41[in2] + 1*65000[lb/in2]*0.445[in2]) = **105.42**[kip]						Eq. J4-5
Flexural rupture	[Kip]	111.91	65.00	DL	0.58	p. 9-6
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.375[in]/4*(21.5[in]^2 - 3[in]^2*7*(7^2 - 1)*1.13[in]/21.5[in]) = **28.5**[in3]						4
$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*28.5[in3]/8.28[in] = **111.91**[kip]						p. 9-6

Plate (support side)

Weld capacity	[Kip]	167.28	65.00	DL	0.39	Tables 8-4 .. 8-11
e = 0						p. 10-135
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*4*22.53[in]) = **167.28**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	398.48	65.00	DL	0.16	p. 7-18,

Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 5.38[in] - 1.06[in]/2) = **4.85**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*
(n - 1))*t_p*F_u*n_c = 0.5*(3.5/(1*7))*(min(1.2*4.85[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*
1[in])*(7 - 1))*1.5[in]*65000[lb/in2]*1 = **398.48**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	1179.00	65.00	DL	0.06	Eq. J4-3

A_g = L_p*t_p = 39.3[in]*1.5[in] = **58.95**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*58.95[in2] = **1179**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	194.22	34.62	DL	0.18	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.415[in] = **16.19**[kip/in] p. 9-5

e = 0 p. 10-135

D_{min} = P/(*(1/Ω)*C*C_1*L) = 32.5[kip]/(0.5*1.86[kip/in]*1*22.53[in]) = **1.55** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*(2)$^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*1.55/16 [in] = **2.89**[kip/in] p. 9-5

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area
A_g: Gross area
A_{gv}: Gross area subject to shear
A_{nt}: Net area subject to tension
A_{nv}: Net area subjected to shear
(1/Ω)R_n: Available shear strength per bolt
BoltFactor: Bolt capacity factor
C: Bolt group coefficient
c: Coped length
C_1: Electrode strength coefficient
C_2: Edge distance increment
C: Weld group coefficient
d: Nominal bolt diameter
d_h: Nominal hole dimension
dh_h: Horizontal hole dimension
dh_v: Vertical hole dimension
D: Number of sixteenths of an inch in the weld size
D_{min}: Number of sixteenths of an inch in the minimum weld size
e: Load eccentricity
F_{EXX}: Electrode classification number
F_{nv}: Nominal shear stress
F_u: Specified minimum tensile strength
f_v: Required shear stress
F_y: Specified minimum yield stress
h_o: Reduced beam depth
HasWeldsOnBothSides: Has welds on both sides
IsCorrosionConsidered: Is corrosion considered
IsStandardHole: Is standard hole (STD)
IsStressUniform: Is the stress uniform
k_1: Bearing factor
k_2: Bearing factor
L: Length
$L_{c\text{-}end}$: Clear distance
L_e: Effective length
L_e: Edge distance
L_{eh}: Horizontal edge distance
L_{emin}: Minimum edge distance
L_{ev}: Vertical edge distance
L_h: Hole dimension for tension and shear net area
L_p: Plate length
L: Length of weld
λ: Slenderness
e_{dmin}: Minimum edge distance
n: Bolts rows number
n_c: Number of bolt columns
P: Required axial force
(1/Ω): Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

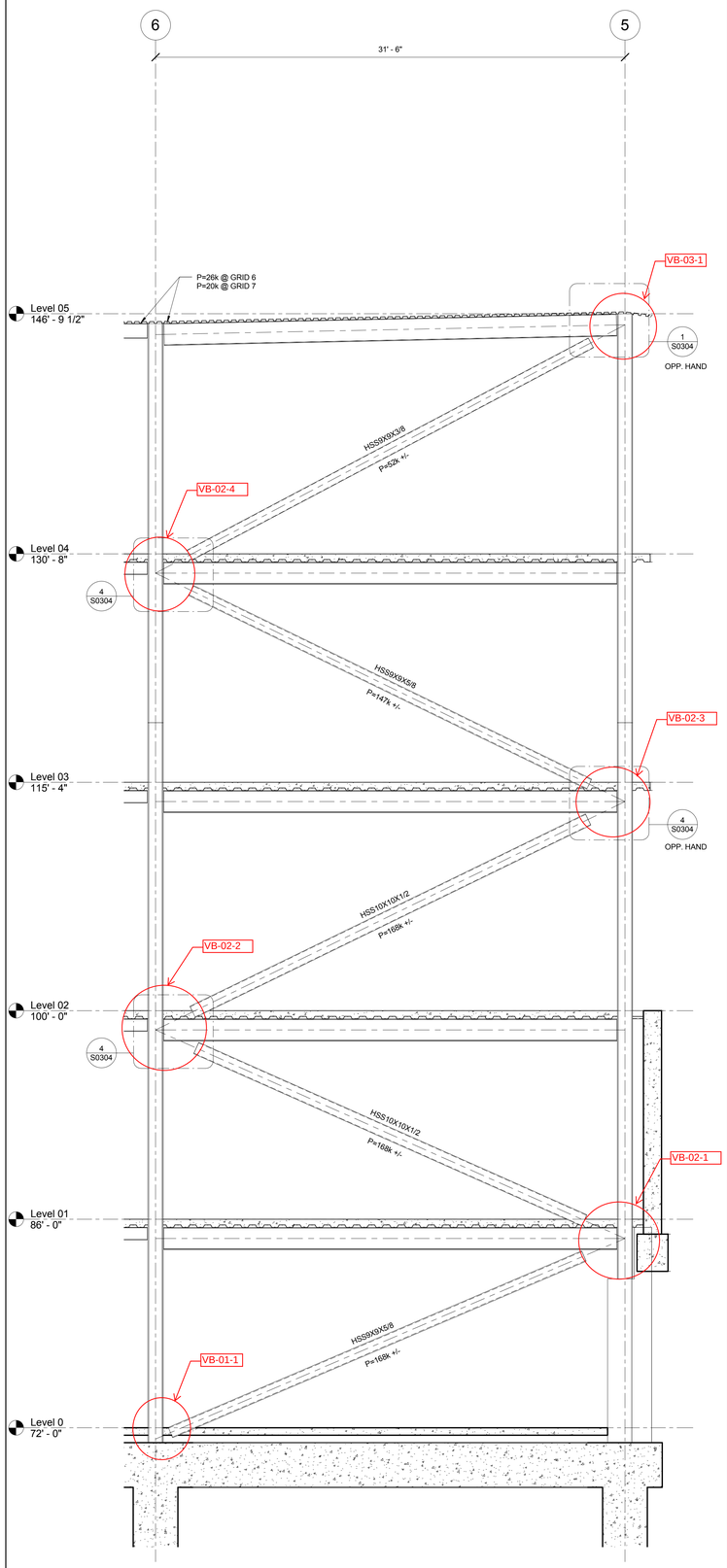
$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

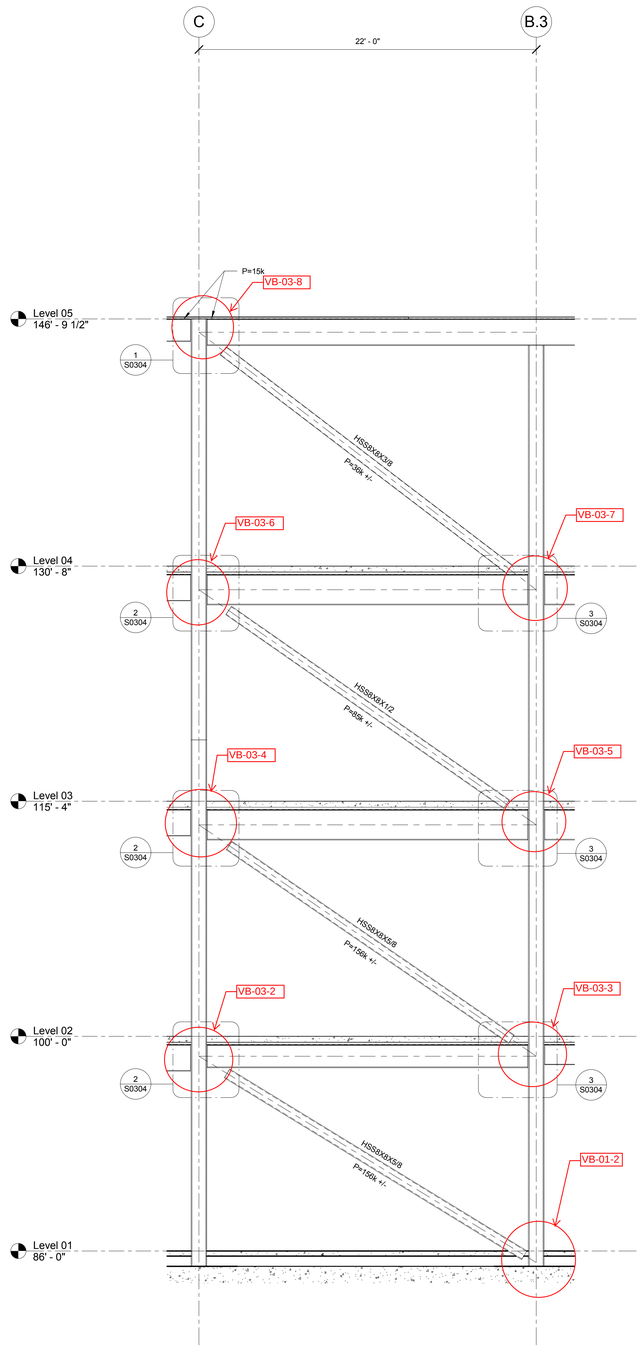
R_n: Nominal strength
R_u: Required strength
s_{max}: Maximum spacing
s_{min}: Minimum spacing
spa: Transversal spacing between bolts or welds
s: Longitudinal bolt spacing
$L_{c\text{-}spa}$: Distance between adjacent holes edges
t_p: Thickness of the connected material
t_p: Plate thickness
t_w: Web thickness
U_{bs}: Stress index
V: Shear load
w_{min}: Minimum weld size required
Z: Plastic modulus
Z_{net}: Net plastic section modulus
Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98



1 BRACED FRAME ELEVATION - BF-1
1/4" = 1'-0"



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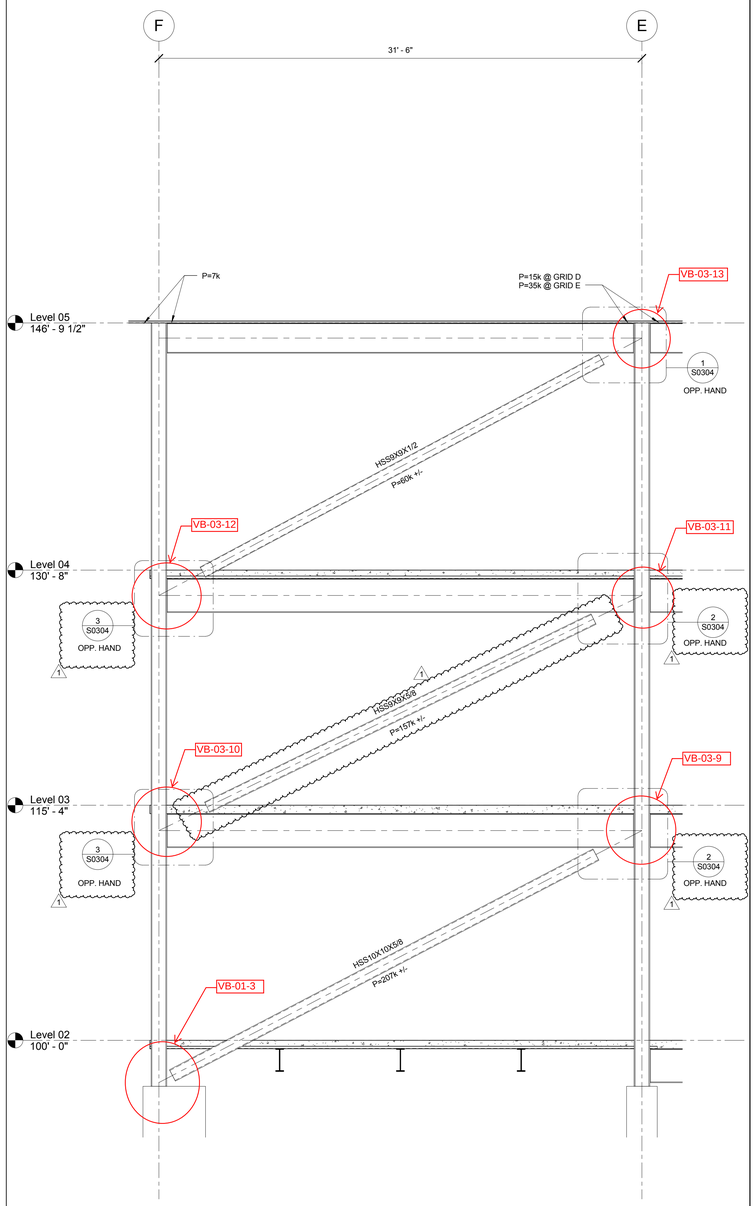

3 BRACED FRAME ELEVATION - BF-3
1/4" = 1'-0"

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No.	Description	Date
1	ADDENDUM 1-7	16 MAR 2016
-	ISSUED FOR CONSTRUCTION (BP1)	15 JAN 2016

Drawing Title:

BRACED FRAME ELEVATIONS

Project No.: 04561.01 Checked by:

S0400

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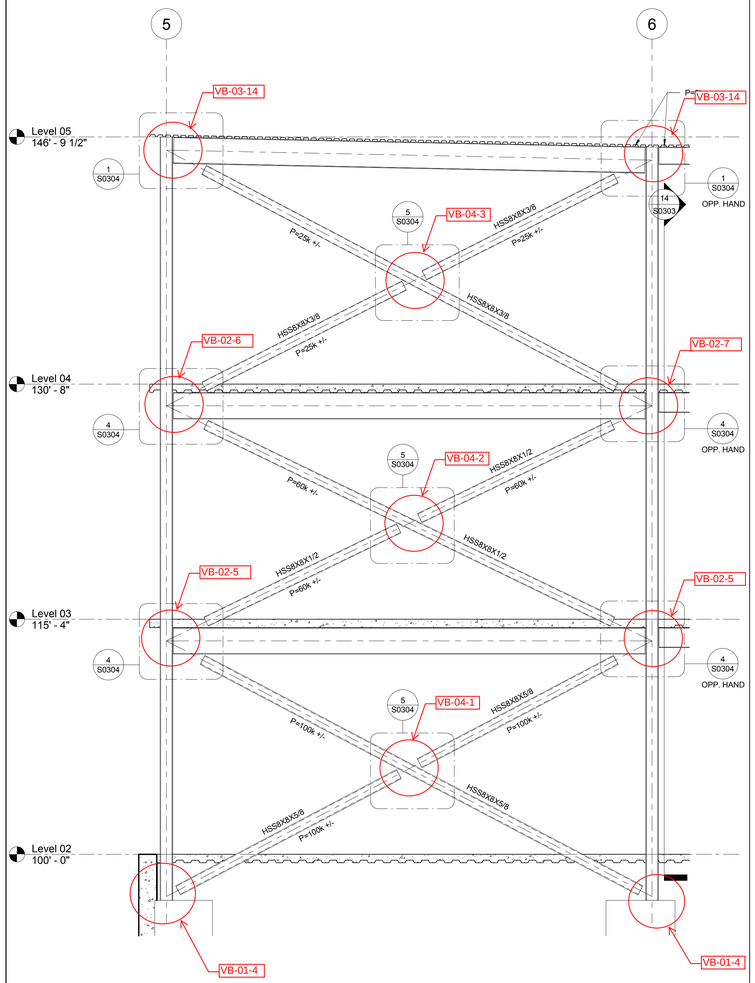

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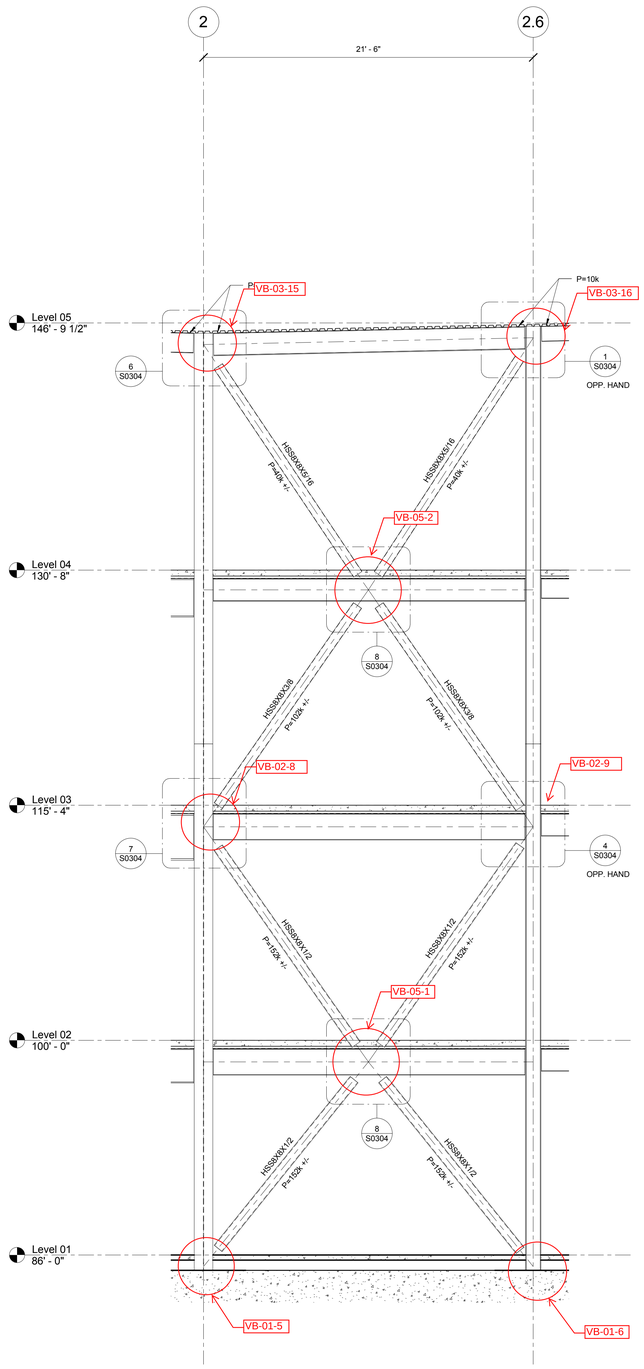

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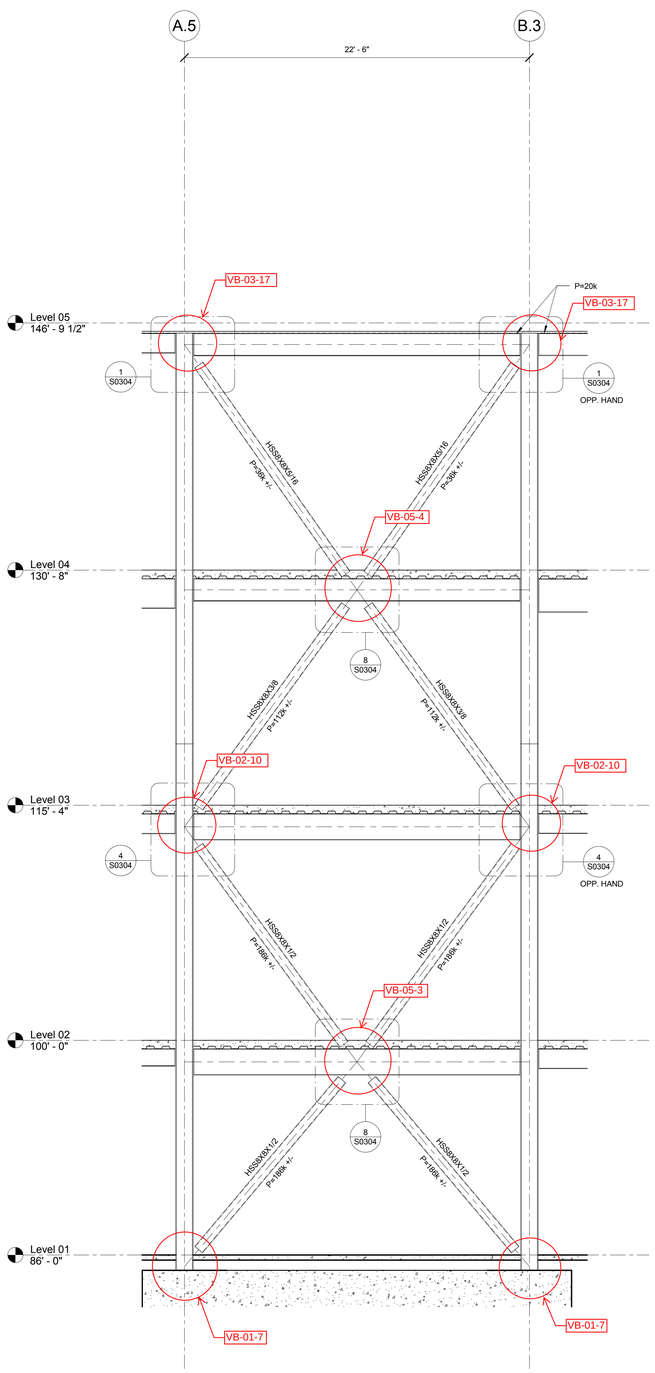

3 BRACED FRAME ELEVATION - BF-6
1/4" = 1'-0"

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No.	Description	Date
-	ISSUED FOR CONSTRUCTION (BP1)	15 JAN 2016

Drawing Title:

BRACED FRAME ELEVATIONS

Project No.: 04561.01 Checked by:

S0401

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VB-01 HSS Brace at Column Base Connection

Connection ID	Column Size	HSS Brace			Gusset Plate (A36) Thickness (inch) "tg"	Gusset Plate To Column Interface		Gusset Plate To Base Plate Interface		Gusset Plate To HSS Interface		
		HSS Size	Slope Angle "θ" (Deg)	Axial Loading (kips) "±A"		Weld Size (inch) "W_V"	Weld length (inch) "L_V"	Weld Size (inch) "W_H"	Weld Length (inch) "L_H"*	Weld Size (inch) "W"	Weld Length (inch) "L"*	Maximum Distance to Beam (inch) "L_p"
VB-01-1	W12x87 Flange	HSS9x9x5/8	23.6	±168	3/4"	5/16"	12.3"	5/16"	22.6"	5/16"	10"	11.7"
VB-01-2	W12x87 Flange	HSS8x8x5/8	32.0	±156	3/4"	5/16"	15.3"	5/16"	16.8"	5/16"	10"	6.1"
VB-01-3	W12x72 Flange	HSS10x10x5/8	27.8	±207	3/4"	5/16"	15.5"	5/16"	22.8	5/16"	12"	10"
VB-01-4	W10x49 Flange	HSS8x8x5/8	28.5	±100	3/4"	5/16"	13.1"	5/16"	19.7"	5/16"	10"	9.1"
VB-01-5	W14x90 Web	HSS8x8x1/2	51.4	±152	3/4"	5/16"	17"	5/16"	15.9"	5/16"	10"	7"
VB-01-6	W12x53 Flange	HSS8x8x1/2	51.4	±152	3/4"	5/16"	24.5"	5/16"	9.9"	5/16"	10"	8.9"
VB-01-7	W14x90 Flange	HSS8x8x1/2	50.2	±186	3/4"	5/16"	26.3"	5/16"	10.8"	5/16"	12"	8.7"

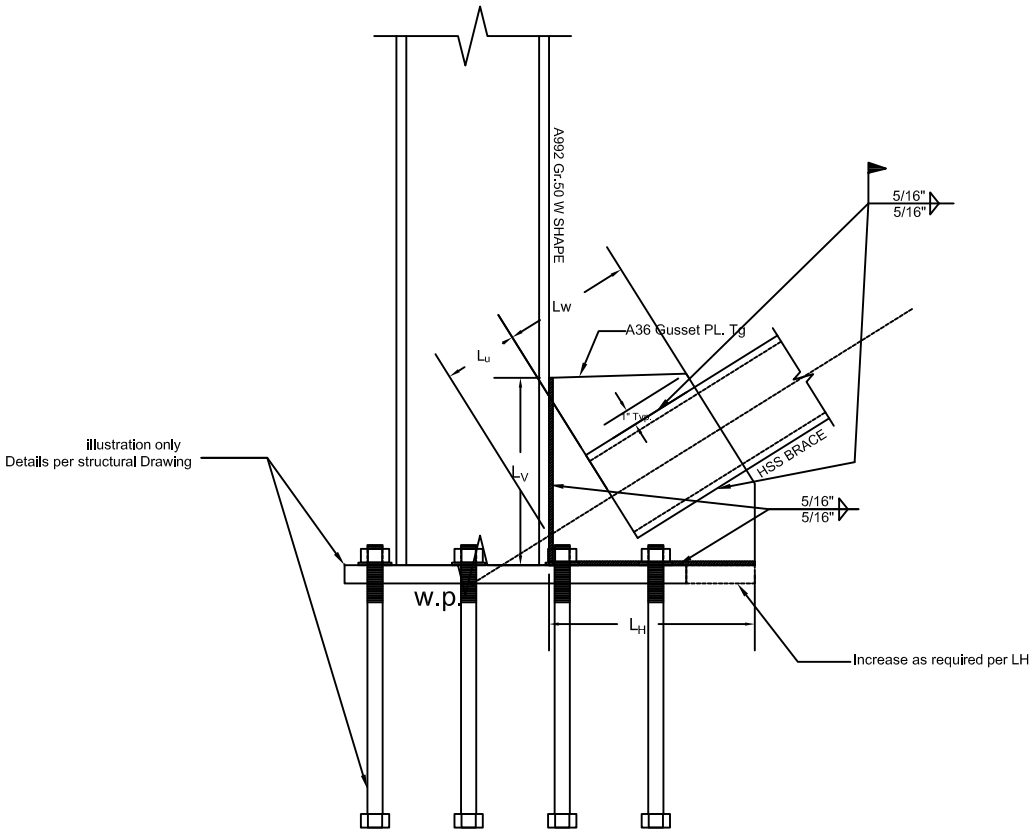
*stress relieve hole length not included

Base plate / Anchor rod size per S0503. No Calculation is performed.

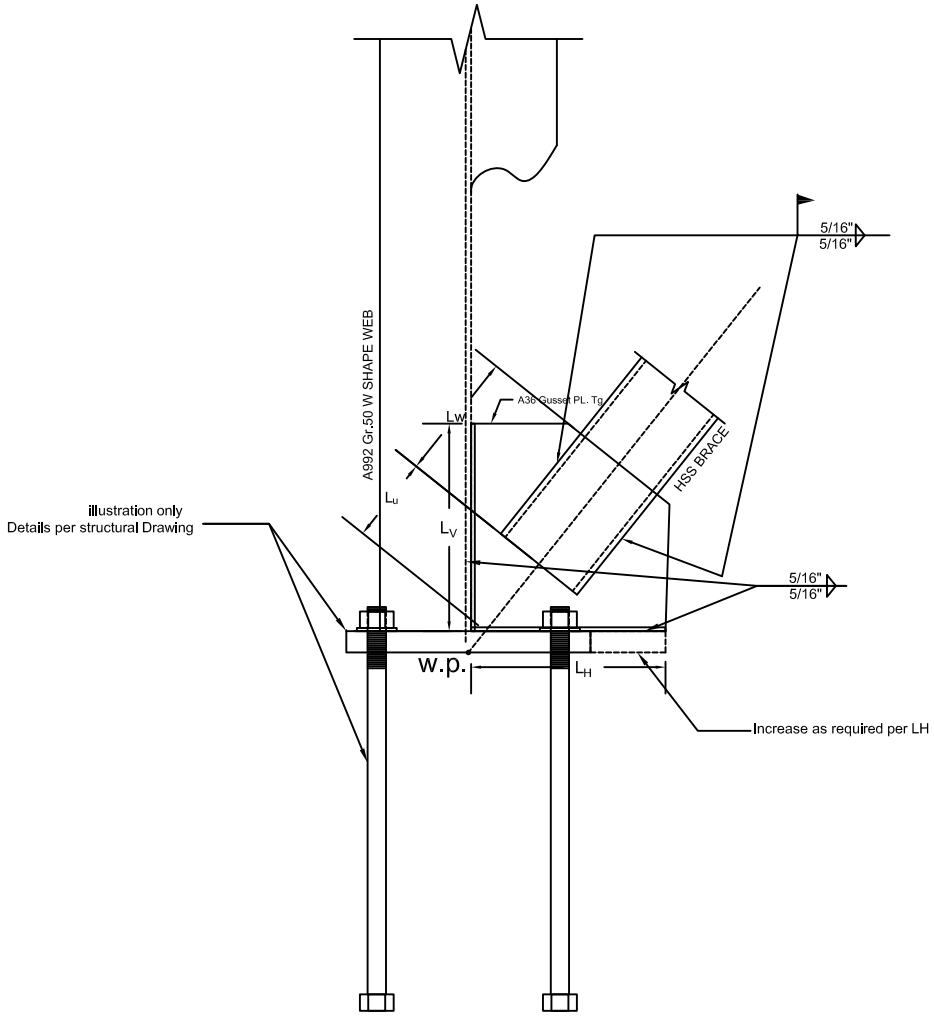
WP for Calculation/Detailing at bottom of Base Plate

VB-01

Vertical Brace at Column Base Plate



VB-01 Vertical Brace at Column Base Plate



Current Date: 2016-05-25 2:31 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : Gusset BP

Connection ID : VB-01-1

Family: Column - Base (CB)

Type: Gusset

Description: W12X87

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
168.00	DL	Design
-168.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	168.00	DL	0.91	Eq. J2-4, Eq. J2-6
F_w = 0.6*F_{EXX} = 0.6*70000[lb/in2] = **42000**[lb/in2]						Sec. J2.4
A_w = $(2)^{1/2}$/2*D/16 [in]*L = $(2)^{1/2}$/2*5/16 [in]*10[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*2.21[in2]) = **92.81**[kip]						Eq. J2-4
F_w = 0.6*F_{EXX} = 0.6*70000[lb/in2] = **42000**[lb/in2]						Sec. J2.4
A_w = $(2)^{1/2}$/2*D/16 [in]*L = $(2)^{1/2}$/2*5/16 [in]*10[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*2.21[in2]) = **92.81**[kip]						Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 92.81[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	404.38	168.00	DL	0.42	Eq. J4-4

$L_e = L_t + L_h$ = 10[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p$ = 20[in]*0.581[in] = **11.62**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*11.62[in2]) = **404.38**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	261.00	168.00	DL	0.64	Eq. J4-4

$L_e = L_t + L_h$ = 10[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p$ = 20[in]*0.75[in] = **15**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u$*$A_{nv}$ = 0.5*0.60*58000[lb/in2]*15[in2] = **261**[kip] Eq. J4-4

Block shear on gusset	[Kip]	365.85	168.00	DL	0.46	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10[in], 10[in])$ = **10**[in]

$L = L_{max} + d_w$ = 10[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p$ = 2*10.5[in]*0.75[in] = **15.75**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **15.75**[in2] Sec. J4.3

$A_{nt} = b*t_p$ = 9[in]*0.75[in] = **6.75**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*58000[lb/in2]*15.75[in2] + 1*58000[lb/in2]*6.75[in2], 0.6*36000[lb/in2]*15.75[in2] + 1*58000[lb/in2]*6.75[in2]) = **365.85**[kip] Eq. J4-5

Ratio **0.91**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	515.09	168.00	DL	0.33	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*18.7[in2] = **515.09**[kip] Eq. J4-1

Tension rupture	[Kip]	339.74	168.00	DL	0.49	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t$ = 18.7[in2] - 2*(0.75[in] + 1/8 [in])*0.581[in] = **17.68**[in2] Sec. D3.2

$U = 1 - x/l$ = 1 - 3.38[in]/10[in] = **0.663** Table D3.1

$A_e = A_n*U$ = 17.68[in2]*0.663 = **11.72**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*11.72[in2] = **339.74**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	240.53	168.00	DL	0.70	Eq. J4-1

$A_g = L_w*t_p$ = 14.88[in]*0.75[in] = **11.16**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*11.16[in2] = **240.53**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	298.46	168.00	DL1	0.56	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.07$[in]$/0.217$[in]$)^2 =$ **1.24E+06**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.24E+06$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$^{/1.24E+06}$[lb/in2]$^{)}*36000$[lb/in2] =

35564.13[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35564.13$[lb/in2]$*14.02$[in2] = **298.46**[kip] Eq. E3-1

Ratio **0.70**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\alpha = \alpha_{bar} =$ **11.35**[in] p. 13-10

$\beta = (\alpha + e_c)/tan\theta - e_b = (11.35$[in]$ + 6.25$[in]$)/2.29 - 1.5$[in]$ =$ **6.19**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((11.35$[in]$ + 6.25$[in]$)^2 + (6.19$[in]$ + 1.5$[in]$)^2)^{1/2} =$ **19.2**[in] p. 13-5

$H_b = \alpha*P/r = 11.35$[in]$*168$[kip]$/19.2$[in] = **99.27**[kip] p. 13-5

$H_c = e_c*P/r = 6.25$[in]$*168$[kip]$/19.2$[in] = **54.68**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*168$[kip]$/19.2$[in] $- 0$[kip] = **13.12**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 6.19$[in]$*168$[kip]$/19.2$[in] $+ 0$[kip] = **54.13**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(13.12$[kip]$*(11.35$[in]$ - 11.35$[in]$)) +$

$abs(0$[kip]$*11.35$[in]$) =$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(54.68$[kip]$*(6.19$[in]$ - 6.19$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\alpha = \alpha_{bar} =$ **11.35**[in] p. 13-10

$\beta = (\alpha + e_c)/tan\theta - e_b = (11.35$[in]$ + 6.25$[in]$)/2.29 - 1.5$[in]$ =$ **6.19**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((11.35$[in]$ + 6.25$[in]$)^2 + (6.19$[in]$ + 1.5$[in]$)^2)^{1/2} =$ **19.2**[in] p. 13-5

$H_b = \alpha*P/r = 11.35$[in]$*-168$[kip]$/19.2$[in] = **-99.27**[kip] p. 13-5

$H_c = e_c*P/r = 6.25$[in]$*-168$[kip]$/19.2$[in] = **-54.68**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*-168$[kip]$/19.2$[in] $- 0$[kip] = **-13.12**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 6.19$[in]$*-168$[kip]$/19.2$[in] $+ 0$[kip] = **-54.13**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-13.12$[kip]$*(11.35$[in]$ - 11.35$[in]$)) +$

$abs(0$[kip]$*11.35$[in]$) =$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-54.68$[kip]$*(6.19$[in]$ - 6.19$[in]$)) =$ **0**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**

	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	99.27	13.12	0.00	0.00	0.00	0.00	Design
DL1	-99.27	-13.12	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	366.85	13.12	DL	0.04	Eq. J4-1
$A_g = L_p*t_p$ = 22.69[in]*0.75[in] = **17.02**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*17.02[in2] = **366.85**[kip]						Eq. J4-1
Shear yielding	[Kip]	245.06	99.27	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 22.69[in]*0.75[in] = **17.02**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_y*A_g$ = 0.667*0.60*36000[lb/in2]*17.02[in2] = **245.06**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	111051.60	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 13.12[kip]/(0.75[in]*22.69[in]) = **771.19**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	839944.50	DL	0.41	J4-1
$(1/\Omega)F_n = (1/\Omega)$*0.6*$F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 99.27[kip]/(0.75[in]*22.69[in]) = **5832.95**[lb/in2]						9
Weld capacity	[Kip]	215.58	125.16	DL	0.58	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.9[kip/in]*1*5*22.69[in]) = **215.58**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 13.12[kip]/22.69[in] = **0.578**[kip/in]						9
$f_{uv} = H_c/l$ = 99.27[kip]/22.69[in] = **4.37**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(22.69[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.578[kip/in] + 0[kip/in])^2 + 4.37[kip/in]^2)$^{1/2}$ = **4.41**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.578[kip/in] - 0[kip/in])^2 + 4.37[kip/in]^2)$^{1/2}$ + ((0.578[kip/in] + 0[kip/in])^2 + 4.37[kip/in]^2)$^{1/2}$) = **4.41**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 22.69[in]*max(4.41[kip/in], 1.25*4.41[kip/in]) = **125.16**[kip]						9
Ratio	**0.58**					

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	54.13	54.68	0.00	0.00	0.00	0.00	Design
DL1	-54.13	-54.68	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	200.07	54.68	DL	0.27	Eq. J4-1
$A_g = L_p*t_p$ = 12.37[in]*0.75[in] = **9.28**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*9.28[in2] = **200.07**[kip]						Eq. J4-1
Shear yielding	[Kip]	133.64	54.13	DL	0.41	Eq. J4-3
$A_g = L_p*t_p$ = 12.37[in]*0.75[in] = **9.28**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*9.28[in2] = **133.64**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	848468.60	DL	0.27	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 54.68[kip]/(0.75[in]*12.37[in]) = **5892.14**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	839944.50	DL	0.41	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 54.13[kip]/(0.75[in]*12.37[in]) = **5832.95**[lb/in2]						9
Weld capacity	[Kip]	149.25	96.18	DL	0.64	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.41[kip/in]*1*5*12.37[in]) = **149.25**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 54.68[kip]/12.37[in] = **4.42**[kip/in]						9
$f_{uv} = H_c/l$ = 54.13[kip]/12.37[in] = **4.37**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(12.37[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((4.42[kip/in] + 0[kip/in])^2 + 4.37[kip/in]^2)$^{1/2}$ = **6.22**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((4.42[kip/in] - 0[kip/in])^2 + 4.37[kip/in]^2)$^{1/2}$ + ((4.42[kip/in] + 0[kip/in])^2 + 4.37[kip/in]^2)$^{1/2}$) = **6.22**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 12.37[in]*max(6.22[kip/in], 1.25*6.22[kip/in]) = **96.18**[kip]						9
Column						
Web crippling	[Kip]	401.43	54.68	DL1	0.14	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **12.37**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.515[in]^2*(1 + 3*(12.37[in]/12.5[in])*(0.515[in]/0.81[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*						

$0.81_{[in]}/0.515_{[in]})^{1/2}$ = **401.43**[kip] Eq. J10-4

Local web yielding	[Kip]	333.45	54.68	DL	0.16	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **12.37**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.41_{[in]} + 12.37_{[in]})*50000_{[lb/in2]}*0.515_{[in]}$ =
333.45[kip] Eq. J10-2

Ratio **0.64**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}: Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\,max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}: Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Bearing length

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

(1/Ω): Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 2:32 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : **Gusset BP**
Connection ID : **VB-01-2**

Family: Column - Base (CB)

Type: Gusset

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
156.00	DL	Design
-156.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	156.00	DL	0.84	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6

Maximum weld force that brace can develop	[Kip]	404.38	156.00	DL	0.39	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e * t_p = 20$[in]*0.581[in] = **11.62**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]*11.62[in2]) = **404.38**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	261.00	156.00	DL	0.60	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e * t_p = 20$[in]*0.75[in] = **15**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]*15[in2] = **261**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	344.10	156.00	DL	0.45	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]) = **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]*0.75[in] = **15.75**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **15.75**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]*0.75[in] = **6**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]*15.75[in2] + 1*58000[lb/in2]*6[in2], 0.6*36000[lb/in2]*15.75[in2] + 1*58000[lb/in2]*6[in2]) = **344.1**[kip]						Eq. J4-5
Ratio	**0.84**					

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	451.74	156.00	DL	0.35	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]*16.4[in2] = **451.74**[kip]						Eq. J4-1
Tension rupture	[Kip]	312.28	156.00	DL	0.50	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in])$*t = 16.4$[in2] - 2*(0.75[in] + 1/8 [in])*0.581[in] = **15.38**[in2]						Sec. D3.2
$U = 1 - x/l = 1 - 3$[in]/10[in] = **0.7**						Table D3.1
$A_e = A_n*U = 15.38$[in2]*0.7 = **10.77**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]*10.77[in2] = **312.28**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	265.08	156.00	DL	0.59	Eq. J4-1
$A_g = L_w*t_p = 16.4$[in]*0.75[in] = **12.3**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*36000$[lb/in2]*12.3[in2] = **265.08**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	315.84	156.00	DL1	0.49	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*1.14$[in]$/0.217$[in]$)^2 =$ **2.45E+07**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 2.45E+07$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$/2.45E+07$[lb/in2]$)*36000$[lb/in2] =

35977.91[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35977.91$[lb/in2]$*14.66$[in2] = **315.84**[kip] Eq. E3-1

Ratio **0.59**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*1.6 - 6.25$[in] = **-3.85**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 8.43$[in]$*(1.6 + 8.43$[in]$/7.67$[in]$) =$ **22.75**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.6)^2 + (8.43$[in]$/7.67$[in]$)^2 =$ **3.77** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (22.75$[in]$*1.6 + -3.85$[in]$*(8.43$[in]$/$

7.67[in]$)^2)/3.77 =$ **8.43**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (22.75$[in] $- -3.85$[in]$*1.6)/3.77 =$ **7.67**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((8.43$[in]$ + 6.25$[in]$)^2 + (7.67$[in]$ + 1.5$[in]$)^2)^{1/}$

$^2 =$ **17.31**[in] p. 13-5

$H_b = \alpha*P/r = 8.43$[in]$*156$[kip]$/17.31$[in] = **75.97**[kip] p. 13-5

$H_c = e_c*P/r = 6.25$[in]$*156$[kip]$/17.31$[in] = **56.32**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*156$[kip]$/17.31$[in] $- 0$[kip] = **13.52**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 7.67$[in]$*156$[kip]$/17.31$[in] $+ 0$[kip] = **69.15**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(13.52$[kip]$*(8.43$[in] $- 8.43$[in]$)) +$

$abs(0$[kip]$*8.43$[in]$) =$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(56.32$[kip]$*(7.67$[in] $- 7.67$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*1.6 - 6.25$[in] = **-3.85**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 8.43$[in]$*(1.6 + 8.43$[in]$/7.67$[in]$) =$ **22.75**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.6)^2 + (8.43$[in]$/7.67$[in]$)^2 =$ **3.77** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (22.75$[in]$*1.6 + -3.85$[in]$*(8.43$[in]$/$

7.67[in]$)^2)/3.77 =$ **8.43**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (22.75$[in] $- -3.85$[in]$*1.6)/3.77 =$ **7.67**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((8.43$[in]$ + 6.25$[in]$)^2 + (7.67$[in]$ + 1.5$[in]$)^2)^{1/}$

$^2 =$ **17.31**[in] p. 13-5

$H_b = \alpha*P/r = 8.43$[in]$*-156$[kip]$/17.31$[in] = **-75.97**[kip] p. 13-5

$H_c = e_c*P/r = 6.25$[in]$*-156$[kip]$/17.31$[in] = **-56.32**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*-156$[kip]$/17.31$[in] $- 0$[kip] = **-13.52**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 7.67$[in]$*-156$[kip]$/17.31$[in] $+ 0$[kip] = **-69.15**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-13.52$[kip]$*(8.43$[in] $- 8.43$[in]$)) +$

$abs(0$[kip]$*8.43$[in]$) =$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-56.32$[kip]$*(7.67$[in] $- 7.67$[in]$)) =$ **0**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	75.97	13.52	0.00	0.00	0.00	0.00	Design
DL1	-75.97	-13.52	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	272.61	13.52	DL	0.05	Eq. J4-1
$A_g = L_p*t_p$ = 16.86[in]*0.75[in] = **12.65**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*12.65[in2] = **272.61**[kip]						Eq. J4-1
Shear yielding	[Kip]	182.11	75.97	DL	0.42	Eq. J4-3
$A_g = L_p*t_p$ = 16.86[in]*0.75[in] = **12.65**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*12.65[in2] = **182.11**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	153917.60	DL	0.05	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 13.52[kip]/(0.75[in]*16.86[in]) = **1068.87**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	865099.90	DL	0.42	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 75.97[kip]/(0.75[in]*16.86[in]) = **6007.64**[lb/in2]						9
Weld capacity	[Kip]	162.23	96.46	DL	0.59	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.92[kip/in]*1*5*16.86[in]) = **162.23**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 13.52[kip]/16.86[in] = **0.802**[kip/in]						9
$f_{uv} = H_c/l$ = 75.97[kip]/16.86[in] = **4.51**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(16.86[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.802[kip/in] + 0[kip/in])^2 + 4.51[kip/in]^2)$^{1/2}$ = **4.58**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.802[kip/in] - 0[kip/in])^2 + 4.51[kip/in]^2)$^{1/2}$ + ((0.802[kip/in] + 0[kip/in])^2 + 4.51[kip/in]^2)$^{1/2}$) = **4.58**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 16.86[in]*max(4.58[kip/in], 1.25*4.58[kip/in]) = **96.46**[kip]						9

Ratio **0.59**

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	69.15	56.32	0.00	0.00	0.00	0.00	Design
DL1	-69.15	-56.32	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	248.13	56.32	DL	0.23	Eq. J4-1
$A_g = L_p*t_p$ = 15.35[in]*0.75[in] = **11.51**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*11.51[in2] = **248.13**[kip]						Eq. J4-1
Shear yielding	[Kip]	165.75	69.15	DL	0.42	Eq. J4-3
$A_g = L_p*t_p$ = 15.35[in]*0.75[in] = **11.51**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*11.51[in2] = **165.75**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	704608.30	DL	0.23	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 56.32[kip]/(0.75[in]*15.35[in]) = **4893.11**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	865099.90	DL	0.42	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 69.15[kip]/(0.75[in]*15.35[in]) = **6007.64**[lb/in2]						9
Weld capacity	[Kip]	178.17	111.48	DL	0.63	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.32[kip/in]*1*5*15.35[in]) = **178.17**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 56.32[kip]/15.35[in] = **3.67**[kip/in]						9
$f_{uv} = H_c/l$ = 69.15[kip]/15.35[in] = **4.51**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(15.35[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((3.67[kip/in] + 0[kip/in])^2 + 4.51[kip/in]^2)$^{1/2}$ = **5.81**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((3.67[kip/in] - 0[kip/in])^2 + 4.51[kip/in]^2)$^{1/2}$ + ((3.67[kip/in] + 0[kip/in])^2 + 4.51[kip/in]^2)$^{1/2}$) = **5.81**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 15.35[in]*max(5.81[kip/in], 1.25*5.81[kip/in]) = **111.48**[kip]						9

Column

Web crippling	[Kip]	459.38	56.32	DL1	0.12	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **15.35**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515_{[in]}{}^2*(1 + 3*(15.35_{[in]}/12.5_{[in]})*(0.515_{[in]}/0.81_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*$
$0.81_{[in]}/0.515_{[in]})^{1/2} =$ **459.38**[kip] Eq. J10-4

Local web yielding	[Kip]	384.48	56.32	DL	0.15	Eq. J10-2

IsBeamReaction → **False**

$N = N =$ **15.35**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.41_{[in]} + 15.35_{[in]})*50000_{[lb/in2]}*0.515_{[in]} =$
384.48[kip] Eq. J10-2

Ratio **0.63**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}:Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\,max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}: Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Bearing length

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 2:33 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : **Gusset BP**

Connection ID : **VB-01-3**

Family: Column - Base (CB)

Type: Gusset

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
207.00	DL	Design
-207.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	207.00	DL	0.93	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip]						Eq. J2-6

Maximum weld force that brace can develop	[Kip]	485.25	207.00	DL	0.43	Eq. J4-4

$L_e = L_t + L_h = 12\text{[in]} + 12\text{[in]} = \mathbf{24}\text{[in]}$

$A_{nv} = L_e * t_p = 24\text{[in]} * 0.581\text{[in]} = \mathbf{13.94}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5 * 0.60 * 58000\text{[lb/in2]} * 13.94\text{[in2]}) = \mathbf{485.25}\text{[kip]}$ Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	313.20	207.00	DL	0.66	Eq. J4-4

$L_e = L_t + L_h = 12\text{[in]} + 12\text{[in]} = \mathbf{24}\text{[in]}$

$A_{nv} = L_e * t_p = 24\text{[in]} * 0.75\text{[in]} = \mathbf{18}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 58000\text{[lb/in2]} * 18\text{[in2]} = \mathbf{313.2}\text{[kip]}$ Eq. J4-4

Block shear on gusset	[Kip]	420.00	207.00	DL	0.49	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12\text{[in]}, 12\text{[in]}) = \mathbf{12}\text{[in]}$

$L = L_{max} + d_w = 12\text{[in]} + 0.5\text{[in]} = \mathbf{12.5}\text{[in]}$ Sec. J4.3

$A_{gv} = 2 * L * t_p = 2 * 12.5\text{[in]} * 0.75\text{[in]} = \mathbf{18.75}\text{[in2]}$ Sec. J4.3

$A_{nv} = A_{gv} = \mathbf{18.75}\text{[in2]}$ Sec. J4.3

$A_{nt} = b * t_p = 10\text{[in]} * 0.75\text{[in]} = \mathbf{7.5}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$

$0.5 * \min(0.6 * 58000\text{[lb/in2]} * 18.75\text{[in2]} + 1 * 58000\text{[lb/in2]} * 7.5\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 18.75\text{[in2]} + 1 * 58000\text{[lb/in2]} * 7.5\text{[in2]}) = \mathbf{420}\text{[kip]}$ Eq. J4-5

Ratio **0.93**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	578.44	207.00	DL	0.36	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 46000\text{[lb/in2]} * 21\text{[in2]} = \mathbf{578.44}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	398.42	207.00	DL	0.52	Eq. J4-2

$A_n = A_g - 2 * (t_p + 1/8\text{ [in]}) * t = 21\text{[in2]} - 2 * (0.75\text{[in]} + 1/8\text{ [in]}) * 0.581\text{[in]} = \mathbf{19.98}\text{[in2]}$ Sec. D3.2

$U = 1 - x/l = 1 - 3.75\text{[in]}/12\text{[in]} = \mathbf{0.688}$ Table D3.1

$A_e = A_n * U = 19.98\text{[in2]} * 0.688 = \mathbf{13.74}\text{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 13.74\text{[in2]} = \mathbf{398.42}\text{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	293.26	207.00	DL	0.71	Eq. J4-1

$A_g = L_w * t_p = 18.14\text{[in]} * 0.75\text{[in]} = \mathbf{13.6}\text{[in2]}$

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 13.6\text{[in2]} = \mathbf{293.26}\text{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	367.18	207.00	DL1	0.56	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*3.16$[in]$/0.217$[in]$)^2 =$ **3.17E+06**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 3.17E+06$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$^{/3.17E+06}$[lb/in2]$^{)}*36000$[lb/in2] =

35829.36[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35829.36$[lb/in2]$*17.11$[in2] = **367.18**[kip] Eq. E3-1

Ratio **0.71**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*1.9 - 6.15$[in] = **-3.3**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 11.43$[in]$*(1.9 + 11.43$[in]$/7.77$[in]$) =$ **38.49**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.9)^2 + (11.43$[in]$/7.77$[in]$)^2 =$ **5.76** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (38.49$[in]$*1.9 + -3.3$[in]$*(11.43$[in]$/$
7.77[in]$)^2)/5.76 =$ **11.43**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (38.49$[in] $- -3.3$[in]$*1.9)/5.76 =$ **7.77**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((11.43$[in] $+ 6.15$[in]$)^2 + (7.77$[in] $+ 1.5$[in]$)^2)^{1/}$
$^2 =$ **19.87**[in] p. 13-5

$H_b = \alpha*P/r = 11.43$[in]$*207$[kip]$/19.87$[in] = **119.04**[kip] p. 13-5

$H_c = e_c*P/r = 6.15$[in]$*207$[kip]$/19.87$[in] = **64.06**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*207$[kip]$/19.87$[in] $- 0$[kip] = **15.63**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 7.77$[in]$*207$[kip]$/19.87$[in] $+ 0$[kip] = **80.92**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(15.63$[kip]$*(11.43$[in] $- 11.43$[in]$)) +$
$abs(0$[kip]$*11.43$[in]$) =$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(64.06$[kip]$*(7.77$[in] $- 7.77$[in]$)) =$ **1.42E-14**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*1.9 - 6.15$[in] = **-3.3**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 11.43$[in]$*(1.9 + 11.43$[in]$/7.77$[in]$) =$ **38.49**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.9)^2 + (11.43$[in]$/7.77$[in]$)^2 =$ **5.76** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (38.49$[in]$*1.9 + -3.3$[in]$*(11.43$[in]$/$
7.77[in]$)^2)/5.76 =$ **11.43**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (38.49$[in] $- -3.3$[in]$*1.9)/5.76 =$ **7.77**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((11.43$[in] $+ 6.15$[in]$)^2 + (7.77$[in] $+ 1.5$[in]$)^2)^{1/}$
$^2 =$ **19.87**[in] p. 13-5

$H_b = \alpha*P/r = 11.43$[in]$*-207$[kip]$/19.87$[in] = **-119.04**[kip] p. 13-5

$H_c = e_c*P/r = 6.15$[in]$*-207$[kip]$/19.87$[in] = **-64.06**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*-207$[kip]$/19.87$[in] $- 0$[kip] = **-15.63**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 7.77$[in]$*-207$[kip]$/19.87$[in] $+ 0$[kip] = **-80.92**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-15.63$[kip]$*(11.43$[in] $- 11.43$[in]$)) +$
$abs(0$[kip]$*11.43$[in]$) =$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-64.06$[kip]$*(7.77$[in] $- 7.77$[in]$)) =$ **1.42E-14**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	119.04	15.63	0.00	0.00	0.00	0.00	Design
DL1	-119.04	-15.63	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	369.53	15.63	DL	0.04	Eq. J4-1
$A_g = L_p*t_p$ = 22.86[in]*0.75[in] = **17.14**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*17.14[in2] = **369.53**[kip]						Eq. J4-1
Shear yielding	[Kip]	246.84	119.04	DL	0.48	Eq. J4-3
$A_g = L_p*t_p$ = 22.86[in]*0.75[in] = **17.14**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*17.14[in2] = **246.84**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	131260.80	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 15.63[kip]/(0.75[in]*22.86[in]) = **911.53**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	1000026.00	DL	0.48	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 119.04[kip]/(0.75[in]*22.86[in]) = **6944.63**[lb/in2]						9
Weld capacity	[Kip]	217.10	150.08	DL	0.69	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.9[kip/in]*1*5*22.86[in]) = **217.1**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 15.63[kip]/22.86[in] = **0.684**[kip/in]						9
$f_{uv} = H_c/l$ = 119.04[kip]/22.86[in] = **5.21**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(22.86[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.684[kip/in] + 0[kip/in])^2 + 5.21[kip/in]^2)$^{1/2}$ = **5.25**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.684[kip/in] - 0[kip/in])^2 + 5.21[kip/in]^2)$^{1/2}$ + ((0.684[kip/in] + 0[kip/in])^2 + 5.21[kip/in]^2)$^{1/2}$) = **5.25**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 22.86[in]*max(5.25[kip/in], 1.25*5.25[kip/in]) = **150.08**[kip]						9

Ratio **0.69**

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	80.92	64.06	0.00	0.00	0.00	0.00	Design
DL1	-80.92	-64.06	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	251.17	64.06	DL	0.26	Eq. J4-1
$A_g = L_p*t_p$ = 15.54[in]*0.75[in] = **11.65**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*11.65[in2] = **251.17**[kip]						Eq. J4-1
Shear yielding	[Kip]	167.78	80.92	DL	0.48	Eq. J4-3
$A_g = L_p*t_p$ = 15.54[in]*0.75[in] = **11.65**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*11.65[in2] = **167.78**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	791751.40	DL	0.26	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 64.06[kip]/(0.75[in]*15.54[in]) = **5498.27**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	1000026.00	DL	0.48	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 80.92[kip]/(0.75[in]*15.54[in]) = **6944.63**[lb/in2]						9
Weld capacity	[Kip]	179.44	129.01	DL	0.72	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.31[kip/in]*1*5*15.54[in]) = **179.44**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 64.06[kip]/15.54[in] = **4.12**[kip/in]						9
$f_{uv} = H_c/l$ = 80.92[kip]/15.54[in] = **5.21**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 1.42E-14[kip*ft]/(15.54[in]^2/6) = **4.24E-15**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((4.12[kip/in] + 4.24E-15[kip/in])^2 + 5.21[kip/in]^2)$^{1/2}$ = **6.64**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((4.12[kip/in] - 4.24E-15[kip/in])^2 + 5.21[kip/in]^2)$^{1/2}$ + ((4.12[kip/in] + 4.24E-15[kip/in])^2 + 5.21[kip/in]^2)$^{1/2}$) = **6.64**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 15.54[in]*max(6.64[kip/in], 1.25*6.64[kip/in]) =						

129.01[kip] 9

Column

Web crippling	[Kip]	327.75	64.06	DL1	0.20	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **15.54**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5* 0.80*0.43[in]^2*(1 + 3*(15.54[in]/12.3[in])*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]* 0.67[in]/0.43[in])$^{1/2}$ = **327.75**[kip] Eq. J10-4

Local web yielding	[Kip]	313.69	64.06	DL	0.20	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **15.54**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.27[in] + 15.54[in])*50000[lb/in2]*0.43[in] = **313.69**[kip] Eq. J10-2

Ratio **0.72**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}:Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\,max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}: Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Bearing length

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 2:34 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : **Gusset BP**
Connection ID : **VB-01-4**

Family: Column - Base (CB)

Type: Gusset

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
100.00	DL	Design
-100.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	100.00	DL	0.54	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6

Maximum weld force that brace can develop	[Kip]	404.38	100.00	DL	0.25	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e * t_p = 20$[in]*0.581[in] = **11.62**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.62$[in2]$)$ = **404.38**[kip]						Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	261.00	100.00	DL	0.38	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e * t_p = 20$[in]*0.75[in] = **15**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*58000$[lb/in2]$*15$[in2] = **261**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	344.10	100.00	DL	0.29	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]*0.75[in] = **15.75**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **15.75**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]*0.75[in] = **6**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*58000$[lb/in2]$*15.75$[in2] + $1*58000$[lb/in2]$*6$[in2], $0.6*36000$[lb/in2]$*15.75$[in2] + $1*58000$[lb/in2]$*6$[in2]$)$ = **344.1**[kip]						Eq. J4-5

Ratio	**0.54**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	451.74	100.00	DL	0.22	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*16.4$[in2] = **451.74**[kip]						Eq. J4-1
Tension rupture	[Kip]	312.28	100.00	DL	0.32	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 16.4$[in2] $- 2*(0.75$[in] $+ 1/8$ [in]$)*0.581$[in] = **15.38**[in2]						Sec. D3.2
$U = 1 - x/l = 1 - 3$[in]$/10$[in] = **0.7**						Table D3.1
$A_e = A_n*U = 15.38$[in2]$*0.7 =$ **10.77**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*10.77$[in2] = **312.28**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	250.92	100.00	DL	0.40	Eq. J4-1
$A_g = L_w*t_p = 15.52$[in]$*0.75$[in] = **11.64**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*36000$[lb/in2]$*11.64$[in2] = **250.92**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	305.61	100.00	DL1	0.33	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*3.23$[in]$/0.217$[in]$)^2 =$ **3.04E+06**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 3.04E+06$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$^{/3.04E+06}$[lb/in2]$^{)}*36000$[lb/in2] =

35822.09[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35822.09$[lb/in2]$*14.25$[in2] = **305.61**[kip] Eq. E3-1

Ratio **0.40**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*1.84 - 5$[in] = **-2.24**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 9.86$[in]$*(1.84 + 9.86$[in]$/6.57$[in]$) =$ **32.96**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.84)^2 + (9.86$[in]$/6.57$[in]$)^2 =$ **5.65** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (32.96$[in]$*1.84 + -2.24$[in]$*(9.86$[in]$/$

6.57[in]$)^2)/5.65 =$ **9.86**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (32.96$[in]$ - -2.24$[in]$*1.84)/5.65 =$ **6.57**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.86$[in]$ + 5$[in]$)^2 + (6.57$[in]$ + 1.5$[in]$)^2)^{1/2} =$

16.91[in] p. 13-5

$H_b = \alpha*P/r = 9.86$[in]$*100$[kip]$/16.91$[in] = **58.31**[kip] p. 13-5

$H_c = e_c*P/r = 5$[in]$*100$[kip]$/16.91$[in] = **29.57**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*100$[kip]$/16.91$[in] $- 0$[kip] = **8.87**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 6.57$[in]$*100$[kip]$/16.91$[in] $+ 0$[kip] = **38.84**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(8.87$[kip]$*(9.86$[in]$ - 9.86$[in]$)) +$

$abs(0$[kip]$*9.86$[in]$) =$ **1.97E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(29.57$[kip]$*(6.57$[in]$ - 6.57$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*1.84 - 5$[in] = **-2.24**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 9.86$[in]$*(1.84 + 9.86$[in]$/6.57$[in]$) =$ **32.96**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.84)^2 + (9.86$[in]$/6.57$[in]$)^2 =$ **5.65** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (32.96$[in]$*1.84 + -2.24$[in]$*(9.86$[in]$/$

6.57[in]$)^2)/5.65 =$ **9.86**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (32.96$[in]$ - -2.24$[in]$*1.84)/5.65 =$ **6.57**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.86$[in]$ + 5$[in]$)^2 + (6.57$[in]$ + 1.5$[in]$)^2)^{1/2} =$

16.91[in] p. 13-5

$H_b = \alpha*P/r = 9.86$[in]$*-100$[kip]$/16.91$[in] = **-58.31**[kip] p. 13-5

$H_c = e_c*P/r = 5$[in]$*-100$[kip]$/16.91$[in] = **-29.57**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*-100$[kip]$/16.91$[in] $- 0$[kip] = **-8.87**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 6.57$[in]$*-100$[kip]$/16.91$[in] $+ 0$[kip] = **-38.84**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-8.87$[kip]$*(9.86$[in]$ - 9.86$[in]$)) +$

$abs(0$[kip]$*9.86$[in]$) =$ **1.97E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-29.57$[kip]$*(6.57$[in]$ - 6.57$[in]$)) =$ **0**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Beam Mu [Kip*ft]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	58.31	8.87	0.00	0.00	0.00	0.00	Design
DL1	-58.31	-8.87	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	318.78	8.87	DL	0.03	Eq. J4-1
$A_g = L_p*t_p$ = 19.72[in]*0.75[in] = **14.79**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*14.79[in2] = **318.78**[kip]						Eq. J4-1
Shear yielding	[Kip]	212.95	58.31	DL	0.27	Eq. J4-3
$A_g = L_p*t_p$ = 19.72[in]*0.75[in] = **14.79**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*14.79[in2] = **212.95**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	86390.35	DL	0.03	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 8.87[kip]/(0.75[in]*19.72[in]) = **599.93**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	567794.00	DL	0.27	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 58.31[kip]/(0.75[in]*19.72[in]) = **3943.01**[lb/in2]						9
Weld capacity	[Kip]	188.33	73.73	DL	0.39	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.91[kip/in]*1*5*19.72[in]) = **188.33**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 8.87[kip]/19.72[in] = **0.45**[kip/in]						9
$f_{uv} = H_c/l$ = 58.31[kip]/19.72[in] = **2.96**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 1.97E-15[kip*ft]/(19.72[in]^2/6) = **3.65E-16**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.45[kip/in] + 3.65E-16[kip/in])^2 + 2.96[kip/in^2])$^{1/2}$ = **2.99**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.45[kip/in] - 3.65E-16[kip/in])^2 + 2.96[kip/in^2])$^{1/2}$ + ((0.45[kip/in] + 3.65E-16[kip/in])^2 + 2.96[kip/in^2])$^{1/2}$) = **2.99**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 19.72[in]*max(2.99[kip/in], 1.25*2.99[kip/in]) = **73.73**[kip]						9

Ratio **0.39**

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	38.84	29.57	0.00	0.00	0.00	0.00	Design
DL1	-38.84	-29.57	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	212.36	29.57	DL	0.14	Eq. J4-1
$A_g = L_p*t_p$ = 13.14[in]*0.75[in] = **9.85**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*9.85[in2] = **212.36**[kip]						Eq. J4-1
Shear yielding	[Kip]	141.86	38.84	DL	0.27	Eq. J4-3
$A_g = L_p*t_p$ = 13.14[in]*0.75[in] = **9.85**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*9.85[in2] = **141.86**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	432270.30	DL	0.14	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 29.57[kip]/(0.75[in]*13.14[in]) = **3001.88**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	567794.00	DL	0.27	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 38.84[kip]/(0.75[in]*13.14[in]) = **3943.01**[lb/in2]						9
Weld capacity	[Kip]	150.64	61.03	DL	0.41	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.29[kip/in]*1*5*13.14[in]) = **150.64**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 29.57[kip]/13.14[in] = **2.25**[kip/in]						9
$f_{uv} = H_c/l$ = 38.84[kip]/13.14[in] = **2.96**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(13.14[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((2.25[kip/in] + 0[kip/in])^2 + 2.96[kip/in]^2)$^{1/2}$ = **3.72**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((2.25[kip/in] - 0[kip/in])^2 + 2.96[kip/in]^2)$^{1/2}$ + ((2.25[kip/in] + 0[kip/in])^2 + 2.96[kip/in]^2)$^{1/2}$) = **3.72**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 13.14[in]*max(3.72[kip/in], 1.25*3.72[kip/in]) = **61.03**[kip]						9

Column

Web crippling	[Kip]	204.67	29.57	DL1	0.14	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{13.14}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34$[in]$^2*(1 + 3*(13.14$[in]$/10$[in]$)*(0.34$[in]$/0.56$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.56[in]$/0.34$[in]$)^{1/2} = \mathbf{204.67}$[kip] Eq. J10-4

Local web yielding	[Kip]	208.93	29.57	DL	0.14	Eq. J10-2

IsBeamReaction → **False**

$N = N = \mathbf{13.14}$[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.06$[in]$ + 13.14$[in]$)*50000$[lb/in2]$*0.34$[in] =
$\mathbf{208.93}$[kip] Eq. J10-2

Ratio **0.41**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}:Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\ max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}:Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Bearing length

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 2:35 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : **Gusset BP**

Connection ID : **VB-01-5**

Family: Column - Base (CB)

Type: Gusset

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
152.00	DL	Design
-152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	152.00	DL	0.82	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6

Maximum weld force that brace can develop	[Kip]	323.64	152.00	DL	0.47	Eq. J4-4

$L_e = L_t + L_h = 10\text{[in]} + 10\text{[in]} = \mathbf{20}\text{[in]}$

$A_{nv} = L_e * t_p = 20\text{[in]} * 0.465\text{[in]} = \mathbf{9.3}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5 * 0.60 * 58000\text{[lb/in2]} * 9.3\text{[in2]}) = \mathbf{323.64}\text{[kip]}$ Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	261.00	152.00	DL	0.58	Eq. J4-4

$L_e = L_t + L_h = 10\text{[in]} + 10\text{[in]} = \mathbf{20}\text{[in]}$

$A_{nv} = L_e * t_p = 20\text{[in]} * 0.75\text{[in]} = \mathbf{15}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 58000\text{[lb/in2]} * 15\text{[in2]} = \mathbf{261}\text{[kip]}$ Eq. J4-4

Block shear on gusset	[Kip]	344.10	152.00	DL	0.44	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10\text{[in]}, 10\text{[in]}) = \mathbf{10}\text{[in]}$

$L = L_{max} + d_w = 10\text{[in]} + 0.5\text{[in]} = \mathbf{10.5}\text{[in]}$ Sec. J4.3

$A_{gv} = 2 * L * t_p = 2 * 10.5\text{[in]} * 0.75\text{[in]} = \mathbf{15.75}\text{[in2]}$ Sec. J4.3

$A_{nv} = A_{gv} = \mathbf{15.75}\text{[in2]}$ Sec. J4.3

$A_{nt} = b * t_p = 8\text{[in]} * 0.75\text{[in]} = \mathbf{6}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$

$0.5 * \min(0.6 * 58000\text{[lb/in2]} * 15.75\text{[in2]} + 1 * 58000\text{[lb/in2]} * 6\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 15.75\text{[in2]} + 1 * 58000\text{[lb/in2]} * 6\text{[in2]}) = \mathbf{344.1}\text{[kip]}$ Eq. J4-5

Ratio **0.82**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	152.00	DL	0.41	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 46000\text{[lb/in2]} * 13.5\text{[in2]} = \mathbf{371.86}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	257.53	152.00	DL	0.59	Eq. J4-2

$A_n = A_g - 2 * (t_p + 1/8\text{ [in]}) * t = 13.5\text{[in2]} - 2 * (0.75\text{[in]} + 1/8\text{ [in]}) * 0.465\text{[in]} = \mathbf{12.69}\text{[in2]}$ Sec. D3.2

$U = 1 - x/l = 1 - 3\text{[in]}/10\text{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n * U = 12.69\text{[in2]} * 0.7 = \mathbf{8.88}\text{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 8.88\text{[in2]} = \mathbf{257.53}\text{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	257.01	152.00	DL	0.59	Eq. J4-1

$A_g = L_w * t_p = 15.9\text{[in]} * 0.75\text{[in]} = \mathbf{11.92}\text{[in2]}$

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 11.92\text{[in2]} = \mathbf{257.01}\text{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	315.69	152.00	DL1	0.48	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*1.51$[in]$/0.217$[in]$)^2 =$ **1.39E+07**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.39E+07$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$/1.39E+07$[lb/in2]$)*36000$[lb/in2] =

35960.89[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35960.89$[lb/in2]$*14.66$[in2] = **315.69**[kip] Eq. E3-1

Ratio **0.59**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.75$[in]$*0.798 - 0.22$[in] = **1.18**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 7.96$[in]$*(0.798 + 7.96$[in]$/8.5$[in]$) =$ **13.82**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.798)^2 + (7.96$[in]$/8.5$[in]$)^2 =$ **1.51** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (13.82$[in]$*0.798 + 1.18$[in]$*(7.96$[in]$/$

8.5[in]$)^2)/1.51 =$ **7.96**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (13.82$[in]$ - 1.18$[in]$*0.798)/1.51 =$ **8.5**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((7.96$[in]$ + 0.22$[in]$)^2 + (8.5$[in]$ + 1.75$[in]$)^2)^{1/}$

$^2 =$ **13.12**[in] p. 13-5

$H_b = \alpha*P/r = 7.96$[in]$*152$[kip]$/13.12$[in] = **92.28**[kip] p. 13-5

$H_c = e_c*P/r = 0.22$[in]$*152$[kip]$/13.12$[in] = **2.55**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.75$[in]$*152$[kip]$/13.12$[in] $- 0$[kip] = **20.28**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 8.5$[in]$*152$[kip]$/13.12$[in] $+ 0$[kip] = **98.51**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(20.28$[kip]$*(7.96$[in]$ - 7.96$[in]$)) +$

$abs(0$[kip]$*7.96$[in]$) =$ **4.50E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(2.55$[kip]$*(8.5$[in]$ - 8.5$[in]$)) =$ **2.83E-16**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.75$[in]$*0.798 - 0.22$[in] = **1.18**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 7.96$[in]$*(0.798 + 7.96$[in]$/8.5$[in]$) =$ **13.82**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.798)^2 + (7.96$[in]$/8.5$[in]$)^2 =$ **1.51** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (13.82$[in]$*0.798 + 1.18$[in]$*(7.96$[in]$/$

8.5[in]$)^2)/1.51 =$ **7.96**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (13.82$[in]$ - 1.18$[in]$*0.798)/1.51 =$ **8.5**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((7.96$[in]$ + 0.22$[in]$)^2 + (8.5$[in]$ + 1.75$[in]$)^2)^{1/}$

$^2 =$ **13.12**[in] p. 13-5

$H_b = \alpha*P/r = 7.96$[in]$*-152$[kip]$/13.12$[in] = **-92.28**[kip] p. 13-5

$H_c = e_c*P/r = 0.22$[in]$*-152$[kip]$/13.12$[in] = **-2.55**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.75$[in]$*-152$[kip]$/13.12$[in] $- 0$[kip] = **-20.28**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 8.5$[in]$*-152$[kip]$/13.12$[in] $+ 0$[kip] = **-98.51**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-20.28$[kip]$*(7.96$[in]$ - 7.96$[in]$)) +$

$abs(0$[kip]$*7.96$[in]$) =$ **4.50E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-2.55$[kip]$*(8.5$[in]$ - 8.5$[in]$)) =$ **2.83E-16**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	92.28	20.28	0.00	0.00	0.00	0.00	Design
DL1	-92.28	-20.28	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	257.52	20.28	DL	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 15.93[in]*0.75[in] = **11.95**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*11.95[in2] = **257.52**[kip]						Eq. J4-1
Shear yielding	[Kip]	172.02	92.28	DL	0.54	Eq. J4-3
$A_g = L_p*t_p$ = 15.93[in]*0.75[in] = **11.95**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*11.95[in2] = **172.02**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	244431.10	DL	0.08	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 20.28[kip]/(0.75[in]*15.93[in]) = **1697.44**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	1112371.00	DL	0.54	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 92.28[kip]/(0.75[in]*15.93[in]) = **7724.8**[lb/in2]						9
Weld capacity	[Kip]	155.17	118.10	DL	0.76	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.95[kip/in]*1*5*15.93[in]) = **155.17**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 20.28[kip]/15.93[in] = **1.27**[kip/in]						9
$f_{uv} = H_c/l$ = 92.28[kip]/15.93[in] = **5.79**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 4.50E-15[kip*ft]/(15.93[in]^2/6) = **1.28E-15**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((1.27[kip/in] + 1.28E-15[kip/in])^2 + 5.79[kip/in^2])$^{1/2}$ = **5.93**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((1.27[kip/in] - 1.28E-15[kip/in])^2 + 5.79[kip/in^2])$^{1/2}$ + ((1.27[kip/in] + 1.28E-15[kip/in])^2 + 5.79[kip/in^2])$^{1/2}$) = **5.93**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 15.93[in]*max(5.93[kip/in], 1.25*5.93[kip/in]) = **118.1**[kip]						9

Ratio **0.76**

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	98.51	2.55	0.00	0.00	0.00	0.00	Design
DL1	-98.51	-2.55	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	274.91	2.55	DL	0.01	Eq. J4-1
$A_g = L_p*t_p$ = 17[in]*0.75[in] = **12.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*12.75[in2] = **274.91**[kip]						Eq. J4-1
Shear yielding	[Kip]	183.64	98.51	DL	0.54	Eq. J4-3
$A_g = L_p*t_p$ = 17[in]*0.75[in] = **12.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*12.75[in2] = **183.64**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	28784.27	DL	0.01	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 2.55[kip]/(0.75[in]*17[in]) = **199.89**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	1112371.00	DL	0.54	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 98.51[kip]/(0.75[in]*17[in]) = **7724.8**[lb/in2]						9
Weld capacity	[Kip]	158.14	123.18	DL1	0.78	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*5*17[in]) = **158.14**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = -2.55[kip]/17[in] = **-0.15**[kip/in]						9
$f_{uv} = H_c/l$ = -98.51[kip]/17[in] = **-5.79**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = -2.83E-16[kip*ft]/(17[in]^2/6) = **-7.05E-17**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.15[kip/in] + 7.05E-17[kip/in])^2 + 5.79[kip/in^2])$^{1/2}$ = **5.8**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.15[kip/in] - 7.05E-17[kip/in])^2 + 5.79[kip/in^2])$^{1/2}$ + ((0.15[kip/in] + 7.05E-17[kip/in])^2 + 5.79[kip/in^2])$^{1/2}$) = **5.8**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 17[in]*max(5.8[kip/in], 1.25*5.8[kip/in]) = **123.18**[kip]						9

Ratio	**0.78**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}: Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\,max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

K: Effective length factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}: Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_p: Plate thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 2:36 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : Gusset BP

Connection ID : VB-01-6

Family: Column - Base (CB)

Type: Gusset

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
152.00	DL	Design
-152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	152.00	DL	0.82	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6

Maximum weld force that brace can develop	[Kip]	323.64	152.00	DL	0.47	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p = 20$[in]*0.465[in] = **9.3**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$) =$ **323.64**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	261.00	152.00	DL	0.58	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p = 20$[in]*0.75[in] = **15**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5*0.60*58000$[lb/in2]$*15$[in2] = **261**[kip] Eq. J4-4

Block shear on gusset	[Kip]	344.10	152.00	DL	0.44	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2 * L * t_p = 2*10.5$[in]*0.75[in] = **15.75**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **15.75**[in2] Sec. J4.3

$A_{nt} = b * t_p = 8$[in]*0.75[in] = **6**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*58000$[lb/in2]$*15.75$[in2] + $1*58000$[lb/in2]$*6$[in2], $0.6*36000$[lb/in2]$*15.75$[in2] + $1*58000$[lb/in2]$*6$[in2]$) =$ **344.1**[kip] Eq. J4-5

Ratio **0.82**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	152.00	DL	0.41	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	257.53	152.00	DL	0.59	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$) * t = 13.5$[in2] - $2*(0.75$[in] + 1/8 [in]$)*0.465$[in] = **12.69**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/10$[in] = **0.7** Table D3.1

$A_e = A_n * U = 12.69$[in2]$*0.7 =$ **8.88**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5*58000$[lb/in2]$*8.88$[in2] = **257.53**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	287.03	152.00	DL	0.53	Eq. J4-1

$A_g = L_w * t_p = 17.75$[in]$*0.75$[in] = **13.32**[in2]

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599*36000$[lb/in2]$*13.32$[in2] = **287.03**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	298.62	152.00	DL1	0.51	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.28$[in]$/0.217$[in]$)^2 =$ **1.14E+06**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.14E+06$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$/1.14E+06$[lb/in2]$)*36000$[lb/in2] =

35526.68[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35526.68$[lb/in2]$*14.04$[in2] = **298.62**[kip] Eq. E3-1

Ratio **0.59**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*0.798 - 6.05$[in] = **-4.85**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 4.95$[in]$*(0.798 + 4.95$[in]$/12.28$[in]$) =$ **5.95**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.798)^2 + (4.95$[in]$/12.28$[in]$)^2 =$ **0.8** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (5.95$[in]$*0.798 + -4.85$[in]$*(4.95$[in]$/$

12.28[in]$)^2)/0.8 =$ **4.95**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (5.95$[in] $- -4.85$[in]$*0.798)/0.8 =$ **12.28**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((4.95$[in] $+ 6.05$[in]$)^2 + (12.28$[in] $+ 1.5$[in]$)^2)^{1/}$

$^2 =$ **17.63**[in] p. 13-5

$H_b = \alpha*P/r = 4.95$[in]$*152$[kip]$/17.63$[in] = **42.67**[kip] p. 13-5

$H_c = e_c*P/r = 6.05$[in]$*152$[kip]$/17.63$[in] = **52.16**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*152$[kip]$/17.63$[in] $- 0$[kip] = **12.93**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 12.28$[in]$*152$[kip]$/17.63$[in] $+ 0$[kip] = **105.86**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(12.93$[kip]$*(4.95$[in] $- 4.95$[in]$)) +$

$abs(0$[kip]$*4.95$[in]$) =$ **7.18E-16**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(52.16$[kip]$*(12.28$[in] $- 12.28$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.5$[in]$*0.798 - 6.05$[in] = **-4.85**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 4.95$[in]$*(0.798 + 4.95$[in]$/12.28$[in]$) =$ **5.95**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.798)^2 + (4.95$[in]$/12.28$[in]$)^2 =$ **0.8** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (5.95$[in]$*0.798 + -4.85$[in]$*(4.95$[in]$/$

12.28[in]$)^2)/0.8 =$ **4.95**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (5.95$[in] $- -4.85$[in]$*0.798)/0.8 =$ **12.28**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((4.95$[in] $+ 6.05$[in]$)^2 + (12.28$[in] $+ 1.5$[in]$)^2)^{1/}$

$^2 =$ **17.63**[in] p. 13-5

$H_b = \alpha*P/r = 4.95$[in]$*-152$[kip]$/17.63$[in] = **-42.67**[kip] p. 13-5

$H_c = e_c*P/r = 6.05$[in]$*-152$[kip]$/17.63$[in] = **-52.16**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.5$[in]$*-152$[kip]$/17.63$[in] $- 0$[kip] = **-12.93**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 12.28$[in]$*-152$[kip]$/17.63$[in] $+ 0$[kip] = **-105.86**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-12.93$[kip]$*(4.95$[in] $- 4.95$[in]$)) +$

$abs(0$[kip]$*4.95$[in]$) =$ **7.18E-16**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-52.16$[kip]$*(12.28$[in] $- 12.28$[in]$)) =$ **0**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	42.67	12.93	0.00	0.00	0.00	0.00	Design
DL1	-42.67	-12.93	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	160.03	12.93	DL	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 9.9[in]*0.75[in] = **7.42**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*7.42[in2] = **160.03**[kip]						Eq. J4-1
Shear yielding	[Kip]	106.90	42.67	DL	0.40	Eq. J4-3
$A_g = L_p*t_p$ = 9.9[in]*0.75[in] = **7.42**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*7.42[in2] = **106.9**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	250846.80	DL	0.08	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 12.93[kip]/(0.75[in]*9.9[in]) = **1741.99**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	827663.50	DL	0.40	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 42.67[kip]/(0.75[in]*9.9[in]) = **5747.66**[lb/in2]						9
Weld capacity	[Kip]	99.04	55.73	DL	0.56	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2[kip/in]*1*5*9.9[in]) = **99.04**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 12.93[kip]/9.9[in] = **1.31**[kip/in]						9
$f_{uv} = H_c/l$ = 42.67[kip]/9.9[in] = **4.31**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 7.18E-16[kip*ft]/(9.9[in]^2/6) = **5.28E-16**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((1.31[kip/in] + 5.28E-16[kip/in])^2 + 4.31[kip/in]^2)$^{1/2}$ = **4.5**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((1.31[kip/in] - 5.28E-16[kip/in])^2 + 4.31[kip/in]^2)$^{1/2}$ + ((1.31[kip/in] + 5.28E-16[kip/in])^2 + 4.31[kip/in]^2)$^{1/2}$) = **4.5**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 9.9[in]*max(4.5[kip/in], 1.25*4.5[kip/in]) = **55.73**[kip]						9

Ratio **0.56**

Upper right gusset interface - column

Directly welded

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Beam Mu [Kip*ft]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	105.86	52.16	0.00	0.00	0.00	0.00	Design
DL1	-105.86	-52.16	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	397.03	52.16	DL	0.13	Eq. J4-1
$A_g = L_p*t_p$ = 24.56[in]*0.75[in] = **18.42**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*18.42[in2] = **397.03**[kip]						Eq. J4-1
Shear yielding	[Kip]	265.22	105.86	DL	0.40	Eq. J4-3
$A_g = L_p*t_p$ = 24.56[in]*0.75[in] = **18.42**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*18.42[in2] = **265.22**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	407816.20	DL	0.13	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 52.16[kip]/(0.75[in]*24.56[in]) = **2832.06**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	827663.50	DL	0.40	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 105.86[kip]/(0.75[in]*24.56[in]) = **5747.66**[lb/in2]						9
Weld capacity	[Kip]	261.39	147.51	DL	0.56	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.13[kip/in]*1*5*24.56[in]) = **261.39**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 52.16[kip]/24.56[in] = **2.12**[kip/in]						9
$f_{uv} = H_c/l$ = 105.86[kip]/24.56[in] = **4.31**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 0[kip*ft]/(24.56[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((2.12[kip/in] + 0[kip/in])^2 + 4.31[kip/in]^2)$^{1/2}$ = **4.81**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((2.12[kip/in] - 0[kip/in])^2 + 4.31[kip/in]^2)$^{1/2}$ + ((2.12[kip/in] + 0[kip/in])^2 + 4.31[kip/in]^2)$^{1/2}$) = **4.81**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 24.56[in]*max(4.81[kip/in], 1.25*4.81[kip/in]) = **147.51**[kip]						9

Column

Web crippling	[Kip]	283.45	52.16	DL1	0.18	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{24.56}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.345$[in]$^2*(1 + 3*(24.56$[in]$/12.1$[in]$)*(0.345$[in]$/0.575$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.575[in]$/0.345$[in]$)^{1/2} = \mathbf{283.45}$[kip] Eq. J10-4

Local web yielding	[Kip]	350.26	52.16	DL	0.15	Eq. J10-2

IsBeamReaction → **False**

$N = N = \mathbf{24.56}$[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.18$[in] $+ 24.56$[in]$)*50000$[lb/in2]$*0.345$[in] =
$\mathbf{350.26}$[kip] Eq. J10-2

Ratio **0.56**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}:Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\,max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}: Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Bearing length

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 2:37 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-01 Vertical Brace at Column Base\VB-01.cnx\

Steel connections

Results

Connection name : **Gusset BP**

Connection ID : **VB-01-7**

Family: Column - Base (CB)

Type: Gusset

Design code: AISC 360-05 ASD,

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
186.00	DL	Design
-186.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	186.00	DL	0.84	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip]						Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	186.00	DL	0.48	Eq. J4-4

$L_e = L_t + L_h = 12\text{[in]} + 12\text{[in]} = \mathbf{24}\text{[in]}$

$A_{nv} = L_e * t_p = 24\text{[in]} * 0.465\text{[in]} = \mathbf{11.16}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5 * 0.60 * 58000\text{[lb/in2]} * 11.16\text{[in2]}) = \mathbf{388.37}\text{[kip]}$ Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	313.20	186.00	DL	0.59	Eq. J4-4

$L_e = L_t + L_h = 12\text{[in]} + 12\text{[in]} = \mathbf{24}\text{[in]}$

$A_{nv} = L_e * t_p = 24\text{[in]} * 0.75\text{[in]} = \mathbf{18}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 58000\text{[lb/in2]} * 18\text{[in2]} = \mathbf{313.2}\text{[kip]}$ Eq. J4-4

Block shear on gusset	[Kip]	376.50	186.00	DL	0.49	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12\text{[in]}, 12\text{[in]}) = \mathbf{12}\text{[in]}$

$L = L_{max} + d_w = 12\text{[in]} + 0.5\text{[in]} = \mathbf{12.5}\text{[in]}$ Sec. J4.3

$A_{gv} = 2 * L * t_p = 2 * 12.5\text{[in]} * 0.75\text{[in]} = \mathbf{18.75}\text{[in2]}$ Sec. J4.3

$A_{nv} = A_{gv} = \mathbf{18.75}\text{[in2]}$ Sec. J4.3

$A_{nt} = b * t_p = 8\text{[in]} * 0.75\text{[in]} = \mathbf{6}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$

$0.5 * \min(0.6 * 58000\text{[lb/in2]} * 18.75\text{[in2]} + 1 * 58000\text{[lb/in2]} * 6\text{[in2]}, 0.6 * 36000\text{[lb/in2]} * 18.75\text{[in2]} + 1 * 58000\text{[lb/in2]} * 6\text{[in2]}) = \mathbf{376.5}\text{[kip]}$ Eq. J4-5

Ratio **0.84**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	186.00	DL	0.50	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 46000\text{[lb/in2]} * 13.5\text{[in2]} = \mathbf{371.86}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	275.93	186.00	DL	0.67	Eq. J4-2

$A_n = A_g - 2 * (t_p + 1/8\text{ [in]}) * t = 13.5\text{[in2]} - 2 * (0.75\text{[in]} + 1/8\text{ [in]}) * 0.465\text{[in]} = \mathbf{12.69}\text{[in2]}$ Sec. D3.2

$U = 1 - x/l = 1 - 3\text{[in]}/12\text{[in]} = \mathbf{0.75}$ Table D3.1

$A_e = A_n * U = 12.69\text{[in2]} * 0.75 = \mathbf{9.51}\text{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 9.51\text{[in2]} = \mathbf{275.93}\text{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	327.48	186.00	DL	0.57	Eq. J4-1

$A_g = L_w * t_p = 20.26\text{[in]} * 0.75\text{[in]} = \mathbf{15.19}\text{[in2]}$

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 36000\text{[lb/in2]} * 15.19\text{[in2]} = \mathbf{327.48}\text{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	334.98	186.00	DL1	0.56	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*4.75$[in]$/0.217$[in]$)^2 =$ **1.41E+06**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.41E+06$[lb/in2]$>=0.44*1*36000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*36000}$[lb/in2]$/1.41E+06$[lb/in2]$)*36000$[lb/in2] =

35616.57[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*35616.57$[lb/in2]$*15.71$[in2] = **334.98**[kip] Eq. E3-1

Ratio **0.67**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.75$[in]$*0.833 - 7$[in] = **-5.54**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 5.42$[in]$*(0.833 + 5.42$[in]$/13.16$[in]$) =$ **6.75**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.833)^2 + (5.42$[in]$/13.16$[in]$)^2 =$ **0.864** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (6.75$[in]$*0.833 + -5.54$[in]$*(5.42$[in]$/$

13.16[in]$)^2)/0.864 =$ **5.42**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (6.75$[in] - -5.54[in]$*0.833)/0.864 =$ **13.16**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((5.42$[in] + 7[in]$)^2 + (13.16$[in] + 1.75[in]$)^2)^{1/}$

$^2 =$ **19.4**[in] p. 13-5

$H_b = \alpha*P/r = 5.42$[in]$*186$[kip]$/19.4$[in] = **51.95**[kip] p. 13-5

$H_c = e_c*P/r = 7$[in]$*186$[kip]$/19.4$[in] = **67.11**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.75$[in]$*186$[kip]$/19.4$[in] - 0[kip] = **16.78**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 13.16$[in]$*186$[kip]$/19.4$[in] + 0[kip] = **126.12**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(16.78$[kip]$*(5.42$[in] - 5.42[in]$)) +$

$abs(0$[kip]$*5.42$[in]$) =$ **9.31E-16**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(67.11$[kip]$*(13.16$[in] - 13.16[in]$)) =$ **2.98E-14**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 1.75$[in]$*0.833 - 7$[in] = **-5.54**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 5.42$[in]$*(0.833 + 5.42$[in]$/13.16$[in]$) =$ **6.75**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.833)^2 + (5.42$[in]$/13.16$[in]$)^2 =$ **0.864** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (6.75$[in]$*0.833 + -5.54$[in]$*(5.42$[in]$/$

13.16[in]$)^2)/0.864 =$ **5.42**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (6.75$[in] - -5.54[in]$*0.833)/0.864 =$ **13.16**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((5.42$[in] + 7[in]$)^2 + (13.16$[in] + 1.75[in]$)^2)^{1/}$

$^2 =$ **19.4**[in] p. 13-5

$H_b = \alpha*P/r = 5.42$[in]$*-186$[kip]$/19.4$[in] = **-51.95**[kip] p. 13-5

$H_c = e_c*P/r = 7$[in]$*-186$[kip]$/19.4$[in] = **-67.11**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 1.75$[in]$*-186$[kip]$/19.4$[in] - 0[kip] = **-16.78**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 13.16$[in]$*-186$[kip]$/19.4$[in] + 0[kip] = **-126.12**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-16.78$[kip]$*(5.42$[in] - 5.42[in]$)) +$

$abs(0$[kip]$*5.42$[in]$) =$ **9.31E-16**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-67.11$[kip]$*(13.16$[in] - 13.16[in]$)) =$ **2.98E-14**[kip*ft] p. 13-10

Right gusset interface - base plate

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	51.95	16.78	0.00	0.00	0.00	0.00	Design
DL1	-51.95	-16.78	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	175.24	16.78	DL	0.10	Eq. J4-1
$A_g = L_p*t_p$ = 10.84[in]*0.75[in] = **8.13**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*8.13[in2] = **175.24**[kip]						Eq. J4-1
Shear yielding	[Kip]	117.06	51.95	DL	0.44	Eq. J4-3
$A_g = L_p*t_p$ = 10.84[in]*0.75[in] = **8.13**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*8.13[in2] = **117.06**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	297186.50	DL	0.10	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 16.78[kip]/(0.75[in]*10.84[in]) = **2063.79**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	920320.80	DL	0.44	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 51.95[kip]/(0.75[in]*10.84[in]) = **6391.12**[lb/in2]						9
Weld capacity	[Kip]	109.16	68.24	DL	0.63	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.01[kip/in]*1*5*10.84[in]) = **109.16**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 16.78[kip]/10.84[in] = **1.55**[kip/in]						9
$f_{uv} = H_c/l$ = 51.95[kip]/10.84[in] = **4.79**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = 9.31E-16[kip*ft]/(10.84[in]^2/6) = **5.71E-16**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((1.55[kip/in] + 5.71E-16[kip/in])^2 + 4.79[kip/in]^2)$^{1/2}$ = **5.04**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((1.55[kip/in] - 5.71E-16[kip/in])^2 + 4.79[kip/in]^2)$^{1/2}$ + ((1.55[kip/in] + 5.71E-16[kip/in])^2 + 4.79[kip/in]^2)$^{1/2}$) = **5.04**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 10.84[in]*max(5.04[kip/in], 1.25*5.04[kip/in]) = **68.24**[kip]						9

Ratio **0.63**

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	126.12	67.11	0.00	0.00	0.00	0.00	Design
DL1	-126.12	-67.11	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	425.41	67.11	DL	0.16	Eq. J4-1
$A_g = L_p*t_p$ = 26.31[in]*0.75[in] = **19.73**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*36000[lb/in2]*19.73[in2] = **425.41**[kip]						Eq. J4-1
Shear yielding	[Kip]	284.17	126.12	DL	0.44	Eq. J4-3
$A_g = L_p*t_p$ = 26.31[in]*0.75[in] = **19.73**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*36000[lb/in2]*19.73[in2] = **284.17**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	3104192.00	489674.40	DL	0.16	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*36000[lb/in2] = **21556.89**[lb/in2]						J4-1
$f_{ua} = H_c/(t_p*l)$ = 67.11[kip]/(0.75[in]*26.31[in]) = **3400.52**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2073600.00	920320.80	DL	0.44	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*36000[lb/in2] = **14400**[lb/in2]						J4-1
$f_{uv} = V_c/(t_p*l)$ = 126.12[kip]/(0.75[in]*26.31[in]) = **6391.12**[lb/in2]						9
Weld capacity	[Kip]	283.51	178.58	DL	0.63	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.15[kip/in]*1*5*26.31[in]) = **283.51**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_c/l$ = 67.11[kip]/26.31[in] = **2.55**[kip/in]						9
$f_{uv} = H_c/l$ = 126.12[kip]/26.31[in] = **4.79**[kip/in]						9
$f_{ub} = M_c/(l^2/6)$ = -2.98E-14[kip*ft]/(26.31[in]^2/6) = **-3.10E-15**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((2.55[kip/in] + 3.10E-15[kip/in])^2 + 4.79[kip/in^2])$^{1/2}$ = **5.43**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((2.55[kip/in] - 3.10E-15[kip/in])^2 + 4.79[kip/in^2])$^{1/2}$ + ((2.55[kip/in] + 3.10E-15[kip/in])^2 + 4.79[kip/in^2])$^{1/2}$) = **5.43**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 26.31[in]*max(5.43[kip/in], 1.25*5.43[kip/in]) = **178.58**[kip]						9

Column

Web crippling	[Kip]	444.29	67.11	DL1	0.15	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **26.31**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.44[in]^2*(1 + 3*(26.31[in]/14[in])*(0.44[in]/0.71[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.71[in]/0.44[in])^{1/2} =$ **444.29**[kip] Eq. J10-4

Local web yielding	[Kip]	481.98	67.11	DL	0.14	Eq. J10-2

IsBeamReaction → **False**

$N = N =$ **26.31**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.31[in] + 26.31[in])*50000[lb/in2]*0.44[in] =$
481.98[kip] Eq. J10-2

Ratio **0.63**

NOTATION

A_1: Base plate area

A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

A_2/A_1: Ratio between the concrete support area and the base plate area

b: Plate, connector or member width

B: Base plate design width

b_{eff}:Effective width of the compression block

B_{eff}: Controlling ffective width

B_{min}: Minimum base plate width perpendicular to moment direction

b_{rigid}: Transversal dimension of the surface on the base plate of the column and gussets

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

C_1: Electrode strength coefficient

C: Weld group coefficient

d_{rigid}: Longitudinal dimension of the surface on the base plate of the column and gussets

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

f'_c: Specified compressive strength of concrete

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

$f_{p,\,max}$: Maximum uniformly bearing stress under base plate

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

H_{Top}: Top horizontal component of the gusset forces

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

L: Distance from the anchor rod to the column

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

LoadAngleFactor: Load angle factor

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

m: Base plate bearing interface cantilever direction parallel to moment direction

M_{pl}: Plate bending moment per unit width

M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m

M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n

M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface

M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load

N: Bearing length

N: Base plate design length

n: Base plate bearing interface cantilever direction perpendicular to moment direction

N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction

N_{min}: Minimum base plate length parallel to moment direction

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)M_n$: Design or allowable strength per unit length

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_w$: Fillet weld capacity per unit length

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r: Uniform force method parameter

t_p: Thickness of the connected material

T: Anchor rod tensile strength required

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

θ: Load angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

VB-02 K Vertical Brace Connection

Connection ID	Column Size (Web/Flange)	Beam Size	Upper HSS Brace Slope Angles			Lower HSS Brace Slope Angles			Beam Reaction (kips) "R"	Upper Gusset Plate To HSS Brace Interface				Lower Gusset Plate To HSS Brace Interface				Upper Gusset Plate to Column Connection via Shear Tab								Upper Gusset Plate To Beam Flange via Direct Weld			Lower Gusset Plate to Column Connection via Shear Tab								LOW Gusset Plate To Beam Interface			Beam to Column Connnection Shear Tab Connection (Bolt Group Center at WP Elevation)						
			HSS Size	θ_1 (Deg)	HSS Axial Loading (kips) "$\perp$A1"	HSS Size	θ_2 (Deg)	HSS Brace Load (kips) "$\perp$A2"		A572 Gr.50 Plate Thickness (inch) tg1	Weld Size (inch) "W1"	Weld length (inch) "L1"	Max. Distance to face of beam/column flange (inch) Lu1	A572 Gr.50 Plate Thickness (inch) tg2	Weld Size (inch) "W2"	Weld length (inch) "L2"	Max. Distance to face of beam/column flange (inch) Lu2	A572 Gr.50 Shear Tab Thickness (inch) tp1	Bolt Quantity Row x Col. 3" Type Bolt Spa.	Bolt Grade & Size	Distance between Weld to First Bolt Line (inch) a1	Bolt edge distance "Vertical (inch)"	Bolt edge distance Horizontal (inch)	Shear Tab Weld Size on Column (inch) W_{c1}	Centroid of the Connection to Beam Flange Face β_1	Weld Size (inch) "W_{b1}"	Weld length (inch) "L_{b1}"	Centroid of the Connection to Column Face (inch) α_1	A572 Gr.50 Shear Tab Thickness (inch) tp2	Bolt Quantity Row x Col. 3" Type Bolt Spa.	Bolt Grade & Size"	Distance between Weld to First Bolt Line (inch) a2	Bolt edge distance Vertical (inch)"	Bolt edge distance Horizontal (inch)	Weld Size on Column (inch) "W_{c2}"	Centroid of the Connection to Beam Flange Face β_2	Weld Size (inch) "W_{b2}"	Weld length (inch) "L_{b2}"	Centroid of the Connection to Column Face (inch) α_2	A572 Gr.50 Shear Tab Thickness (inch) tp	Bolt Quantity Row x Col. 3" Type Bolt Spa.	Bolt Grade & Size	Distance between Weld to First Bolt Line (inch) a	Bolt edge distance "Vertical "Tl-ev"" (inch)"	Bolt edge distance Horizontal "Leh" (inch)	Weld Size on Column (inch) "W_c"
VB-02-1	W12x72 F	W18x50	HSS10x10x1/2	24.0	±168	HSS9x9x5/8	23.4	±168	35	1/2"	5/16"	14"	25.9	1/2"	5/16"	14"	24.9	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	5.81	5/16"	52.75	27.12	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	5.32	5/16"	52.37	26.94	3/4"	5x2	1" A490 SC	3"	1.75"	2"	1/2"
VB-02-2	W12x87 F	W18x50	HSS10x10x1/2	26.0	±168	HSS10x10x1/2	24	±168	35	1/2"	5/16"	14"	23.58	1/2"	5/16"	14"	24.6	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	6.45	5/16"	49.37	25.43	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	5.81	5/16"	52.51	27	3/4"	5x2	1" A490 SC	3"	1.75"	2"	1/2"
VB-02-3	W12x72 F	W18x50	HSS9x9x5/8	26.0	±147	HSS10x10x1/2	26	±168	35	1/2"	5/16"	14"	24.6	1/2"	5/16"	14"	25.7	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	6.15	5/16"	48.33	24.91	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	6.43	5/16"	49.47	25.48	3/4"	5x2	1" A490 SC	3"	1.75"	2"	1/2"
VB-02-4	W12x87 F	W18x50	HSS9x9x3/8	28.0	±52	HSS9x9x5/8	26	±147	35	1/2"	5/16"	10"	22.7	1/2"	5/16"	14"	23.58	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	5.8836	5/16"	41.98	21.74	1/2"	3x2	1" A490 SC	3"	1.75"	2"	5/16"	6.18	5/16"	48.23	24.86	3/4"	5x2	1" A490 SC	3"	1.75"	2"	1/2"
VB-02-5	W10x49 F	W21x50	HSS8x8x1/2	25.8	±60	HSS8x8x5/8	28	±100	38	1/2"	5/16"	10"	22.63	1/2"	5/16"	12"	18.78	1/2"	2x1	1" A490 SC	3"	1.75"	2"	5/16"	3.97	5/16"	47.87	24.68	1/2"	2x1	1" A490 SC	3"	1.75"	2"	5/16"	4.33	5/16"	43.92	22.7	1/2"	6x1	1" A490 SC	3"	1.75"	2"	5/16"
VB-02-6	W10x49 F	W21x50	HSS8x8x3/8	26.8	±25	HSS8x8x1/2	25.83	±60	38	1/2"	5/16"	10"	22.22	1/2"	5/16"	10"	22.63	1/2"	2x1	1" A490 SC	3"	1.75"	2"	5/16"	4.25	5/16"	46.41	23.95	1/2"	2x1	1" A490 SC	3"	1.75"	2"	5/16"	3.97	5/16"	47.87	24.68	1/2"	5x1	1" A490 SC	3"	1.75"	2"	5/16"
VB-02-7	W10x49 F	W21x50	HSS8x8x3/8	27.8	±25	HSS8x8x1/2	25.83	±60	38	1/2"	5/16"	10"	21.86	1/2"	5/16"	10"	22.63	1/2"	2x1	1" A490 SC	3"	1.75"	2"	5/16"	4.5	5/16"	45.11	23.3	1/2"	2x1	1" A490 SC	3"	1.75"	2"	5/16"	3.97	5/16"	47.87	24.68	1/2"	5x1	1" A490 SC	3"	1.75"	2"	5/16"
VB-02-9	W12x53 F	W21x44	HSS8x8x3/8	55.2	±102	HSS8x8x1/2	54.97	±152	35	1/2"	5/16"	10"	14.94	1/2"	5/16"	10"	14.76	1/2"	4x1	1" A490 SC	3"	1.75"	2"	5/16"	11.96	5/16"	17.44	9.47	1/2"	5x1	1" A490 SC	3"	1.75"	2"	5/16"	11.87	5/16"	17.55	9.5	3/4"	6x2	1" A490 SC	3"	1.75"	2"	1/2"
VB-02-10	W14x90 F	W21x44	HSS8x8x3/8	53.9	±112	HSS8x8x1/2	53.73	±186	30	1/2"	5/16"	10"	15.5	1/2"	5/16"	12"	15.3	1/2"	4x1	1" A490 SC	3"	1.75"	2"	5/16"	12	5/16"	17.66	9.33	1/2"	6x1	1" A490 SC	3"	1.75"	2"	5/16"	12.79	5/16"	18.46	10	3/4"	6x2	1" A490 SC	3"	1.75"	2"	1/2"

Braing force values (A1, and A2) are always in opposite direction.
All Bolts are slip-critical Type
Beam/gusset plate setback= 3/4" from column face

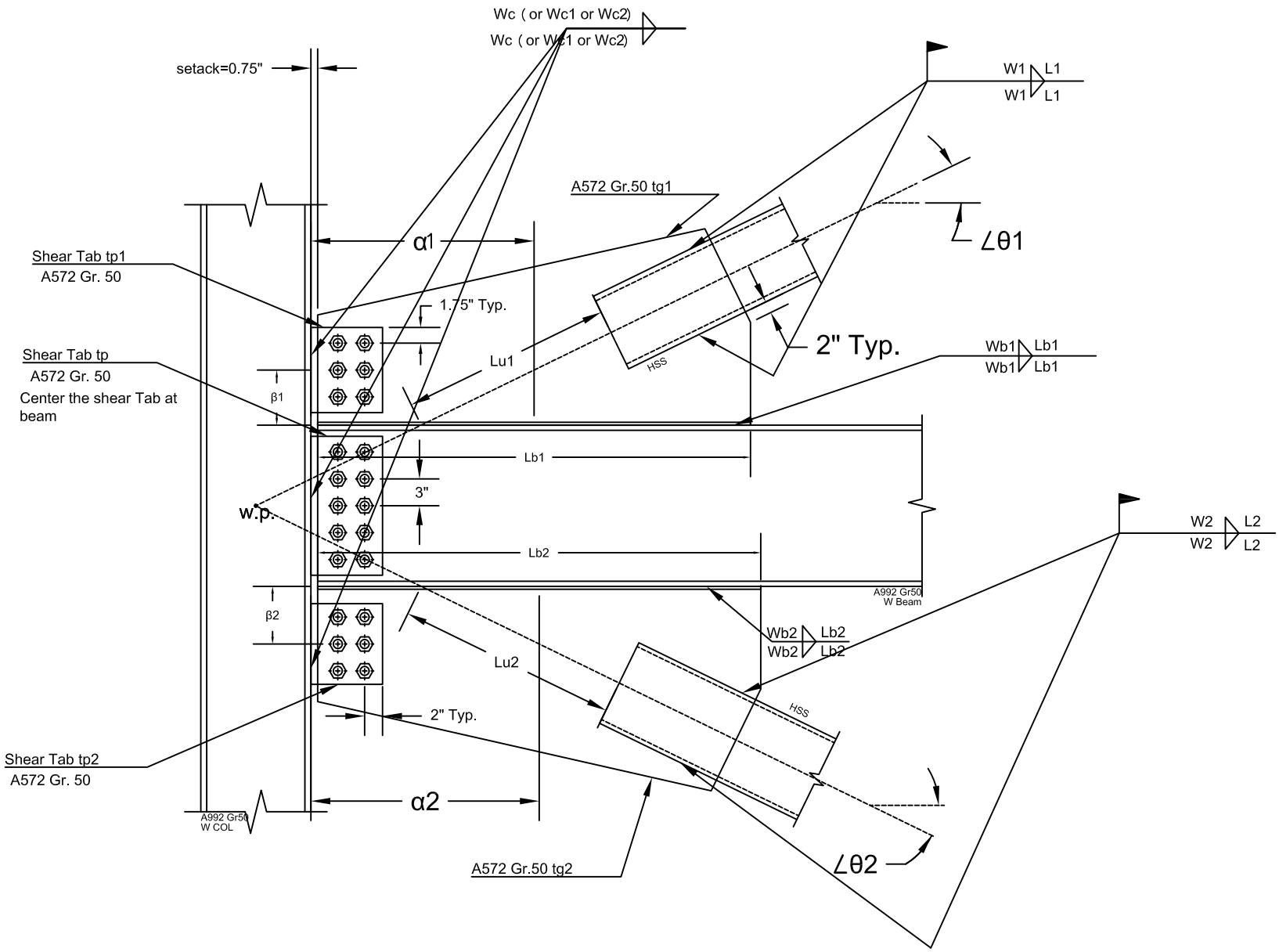
VB-02a K Vertical Brace Connection

Connection ID	Column Size (Web/Flange)	Beam Size	Upper Gusset Plate To HSS Brace Interface			Lower HSS Brace Slope Angles			Beam Reaction (kips) "R"	Upper Gusset Plate To HSS Brace Interface				Lower Gusset Plate To HSS Brace Interface				Upper Gusset Plate to Column Connection via Double Angle								Upper Gusset Plate To Beam Flange via Direct Weld			Lower Gusset Plate to Column Connection via Double Angle								LOW Gusset Plate To Beam Interface			Beam to Column Connnection Double Angle Connection (Bolt Group Center at WP Elevation)						
			HSS Size	θ_1 (Deg)	HSS Axial Loading (kips) "±A1"	HSS Size	θ2 (Deg)	HSS Brace Load (kips) "±A2"		A572 Gr.50 Plate Thickness (inch) tg1	Weld Size (inch) "W1"	Weld length (inch) "L1"	Max. Distance to face of beam/column flange (inch) Lu1	A572 Gr.50 Plate Thickness (inch) tg2	Weld Size (inch) "W2"	Weld length (inch) "L2"	Max. Distance to face of beam/column flange (inch) Lu2	Double Angle Size	Bolt Row 3" Type Bolt Spa.	Bolt Grade & Size	Bolt Gage on Column Web (inch) "Ga."	Bolt edge distance Vertical (inch)	Bolt edge distance Horizontal (inch)	Weld Size on Plate (inch) W_{u3}	Centroid of the Connection to Beam Flange Face β1	Weld Size (inch) "W_{u2}"	Weld length (inch) "L_{u2}"	Centroid of the Connection to Column Face (inch) a1	Double Angle Size	Bolt Row 3" Bolt Spa.	Bolt Grade & Size	Bolt Gage on Column Web (inch) "Ga."	Bolt edge distance Vertical (inch)	Bolt edge distance Horizontal (inch)	Weld Size on Plate (inch) W_{u3}	Centroid of the Connection to Beam Flange Face β2	Weld Size (inch) "W_{u1}"	Weld length (inch) "L_{u1}"	Centroid of the Connection to Column Face (inch) a2	Double Angle Size**	Bolt Quantity Row . 3" Type Bolt Spa.	Bolt Grade & Size	Bolt Gage on Column Web (inch) "Ga."	Bolt edge distance Vertical (inch)	Bolt edge distance Horizontal (inch)	Weld Size on Beam (inch) W_{u3}
VB-02-8	W14x90 W	W21x44	HSS8x8x3/8	55.2	±102	HSS8x8x1/2	54.97	±152	35	1/2"	5/16"	10"	6.3	1/2"	5/16"	10"	6.33	L5x5x5/16	4	1" A490 SC	6.25	1.75	Varies ≥ 1.25"	1/4"	8.4	1/4"	24.17	12.84	L5x5x5/16	4	1" A490 SC	6.25	1.75	Varies ≥ 1.25"	1/4"	8.4	1/4"	24.37	13.38	L5x5x3/8	4	1" A490 SC	6.25	1.75	Varies ≥ 1.25"	1/4"

Braing force values (A1, and A2) are always in opposite direction.
All Bolts are slip-critical Type
Beam/gusset plate setback= 3/4" from column face

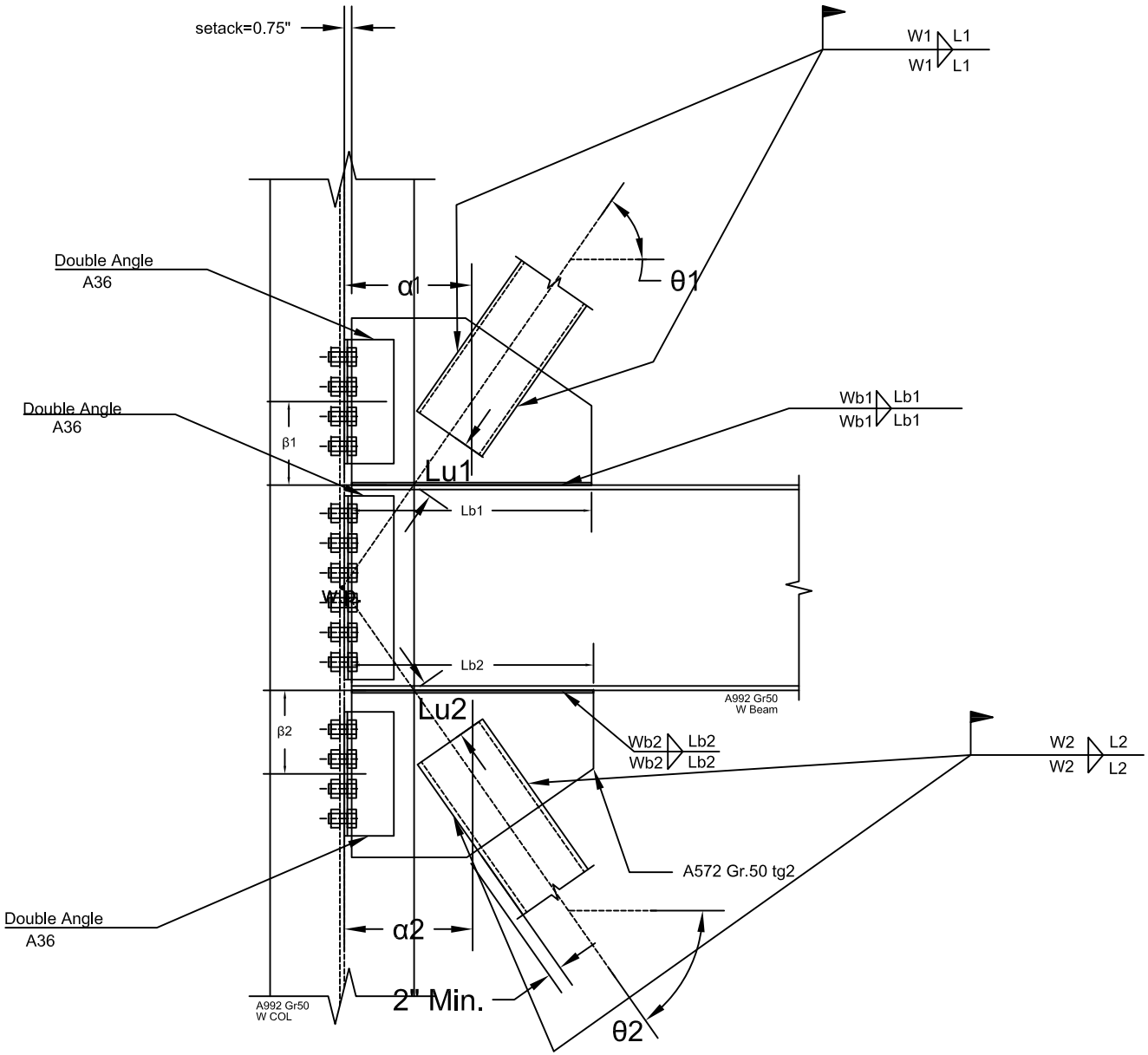
VB-02

K-Vertical Brace Connection



VB-02

K-Vertical Brace Connection



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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : **VB-02-1**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	168.00	0.00	0.00	-168.00	Design
DL1	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	-168.00	0.00	0.00	168.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
168.00	DL	Design
-168.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	168.00	DL	0.65	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$) =$ **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$) =$ **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	453.10	168.00	DL	0.37	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.465$[in] = **13.02**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*13.02$[in2]$) =$ **453.1**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	168.00	DL	0.62	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	380.00	168.00	DL	0.44	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 10$[in]$*0.5$[in] = **5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*5$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*5$[in2]$) =$ **380**[kip] Eq. J4-5

Ratio **0.65**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	473.77	168.00	DL	0.35	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*17.2$[in2] = **473.77**[kip] Eq. J4-1

Tension rupture	[Kip]	352.85	168.00	DL	0.48	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 17.2$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] = **16.62**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3.75_{[in]}/14_{[in]} = \mathbf{0.732}$ Table D3.1

$A_e = A_n*U = 16.62_{[in2]}*0.732 = \mathbf{12.17}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*12.17_{[in2]} = \mathbf{352.85}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	327.27	168.00	DL	0.51	Eq. J4-1

$A_g = L_w*t_p = 21.86_{[in]}*0.5_{[in]} = \mathbf{10.93}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*10.93_{[in2]} = \mathbf{327.27}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	187.10	168.00	DL1	0.90	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*19.79_{[in]}/0.144_{[in]})^2 = \mathbf{36039.7}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 36039.7_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}{}_{[lb/in2]}{}^{/36039.7}{}_{[lb/in2])}*50000_{[lb/in2]} =$

$\mathbf{27975.9}_{[lb/in2]}$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*27975.9_{[lb/in2]}*11.17_{[in2]} = \mathbf{187.1}_{[kip]}$ Eq. E3-1

Ratio **0.90**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.78}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.78_{[in]} + 9_{[in]})*2.25 - 6.15_{[in]} = \mathbf{27.05}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((27.05_{[in]} + 6.15_{[in]})^2 + (5.78_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{36.35}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 27.05_{[in]}*168_{[kip]}/36.35_{[in]} = \mathbf{125.05}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.15_{[in]}*168_{[kip]}/36.35_{[in]} = \mathbf{28.43}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*168_{[kip]}/36.35_{[in]} - 10_{[kip]} = \mathbf{31.6}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.78_{[in]}*168_{[kip]}/36.35_{[in]} + 10_{[kip]} = \mathbf{36.73}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(31.6_{[kip]}*(27.05_{[in]} - 27.05_{[in]})) + abs(10_{[kip]}*27.05_{[in]}) = \mathbf{22.54}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(28.43_{[kip]}*(5.78_{[in]} - 5.78_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.78}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.78_{[in]} + 9_{[in]})*2.25 - 6.15_{[in]} = \mathbf{27.05}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((27.05_{[in]} + 6.15_{[in]})^2 + (5.78_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{36.35}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 27.05_{[in]}*-168_{[kip]}/36.35_{[in]} = \mathbf{-125.05}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.15_{[in]}*-168_{[kip]}/36.35_{[in]} = \mathbf{-28.43}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*-168_{[kip]}/36.35_{[in]} - -10_{[kip]} = \mathbf{-31.6}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.78_{[in]}*-168_{[kip]}/36.35_{[in]} + -10_{[kip]} = \mathbf{-36.73}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-31.6_{[kip]}*(27.05_{[in]} - 27.05_{[in]})) + abs(-$

10[kip]*27.05[in]) = **22.54**[kip*ft] p. 13-10

M_c = abs(H_c*(β - $β_{bar}$)) = abs(-28.43[kip]*(5.78[in] - 5.78[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	125.05	31.60	22.54	0.00	0.00	0.00	Design
DL1	-125.05	-31.60	-22.54	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	787.53	62.46	DL	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 52.61[in]*0.5[in] = **26.3**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)*F_y*A_g$ = 0.599*50000[lb/in2]*26.3[in2] = **787.53**[kip]						Eq. J4-1
Shear yielding	[Kip]	526.07	125.05	DL	0.24	Eq. J4-3
$A_g = L_p*t_p$ = 52.61[in]*0.5[in] = **26.3**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*26.3[in2] = **526.07**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	173000.30	DL	0.04	J4-1
$(1/Ω)F_n = (1/Ω)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 31.6[kip]/(0.5[in]*52.61[in]) = **1201.39**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	684588.80	DL	0.24	J4-1
$(1/Ω)F_n = (1/Ω)$*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 125.05[kip]/(0.5[in]*52.61[in]) = **4754.09**[lb/in2]						9
Weld capacity	[Kip]	501.59	165.52	DL	0.33	Tables 8-4 .. 8-11
$(1/Ω)R_n$ = 2 * ($(1/Ω)*C*C_1*D*L$) = 2 * (0.5*1.91[kip/in]*1*5*52.61[in]) = **501.59**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 31.6[kip]/52.61[in] = **0.601**[kip/in]						9
$f_{uv} = H_b/l$ = 125.05[kip]/52.61[in] = **2.38**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 22.54[kip*ft]/(52.61[in]^2/6) = **0.587**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.601[kip/in] + 0.587[kip/in])^2 + 2.38[kip/in]^2)$^{1/2}$ = **2.66**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.601[kip/in] - 0.587[kip/in])^2 + 2.38[kip/in]^2)$^{1/2}$ + ((0.601[kip/in] + 0.587[kip/in])^2 + 2.38[kip/in]^2)$^{1/2}$) = **2.52**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 52.61[in]*max(2.66[kip/in], 1.25*2.52[kip/in]) =						

165.52[kip] 9

Beam

Weld block shear	[Kip]	426.38	125.05	DL	0.29	Eq. J4-5

$A_{gv} = l*t_w$ = 52.61[in]*0.355[in] = **18.68**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2] 8

$A_{nv} = A_{gv}$ = **18.68**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*18.68[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*18.68[in2] + 1*65000[lb/in2]*4.5[in2]) = **426.38**[kip] Eq. J4-5

Web crippling	[Kip]	408.39	31.60	DL1	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **52.61**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*
0.80*0.355[in]^2*(1 + 3*(52.61[in]/18[in])*(0.355[in]/0.57[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.57[in]/0.355[in])$^{1/2}$ = **408.39**[kip] Eq. J10-4

Local web yielding	[Kip]	680.02	31.60	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **52.61**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.972[in] + 52.61[in])*50000[lb/in2]*
0.355[in] = **680.02**[kip] Eq. J10-2

Ratio **0.33**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	36.73	28.43	0.00	0.00	0.00	Design
DL1	-36.73	-28.43	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	5.78	11.57	✔	p. 10-104

$L_{min} = T/2 = 11.57$[in]$/2 = \mathbf{5.78}$[in] p. 10-104

$L_{max} = L = \mathbf{11.57}$[in]

Thickness	[in]	0.50	--	1.38	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*15.79$[in] $= \mathbf{77.46}$[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*77.46$[kip*ft]$)/(50000$[lb/in2]$*9$[in]$^2) = \mathbf{1.38}$[in] p. 10-103

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $= \mathbf{1.25}$[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

$L_{emin} = 2*d = 2*1$[in] $= \mathbf{2}$[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*1$[in] $= \mathbf{2.67}$[in] Sec. J3.3

IsCorrosionConsidered $\rightarrow$ **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) = \mathbf{12}$[in] Sec. J3.5

Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d = 8/3*1$[in] $= \mathbf{2.67}$[in] Sec. J3.3

IsCorrosionConsidered $\rightarrow$ **False**

$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) = \mathbf{12}$[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.78	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $= \mathbf{1.25}$[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102

$L_{emin} = 2*d = 2*1$[in] $= \mathbf{2}$[in] p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101

$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $= \mathbf{0.026}$ p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	53.95	46.45	DL1	0.86	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = *C*(1/Ω)*R_n**BoltFactor* = 3.2*16.87[kip]*1 = **53.95**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	60.39	36.73	DL1	0.61	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **37.78**[kip] — Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] — Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.2*min(37.78[kip], 75.56[kip]) = **60.39**[kip] — p. 7-18

Shear yielding	[Kip]	90.00	36.73	DL	0.41	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.5[in] = **4.5**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.5[in2] = **90**[kip] — Eq. J4-3

Shear rupture	[Kip]	54.84	36.73	DL	0.67	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.5[in] = **2.81**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.81[in2] = **54.84**[kip] — Eq. J4-4

Block shear	[Kip]	72.62	36.73	DL	0.51	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.5[in] = **3.75**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.34**[in2] — Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.34[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.75[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **72.62**[kip] — Eq. J4-5

Flexural rupture	[Kip]	73.13	36.73	DL	0.50	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9[in]) = **6.75**[in3] — 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*6.75[in3]/3[in] = **73.13**[kip] — p. 9-6

Bolt bearing under axial load	[Kip]	91.56	28.43	DL	0.31	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.2*min(57.28[kip], 75.56[kip]) = **91.56**[kip] p. 7-18

Tension yielding	[Kip]	134.73	28.43	DL	0.21	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.5[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.5[in2] = **134.73**[kip] Eq. J4-1

Tension rupture	[Kip]	91.41	28.43	DL	0.31	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.5[in] = **4.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9[in] - 3*1.13[in])*0.5[in] = **2.81**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.5[in2], 2.81[in2]) = **2.81**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*2.81[in2] = **91.41**[kip] Eq. J4-2

Tear out under axial load	[Kip]	125.53	28.43	DL	0.23	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	103.52	46.45	DL1	0.45	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.6[kip/in]*1*5*9[in] = **103.52**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	22.27	9.18	DL	0.41	p. 10-103

A_g = L_p*t_p = 9[in]*0.5[in] = **4.5**[in2] Sec. D3-1

f_v = V/A_g = 36.73[kip]/4.5[in2] = **8162.47**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*8162.47[lb/in2]^2))$^{1/2}$ = **26391.91**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.5$[in]$*9$[in]$^2/4 =$ **10.13**[in3] T. 17-27

(1/Ω)$M_n = (1/\Omega)F_{cr}*Z = 26391.91$[lb/in2]$*10.13$[in3] = **22.27**[kip*ft] p. 10-103

Web crippling	[Kip]	194.81	28.43	DL1	0.15	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **6**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43$[in]$^2*(1 + 3*(6$[in]$/12.3$[in]$)*(0.43$[in]$/0.67$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.67[in]$/0.43$[in]$)^{1/2} =$ **194.81**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	120.78	36.73	DL1	0.30	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.78$[in]$ - 1.06$[in]$/2) =$ **2.25**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \text{min}(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*2.25$[in]$*0.5$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **78**[kip] Eq. J3-6

$r_{n2} = \text{min}(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*1.94$[in]$*0.5$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **75.56**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\text{min}(r_{n1}, r_{n2}) = 0.5*3.2*\text{min}(78$[kip], 75.56[kip]$) =$ **120.78**[kip] p. 7-18

Shear yielding	[Kip]	115.66	36.73	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 11.57$[in]$*0.5$[in]$ =$ **5.78**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*5.78$[in2] = **115.66**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	28.43	DL	0.13	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in]$ - 1.06$[in]$/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.72$[in]$, 2.4*1$[in]$) + \text{min}(1.2*1.94$[in]$, 2.4*1$[in]$)*(2 - 1))*0.5$[in]$*$
65000[lb/in2]$*3 =$ **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	173.15	28.43	DL	0.16	Eq. J4-1

$A_g = L_p*t_p = 11.57$[in]$*0.5$[in]$ =$ **5.78**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*5.78$[in2] = **173.15**[kip] Eq. J4-1

Tension rupture	[Kip]	133.11	28.43	DL	0.21	Eq. J4-2

$A_g = L_p*t_p = 11.57$[in]$*0.5$[in]$ =$ **5.78**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (11.57$[in]$ - 3*1.13$[in]$)*0.5$[in]$ =$ **4.1**[in2] Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*5.78$[in2], 4.1[in2]$) =$ **4.1**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*4.1$[in2] = **133.11**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	28.43	DL	0.22	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25$[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25$[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	49.97	DL1	0.16	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 46.45$[kip]/(0.5*4.6[kip/in]*1*9[in]) = **2.24** tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.24/16 [in] = **4.16**[kip/in] p. 9-5

Ratio **0.86**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-168.00	DL	Design
168.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	259.86	168.00	DL	0.65	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*$L = (2)^{1/2}$/2*5/16 [in]*14[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*3.09[in2]) = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*$L = (2)^{1/2}$/2*5/16 [in]*14[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*3.09[in2]) = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	168.00	DL	0.30	Eq. J4-4

$L_e = L_t + L_h = 14\text{[in]} + 14\text{[in]} = \mathbf{28}\text{[in]}$

$A_{nv} = L_e * t_p = 28\text{[in]} * 0.581\text{[in]} = \mathbf{16.27}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5 * 0.60 * 58000\text{[lb/in2]} * 16.27\text{[in2]}) = \mathbf{566.13}\text{[kip]}$ Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	168.00	DL	0.62	Eq. J4-4

$L_e = L_t + L_h = 14\text{[in]} + 14\text{[in]} = \mathbf{28}\text{[in]}$

$A_{nv} = L_e * t_p = 28\text{[in]} * 0.5\text{[in]} = \mathbf{14}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 65000\text{[lb/in2]} * 14\text{[in2]} = \mathbf{273}\text{[kip]}$ Eq. J4-4

Block shear on gusset	[Kip]	363.75	168.00	DL1	0.46	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14\text{[in]}, 14\text{[in]}) = \mathbf{14}\text{[in]}$

$L = L_{max} + d_w = 14\text{[in]} + 0.5\text{[in]} = \mathbf{14.5}\text{[in]}$ Sec. J4.3

$A_{gv} = 2 * L * t_p = 2 * 14.5\text{[in]} * 0.5\text{[in]} = \mathbf{14.5}\text{[in2]}$ Sec. J4.3

$A_{nv} = A_{gv} = \mathbf{14.5}\text{[in2]}$ Sec. J4.3

$A_{nt} = b * t_p = 9\text{[in]} * 0.5\text{[in]} = \mathbf{4.5}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$
$0.5 * \min(0.6 * 65000\text{[lb/in2]} * 14.5\text{[in2]} + 1 * 65000\text{[lb/in2]} * 4.5\text{[in2]}, 0.6 * 50000\text{[lb/in2]} * 14.5\text{[in2]} + 1 * 65000\text{[lb/in2]} * 4.5\text{[in2]}) = \mathbf{363.75}\text{[kip]}$ Eq. J4-5

Ratio **0.65**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	515.09	168.00	DL1	0.33	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 46000\text{[lb/in2]} * 18.7\text{[in2]} = \mathbf{515.09}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	395.58	168.00	DL1	0.42	Eq. J4-2

$A_n = A_g - 2 * (t_p + 1/8\text{ [in]}) * t = 18.7\text{[in2]} - 2 * (0.5\text{[in]} + 1/8\text{ [in]}) * 0.581\text{[in]} = \mathbf{17.97}\text{[in2]}$ Sec. D3.2

$U = 1 - x/l = 1 - 3.38\text{[in]}/14\text{[in]} = \mathbf{0.759}$ Table D3.1

$A_e = A_n * U = 17.97\text{[in2]} * 0.759 = \mathbf{13.64}\text{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 13.64\text{[in2]} = \mathbf{395.58}\text{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	310.42	168.00	DL1	0.54	Eq. J4-1

$A_g = L_w * t_p = 20.74\text{[in]} * 0.5\text{[in]} = \mathbf{10.37}\text{[in2]}$

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 50000\text{[lb/in2]} * 10.37\text{[in2]} = \mathbf{310.42}\text{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	180.93	168.00	DL	0.93	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*19.51$[in]$/0.144$[in]$)^2 =$ **37059.11**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 37059.11$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/37059.11$[lb/in2]$)*50000$[lb/in2] =

28426.35[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*28426.35$[lb/in2]$*10.63$[in2] = **180.93**[kip] Eq. E3-1

Ratio **0.93**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} =$ **5.32**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.32$[in]$ + 9$[in]$)*2.31 - 6.15$[in] = **26.94**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((26.94$[in]$ + 6.15$[in]$)^2 + (5.32$[in]$ + 9$[in]$)^2)^{1/2} =$ **36.05**[in] p. 13-5

$H_b = \alpha*P/r = 26.94$[in]$*-168$[kip]$/36.05$[in] = **-125.52**[kip] p. 13-5

$H_c = e_c*P/r = 6.15$[in]$*-168$[kip]$/36.05$[in] = **-28.66**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 9$[in]$*-168$[kip]$/36.05$[in] $- -10$[kip] = **-31.94**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 5.32$[in]$*-168$[kip]$/36.05$[in] $+ -10$[kip] = **-34.78**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-31.94$[kip]$*(26.94$[in]$ - 26.94$[in]$)) + abs(-10$[kip]$*26.94$[in]$) =$ **22.45**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-28.66$[kip]$*(5.32$[in]$ - 5.32$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} =$ **5.32**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.32$[in]$ + 9$[in]$)*2.31 - 6.15$[in] = **26.94**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((26.94$[in]$ + 6.15$[in]$)^2 + (5.32$[in]$ + 9$[in]$)^2)^{1/2} =$ **36.05**[in] p. 13-5

$H_b = \alpha*P/r = 26.94$[in]$*168$[kip]$/36.05$[in] = **125.52**[kip] p. 13-5

$H_c = e_c*P/r = 6.15$[in]$*168$[kip]$/36.05$[in] = **28.66**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 9$[in]$*168$[kip]$/36.05$[in] $- 10$[kip] = **31.94**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 5.32$[in]$*168$[kip]$/36.05$[in] $+ 10$[kip] = **34.78**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(31.94$[kip]$*(26.94$[in]$ - 26.94$[in]$)) +$

$abs(10$[kip]$*26.94$[in]$) =$ **22.45**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(28.66$[kip]$*(5.32$[in]$ - 5.32$[in]$)) =$ **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	

DL	-125.52	-31.94	-22.45	0.00	0.00	0.00	Design
DL1	125.52	31.94	22.45	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	784.03	62.80	DL1	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 52.37[in]*0.5[in] = **26.19**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*26.19[in2] = **784.03**[kip]						Eq. J4-1
Shear yielding	[Kip]	523.73	125.52	DL	0.24	Eq. J4-3
$A_g = L_p*t_p$ = 52.37[in]*0.5[in] = **26.19**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*26.19[in2] = **523.73**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	175638.30	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = -31.94[kip]/(0.5[in]*52.37[in]) = **-1219.71**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	690258.00	DL	0.24	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -125.52[kip]/(0.5[in]*52.37[in]) = **-4793.46**[lb/in2]						9
Weld capacity	[Kip]	499.63	166.18	DL	0.33	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.91[kip/in]*1*5*52.37[in]) = **499.63**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = -31.94[kip]/52.37[in] = **-0.61**[kip/in]						9
$f_{uv} = H_b/l$ = -125.52[kip]/52.37[in] = **-2.4**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -22.45[kip*ft]/(52.37[in]^2/6) = **-0.589**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.61[kip/in] + 0.589[kip/in])^2 + 2.4[kip/in]^2)$^{1/2}$ = **2.68**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.61[kip/in] - 0.589[kip/in])^2 + 2.4[kip/in]^2)$^{1/2}$ + ((0.61[kip/in] + 0.589[kip/in])^2 + 2.4[kip/in]^2)$^{1/2}$) = **2.54**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 52.37[in]*max(2.68[kip/in], 1.25*2.54[kip/in]) = **166.18**[kip]						9
Beam						
Weld block shear	[Kip]	425.14	125.52	DL	0.30	Eq. J4-5
$A_{gv} = l*t_w$ = 52.37[in]*0.355[in] = **18.59**[in2]						Sec. J4.3
$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2]						8
$A_{nv} = A_{gv}$ = **18.59**[in2]						Sec. J4.3
$A_{nt} = A_{gt}$ = **4.5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*18.59[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*18.59[in2] + 1*65000[lb/						

in2]*4.5[in2]) = **425.14**[kip] Eq. J4-5

Web crippling	[Kip]	406.91	31.94	DL	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **52.37**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
0.80*0.355[in]^2*(1 + 3*(52.37[in]/18[in])*(0.355[in]/0.57[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.57[in]/0.355[in])$^{1/2}$ = **406.91**[kip] Eq. J10-4

Local web yielding	[Kip]	677.26	31.94	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **52.37**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.972[in] + 52.37[in])*50000[lb/in2]*
0.355[in] = **677.26**[kip] Eq. J10-2

Ratio **0.33**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-34.78	-28.66	0.00	0.00	0.00	Design
DL1	34.78	28.66	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	5.32	10.64	✔	p. 10-104

$L_{min} = T/2$ = 10.64[in]/2 = **5.32**[in] p. 10-104

$L_{max} = L$ = **10.64**[in]

Thickness	[in]	0.50	--	1.38	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C'$ = 1.25*60000[lb/in2]*0.785[in2]*15.79[in] = **77.46**[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2)$ = (6*77.46[kip*ft])/(50000[lb/in2]*9[in]^2) = **1.38**[in] p. 10-103

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4,

						J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.32	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	54.56	45.07	DL	0.83	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 3.23*16.87[kip]*1 = **54.56**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	61.08	34.78	DL	0.57	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **37.78**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.23*min(37.78[kip], 75.56[kip]) = **61.08**[kip] p. 7-18

Shear yielding	[Kip]	90.00	34.78	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.5[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.5[in2] = **90**[kip] Eq. J4-3

Shear rupture	[Kip]	54.84	34.78	DL	0.63	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.5[in] = **2.81**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.81[in2] = **54.84**[kip] Eq. J4-4

Block shear	[Kip]	72.62	34.78	DL	0.48	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.5[in] = **3.75**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.34**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.34[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.75[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **72.62**[kip] Eq. J4-5

Flexural rupture	[Kip]	73.13	34.78	DL	0.48	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9[in]) = **6.75**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*6.75[in3]/3[in] = **73.13**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	92.60	28.66	DL1	0.31	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.23*min(57.28[kip], 75.56[kip]) = **92.6**[kip] p. 7-18

Tension yielding	[Kip]	134.73	28.66	DL1	0.21	Eq. J4-1
$A_g = L_p*t_p$ = 9[in]*0.5[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.5[in2] = **134.73**[kip]						Eq. J4-1
Tension rupture	[Kip]	91.41	28.66	DL1	0.31	Eq. J4-2
$A_g = L_p*t_p$ = 9[in]*0.5[in] = **4.5**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (9[in] - 3*1.13[in])*0.5[in] = **2.81**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*4.5[in2], 2.81[in2]) = **2.81**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.81[in2] = **91.41**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	125.53	28.66	DL1	0.23	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$n>1$ → 3>1 → **True**						
A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2]						Sec. J4-3
A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2]						Sec. J4-3
A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	104.71	45.07	DL	0.43	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.65[kip/in]*1*5*9[in] = **104.71**[kip]						Tables 8-4 .. 8-11
Flexure with the Von-Mises shear reduction	[Kip*ft]	22.60	8.70	DL	0.38	p. 10-103
$A_g = L_p*t_p$ = 9[in]*0.5[in] = **4.5**[in2]						Sec. D3-1
$f_v = V/A_g$ = -34.78[kip]/4.5[in2] = **-7729.09**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr}$ = (max(0, (($1/\Omega$)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*-7729.09[lb/in2^2]))$^{1/2}$ = **26780.48**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.5[in]*9[in]^2/4 = **10.13**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 26780.48[lb/in2]*10.13[in3] = **22.6**[kip*ft]						p. 10-103
Web crippling	[Kip]	194.81	28.66	DL	0.15	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **6**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*0.80*0.43[in]^2*(1 + 3*(6[in]/12.3[in])*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.67[in]/0.43[in])$^{1/2}$ = **194.81**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	112.64	34.78	DL	0.31	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.32[in] - 1.06[in]/2) = **1.79**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.79[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **69.68**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.23*min(69.68[kip], 75.56[kip]) = **112.64**[kip] p. 7-18

Shear yielding	[Kip]	106.36	34.78	DL	0.33	Eq. J4-3

A_g = L_p*t_p = 10.64[in]*0.5[in] = **5.32**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.32[in2] = **106.36**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	28.66	DL1	0.13	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*3 = **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	159.22	28.66	DL1	0.18	Eq. J4-1

A_g = L_p*t_p = 10.64[in]*0.5[in] = **5.32**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*5.32[in2] = **159.22**[kip] Eq. J4-1

Tension rupture	[Kip]	117.98	28.66	DL1	0.24	Eq. J4-2

A_g = L_p*t_p = 10.64[in]*0.5[in] = **5.32**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (10.64[in] - 3*1.13[in])*0.5[in] = **3.63**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.32[in2], 3.63[in2]) = **3.63**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*3.63[in2] = **117.98**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	28.66	DL1	0.22	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/

in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	47.94	DL1	0.15	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 45.07$[kip]$/(0.5*4.65$[kip/in]$*1*9$[in]$) =$ **2.15** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.15/16$ [in] = **3.99**[kip/in] p. 9-5

Ratio **0.83**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] $+ 125.05$[kip] $+ -125.52$[kip] = **-0.475**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip] $- 31.6$[kip] $+ -31.94$[kip] = **-28.54**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] $+ -125.05$[kip] $+ 125.52$[kip] = **0.475**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip] $- -31.6$[kip] $+ 31.94$[kip] = **98.54**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-28.54	-0.48	0.00	0.00	0.00	Design
DL1	98.54	0.48	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	8.03	16.06	✓	p. 10-104

$L_{min} = T/2 = 16.06$[in]$/2 =$ **8.03**[in] p. 10-104

$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18$[in] $- \max(0.972$[in]$, 0$[in]$) -$
$\max(0.972$[in]$, 0$[in]$) =$ **16.06**[in] p. 10-49

Thickness	[in]	0.75	--	1.21	✓	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*38.67$[in] = **189.72**[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*189.72$[kip*ft]$)/(50000$[lb/in2]$*15$[in]^2) = **1.21**[in] p. 10-103

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	8	8	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.75$[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	108.11	98.54	DL1	0.91 ●	Tables (7-1..14)
(*n*>=10) and (*n*<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6.41*16.87$[kip]$*1 =$ **108.11**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	181.54	98.54	DL1	0.54	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.41*min(56.67[kip], 113.34[kip]) = **181.54**[kip] p. 7-18

Shear yielding	[Kip]	225.00	98.54	DL1	0.44	Eq. J4-3

A_g = L_p*t_p = 15[in]*0.75[in] = **11.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.25[in2] = **225**[kip] Eq. J4-3

Shear rupture	[Kip]	137.11	98.54	DL1	0.72	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 15[in] - 5*1.13[in] = **9.38**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 9.38[in]*0.75[in] = **7.03**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*7.03[in2] = **137.11**[kip] Eq. J4-4

Block shear	[Kip]	163.77	98.54	DL1	0.60	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (5 - 1)*3[in])*0.75[in] = **10.13**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (5 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **6.33**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*6.33[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*10.13[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **163.77**[kip] Eq. J4-5

Flexural rupture	[Kip]	292.50	98.54	DL1	0.34	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75[in]/4*(15[in]^2 - 3[in]^2*5*(5^2 - 1)*1.13[in]/15[in]) = **27**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*27[in3]/3[in] = **292.5**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	275.23	0.48	DL1	0.00	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/

in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.41*min(85.92[kip], 113.34[kip]) = **275.23**[kip] p. 7-18

Tension yielding	[Kip]	336.83	0.48	DL1	0.00	Eq. J4-1

A_g = L_p*t_p = 15[in]*0.75[in] = **11.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*11.25[in2] = **336.83**[kip] Eq. J4-1

Tension rupture	[Kip]	228.52	0.48	DL1	0.00	Eq. J4-2

A_g = L_p*t_p = 15[in]*0.75[in] = **11.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (15[in] - 5*1.13[in])*0.75[in] = **7.03**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*11.25[in2], 7.03[in2]) = **7.03**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*7.03[in2] = **228.52**[kip] Eq. J4-2

Tear out under axial load	[Kip]	279.70	0.48	DL1	0.00	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.75[in] = **5.63**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*5.63[in2]) = **279.7**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	222.78	98.54	DL1	0.44	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.71[kip/in]*1*8*15[in] = **222.78**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	90.74	24.64	DL1	0.27	p. 10-103

A_g = L_p*t_p = 15[in]*0.75[in] = **11.25**[in2] Sec. D3-1

f_v = V/A_g = 98.54[kip]/11.25[in2] = **8759.16**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*8759.16[lb/in2]^2))$^{1/2}$ = **25811.67**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*15[in]^2/4 = **42.19**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 25811.67[lb/in2]*42.19[in3] = **90.74**[kip*ft] p. 10-103

Web crippling	[Kip]	278.46	0.48	DL	0.00	Eq. J10-4

IsBeamReaction → **False**

N = N = **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*
0.80*0.43[in]^2*(1 + 3*(12[in]/12.3[in])*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.67[in]/0.43[in])$^{1/2}$ = **278.46**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	171.85	98.54	DL1	0.57	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}/2) =$ **2.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \text{min}(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*2.47\text{[in]}*0.355\text{[in]}*65000\text{[lb/in2]}, 2.4*1\text{[in]}*0.355\text{[in]}*65000\text{[lb/in2]}) =$ **55.38**[kip] Eq. J3-6

$r_{n2} = \text{min}(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*1.94\text{[in]}*0.355\text{[in]}*65000\text{[lb/in2]}, 2.4*1\text{[in]}*0.355\text{[in]}*65000\text{[lb/in2]}) =$ **53.65**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\text{min}(r_{n1}, r_{n2}) = 0.5*6.41*\text{min}(55.38\text{[kip]}, 53.65\text{[kip]}) =$ **171.85**[kip] p. 7-18

Shear yielding	[Kip]	127.80	98.54	DL1	0.77	Eq. J4-3

$A_g = L_p*t_p = 18\text{[in]}*0.355\text{[in]} =$ **6.39**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*6.39\text{[in2]} =$ **127.8**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	253.10	0.48	DL1	0.00	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.355[in]*
65000[lb/in2]*5 = **253.1**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	0.48	DL1	0.00	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*14.7\text{[in2]} =$ **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	334.45	0.48	DL1	0.00	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 14.7\text{[in2]} - 5*0.355\text{[in]}*1.13\text{[in]} =$ **12.7**[in2] Sec. D3-2

$U = 1 - x/l = 1 - 1.14\text{[in]}/6\text{[in]} =$ **0.81** Table D3.1

$A_e = U*A_n = 0.81*12.7\text{[in2]} =$ **10.29**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*10.29\text{[in2]} =$ **334.45**[kip] Eq. J4-2

Tear out under axial load	[Kip]	135.85	0.48	DL1	0.00	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (2 - 1)*3\text{[in]})*0.355\text{[in]} =$ **3.73**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (2 - 1)*3\text{[in]} - 1.13\text{[in]}*(2 - 0.5))*0.355\text{[in]} =$ **2.53**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(5 - 1)*0.355\text{[in]} =$ **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000[lb/in2]*2.53[in2] + 1*65000[lb/in2]*2.66[in2], 0.6*50000[lb/in2]*3.73[in2] + 1*65000[lb/in2]*2.66[in2]) =$ **135.85**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	78.82	DL1	0.25	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.67[in] =$ **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 98.54[kip]/(0.5*3.71[kip/in]*1*15[in]) =$ **3.54** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*3.54/16$ [in] = **6.57**[kip/in] p. 9-5

Ratio **0.91**

Global critical strength ratio **0.93**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : VB-02-2

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18x50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	168.00	0.00	0.00	-168.00	Design
DL1	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	-168.00	0.00	0.00	168.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
168.00	DL	Design
-168.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	168.00	DL	0.65	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$) =$ **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$) =$ **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	453.10	168.00	DL	0.37	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.465$[in] = **13.02**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*13.02$[in2]$) =$ **453.1**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	168.00	DL	0.62	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	380.00	168.00	DL	0.44	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 10$[in]$*0.5$[in] = **5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*5$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*5$[in2]$) =$ **380**[kip] Eq. J4-5

Ratio **0.65**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	473.77	168.00	DL	0.35	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*17.2$[in2] = **473.77**[kip] Eq. J4-1

Tension rupture	[Kip]	352.85	168.00	DL	0.48	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 17.2$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] = **16.62**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3.75_{[in]}/14_{[in]} = \mathbf{0.732}$ Table D3.1

$A_e = A_n*U = 16.62_{[in2]}*0.732 = \mathbf{12.17}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*12.17_{[in2]} = \mathbf{352.85}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	336.81	168.00	DL	0.50	Eq. J4-1

$A_g = L_w*t_p = 22.5_{[in]}*0.5_{[in]} = \mathbf{11.25}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*11.25_{[in2]} = \mathbf{336.81}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	206.00	168.00	DL1	0.82	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*18.46_{[in]}/0.144_{[in]})^2 = \mathbf{41400.92}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 41400.92_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/41400.92_{[lb/in2]})}*50000_{[lb/in2]} =$

$\mathbf{30160.67}_{[lb/in2]}$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*30160.67_{[lb/in2]}*11.41_{[in2]} = \mathbf{206}_{[kip]}$ Eq. E3-1

Ratio **0.82**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{6.45}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (6.45_{[in]} + 9_{[in]})*2.05 - 6.25_{[in]} = \mathbf{25.43}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((25.43_{[in]} + 6.25_{[in]})^2 + (6.45_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{35.25}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 25.43_{[in]}*168_{[kip]}/35.25_{[in]} = \mathbf{121.21}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.25_{[in]}*168_{[kip]}/35.25_{[in]} = \mathbf{29.79}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*168_{[kip]}/35.25_{[in]} - 10_{[kip]} = \mathbf{32.89}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 6.45_{[in]}*168_{[kip]}/35.25_{[in]} + 10_{[kip]} = \mathbf{40.75}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(32.89_{[kip]}*(25.43_{[in]} - 25.43_{[in]})) + abs(10_{[kip]}*25.43_{[in]}) = \mathbf{21.19}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(29.79_{[kip]}*(6.45_{[in]} - 6.45_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{6.45}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (6.45_{[in]} + 9_{[in]})*2.05 - 6.25_{[in]} = \mathbf{25.43}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((25.43_{[in]} + 6.25_{[in]})^2 + (6.45_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{35.25}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 25.43_{[in]}*-168_{[kip]}/35.25_{[in]} = \mathbf{-121.21}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.25_{[in]}*-168_{[kip]}/35.25_{[in]} = \mathbf{-29.79}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*-168_{[kip]}/35.25_{[in]} - -10_{[kip]} = \mathbf{-32.89}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 6.45_{[in]}*-168_{[kip]}/35.25_{[in]} + -10_{[kip]} = \mathbf{-40.75}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-32.89_{[kip]}*(25.43_{[in]} - 25.43_{[in]})) + abs(-$

10[kip]*25.43[in]) = **21.19**[kip*ft] p. 13-10

M_c = abs(H_c*(β - $β_{bar}$)) = abs(-29.79[kip]*(6.45[in] - 6.45[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	121.21	32.89	21.19	0.00	0.00	0.00	Design
DL1	-121.21	-32.89	-21.19	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	739.03	63.80	DL	0.09	Eq. J4-1
$A_g = L_p*t_p$ = 49.37[in]*0.5[in] = **24.68**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)*F_y*A_g$ = 0.599*50000[lb/in2]*24.68[in2] = **739.03**[kip]						Eq. J4-1
Shear yielding	[Kip]	493.67	121.21	DL	0.25	Eq. J4-3
$A_g = L_p*t_p$ = 49.37[in]*0.5[in] = **24.68**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*24.68[in2] = **493.67**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	191885.60	DL	0.04	J4-1
$(1/Ω)F_n = (1/Ω)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 32.89[kip]/(0.5[in]*49.37[in]) = **1332.54**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	707123.80	DL	0.25	J4-1
$(1/Ω)F_n = (1/Ω)$*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 121.21[kip]/(0.5[in]*49.37[in]) = **4910.58**[lb/in2]						9
Weld capacity	[Kip]	474.36	161.38	DL	0.34	Tables 8-4 .. 8-11
$(1/Ω)R_n$ = 2 * $((1/Ω)*C*C_1*D*L)$ = 2 * (0.5*1.92[kip/in]*1*5*49.37[in]) = **474.36**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 32.89[kip]/49.37[in] = **0.666**[kip/in]						9
$f_{uv} = H_b/l$ = 121.21[kip]/49.37[in] = **2.46**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 21.19[kip*ft]/(49.37[in]^2/6) = **0.626**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.666[kip/in] + 0.626[kip/in])^2 + 2.46[kip/in]^2)$^{1/2}$ = **2.77**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.666[kip/in] - 0.626[kip/in])^2 + 2.46[kip/in]^2)$^{1/2}$ + ((0.666[kip/in] + 0.626[kip/in])^2 + 2.46[kip/in]^2)$^{1/2}$) = **2.62**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 49.37[in]*max(2.77[kip/in], 1.25*2.62[kip/in]) =						

161.38[kip] 9

Beam

Weld block shear	[Kip]	409.13	121.21	DL	0.30	Eq. J4-5

$A_{gv} = l*t_w$ = 49.37[in]*0.355[in] = **17.53**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2] 8

$A_{nv} = A_{gv}$ = **17.53**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*17.53[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*17.53[in2] + 1*65000[lb/in2]*4.5[in2]) = **409.13**[kip] Eq. J4-5

Web crippling	[Kip]	387.98	32.89	DL1	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **49.37**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*

0.80*0.355[in]^2*(1 + 3*(49.37[in]/18[in])*(0.355[in]/0.57[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*

0.57[in]/0.355[in])$^{1/2}$ = **387.98**[kip] Eq. J10-4

Local web yielding	[Kip]	641.69	32.89	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **49.37**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.972[in] + 49.37[in])*50000[lb/in2]*

0.355[in] = **641.69**[kip] Eq. J10-2

Ratio **0.34**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	40.75	29.79	0.00	0.00	0.00	Design
DL1	-40.75	-29.79	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.50	6.45	12.91	✔	p. 10-104

L_{min} = T/2 = 12.91[in]/2 = **6.45**[in] p. 10-104

L_{max} = L = **12.91**[in]

Thickness	[in]	0.50	--	1.24	✔	p. 10-103

M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*15.79[in] = **77.46**[kip*ft] p. 10-103

t_{max} = (6*M_{max})/(F_y*d^2) = (6*77.46[kip*ft])/(50000[lb/in2]*9.5[in]^2) = **1.24**[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in] Sec. J3.5

Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	3.45	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101

w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	53.42	50.48	DL1	0.94	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 3.17*16.87[kip]*1 = **53.42**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	75.24	40.75	DL1	0.54	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **47.53**[kip] — Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] — Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.17*min(47.53[kip], 75.56[kip]) = **75.24**[kip] — p. 7-18

Shear yielding	[Kip]	95.00	40.75	DL	0.43	Eq. J4-3

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.75[in2] = **95**[kip] — Eq. J4-3

Shear rupture	[Kip]	59.72	40.75	DL	0.68	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 9.5[in] - 3*1.13[in] = **6.13**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.13[in]*0.5[in] = **3.06**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.06[in2] = **59.72**[kip] — Eq. J4-4

Block shear	[Kip]	75.05	40.75	DL	0.54	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (3 - 1)*3[in])*0.5[in] = **3.88**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.47**[in2] — Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.47[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.88[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **75.05**[kip] — Eq. J4-5

Flexural rupture	[Kip]	87.58	40.75	DL	0.47	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9.5[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9.5[in]) = **8.08**[in3] — 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*8.08[in3]/3[in] = **87.58**[kip] — p. 9-6

Bolt bearing under axial load	[Kip]	90.67	29.79	DL	0.33	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.17*min(57.28[kip], 75.56[kip]) = **90.67**[kip] p. 7-18

Tension yielding	[Kip]	142.22	29.79	DL	0.21	Eq. J4-1

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.75[in2] = **142.22**[kip] Eq. J4-1

Tension rupture	[Kip]	99.53	29.79	DL	0.30	Eq. J4-2

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9.5[in] - 3*1.13[in])*0.5[in] = **3.06**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.75[in2], 3.06[in2]) = **3.06**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*3.06[in2] = **99.53**[kip] Eq. J4-2

Tear out under axial load	[Kip]	125.53	29.79	DL	0.24	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	108.15	50.48	DL	0.47	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.55[kip/in]*1*5*9.5[in] = **108.15**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	24.43	10.19	DL	0.42	p. 10-103

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

f_v = V/A_g = 40.75[kip]/4.75[in2] = **8579.87**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*8579.87[lb/in2]^2))$^{1/2}$ = **25991.7**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.5$[in]$*9.5$[in]$^2/4 =$ **11.28**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 25991.7$[lb/in2]$*11.28$[in3] $=$ **24.43**[kip*ft] p. 10-103

Web crippling	[Kip]	277.17	29.79	DL1	0.11	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **6**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515$[in]$^2*(1 + 3*(6$[in]$/12.5$[in]$)*(0.515$[in]$/0.81$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.81[in]$/0.515$[in]$)^{1/2} =$ **277.17**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	119.61	40.75	DL1	0.34	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.45$[in]$ - 1.06$[in]$/2) =$ **2.92**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.92$[in]$*0.5$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **78**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.5$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **75.56**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*3.17*\min(78$[kip], 75.56[kip]$) =$ **119.61**[kip] p. 7-18

Shear yielding	[Kip]	129.06	40.75	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 12.91$[in]$*0.5$[in]$ =$ **6.45**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*6.45$[in2] $=$ **129.06**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	29.79	DL	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in]$ - 1.06$[in]$/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(2 - 1))*0.5$[in]$*$
65000[lb/in2]$*3 =$ **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	193.21	29.79	DL	0.15	Eq. J4-1

$A_g = L_p*t_p = 12.91$[in]$*0.5$[in]$ =$ **6.45**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*6.45$[in2] $=$ **193.21**[kip] Eq. J4-1

Tension rupture	[Kip]	154.88	29.79	DL	0.19	Eq. J4-2

$A_g = L_p*t_p = 12.91$[in]$*0.5$[in]$ =$ **6.45**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (12.91$[in]$ - 3*1.13$[in]$)*0.5$[in]$ =$ **4.77**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*6.45$[in2], 4.77[in2]$) =$ **4.77**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*4.77$[in2] $=$ **154.88**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	29.79	DL	0.23	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25$[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25$[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	51.98	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 50.48$[kip]/(0.5*4.55[kip/in]*1*9.5[in]) = **2.33** tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.33/16 [in] = **4.33**[kip/in] p. 9-5

Ratio **0.94**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-168.00	DL	Design
168.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	259.86	168.00	DL	0.65	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*$L = (2)^{1/2}$/2*5/16 [in]*14[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*3.09[in2]) = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*$L = (2)^{1/2}$/2*5/16 [in]*14[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*3.09[in2]) = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	453.10	168.00	DL	0.37	Eq. J4-4
$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]						
$A_{nv} = L_e * t_p = 28$[in]*0.465[in] = **13.02**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]*13.02[in2]) = **453.1**[kip]						Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	168.00	DL	0.62	Eq. J4-4
$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]						
$A_{nv} = L_e * t_p = 28$[in]*0.5[in] = **14**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]*14[in2] = **273**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	380.00	168.00	DL1	0.44	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]) = **14**[in]						
$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*14.5$[in]*0.5[in] = **14.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **14.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 10$[in]*0.5[in] = **5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]*14.5[in2] + 1*65000[lb/in2]*5[in2], 0.6*50000[lb/in2]*14.5[in2] + 1*65000[lb/in2]*5[in2]) = **380**[kip]						Eq. J4-5

Ratio **0.65**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	473.77	168.00	DL1	0.35	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]*17.2[in2] = **473.77**[kip]						Eq. J4-1
Tension rupture	[Kip]	352.85	168.00	DL1	0.48	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in])$*t = 17.2$[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **16.62**[in2]						Sec. D3.2
$U = 1 - x/l = 1 - 3.75$[in]/14[in] = **0.732**						Table D3.1
$A_e = A_n*U = 16.62$[in2]*0.732 = **12.17**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]*12.17[in2] = **352.85**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	327.37	168.00	DL1	0.51	Eq. J4-1
$A_g = L_w*t_p = 21.87$[in]*0.5[in] = **10.93**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]*10.93[in2] = **327.37**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	187.55	168.00	DL	0.90	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*19.75$[in]$/0.144$[in]$)^2 =$ **36172.97**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 36172.97$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/36172.97$[lb/in2]$)*50000$[lb/in2] =

28035.81[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*28035.81$[lb/in2]$*11.17$[in2] = **187.55**[kip] Eq. E3-1

Ratio **0.90**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} =$ **5.81**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.81$[in]$ + 9$[in]$)*2.25 - 6.25$[in] = **27**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((27$[in]$ + 6.25$[in]$)^2 + (5.81$[in]$ + 9$[in]$)^2)^{1/2} =$

36.4[in] p. 13-5

$H_b = \alpha*P/r = 27$[in]$*-168$[kip]$/36.4$[in] = **-124.63**[kip] p. 13-5

$H_c = e_c*P/r = 6.25$[in]$*-168$[kip]$/36.4$[in] = **-28.85**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 9$[in]$*-168$[kip]$/36.4$[in] - -10[kip] = **-31.54**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 5.81$[in]$*-168$[kip]$/36.4$[in] + -10[kip] = **-36.79**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-31.54$[kip]$*(27$[in]$ - 27$[in]$)) + abs(-$

10[kip]$*27$[in]$) =$ **22.5**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-28.85$[kip]$*(5.81$[in]$ - 5.81$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} =$ **5.81**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.81$[in]$ + 9$[in]$)*2.25 - 6.25$[in] = **27**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((27$[in]$ + 6.25$[in]$)^2 + (5.81$[in]$ + 9$[in]$)^2)^{1/2} =$

36.4[in] p. 13-5

$H_b = \alpha*P/r = 27$[in]$*168$[kip]$/36.4$[in] = **124.63**[kip] p. 13-5

$H_c = e_c*P/r = 6.25$[in]$*168$[kip]$/36.4$[in] = **28.85**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 9$[in]$*168$[kip]$/36.4$[in] - 10[kip] = **31.54**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 5.81$[in]$*168$[kip]$/36.4$[in] + 10[kip] = **36.79**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(31.54$[kip]$*(27$[in]$ - 27$[in]$)) + abs(10$[kip]$*$

27[in]$) =$ **22.5**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(28.85$[kip]$*(5.81$[in]$ - 5.81$[in]$)) =$ **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	

DL	-124.63	-31.54	-22.50	0.00	0.00	0.00	Design
DL1	124.63	31.54	22.50	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	786.03	62.40	DL1	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 52.51[in]*0.5[in] = **26.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*26.25[in2] = **786.03**[kip]						Eq. J4-1
Shear yielding	[Kip]	525.07	124.63	DL	0.24	Eq. J4-3
$A_g = L_p*t_p$ = 52.51[in]*0.5[in] = **26.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*26.25[in2] = **525.07**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	172986.70	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = -31.54[kip]/(0.5[in]*52.51[in]) = **-1201.3**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	683595.60	DL	0.24	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -124.63[kip]/(0.5[in]*52.51[in]) = **-4747.19**[lb/in2]						9
Weld capacity	[Kip]	500.74	165.00	DL	0.33	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.91[kip/in]*1*5*52.51[in]) = **500.74**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = -31.54[kip]/52.51[in] = **-0.601**[kip/in]						9
$f_{uv} = H_b/l$ = -124.63[kip]/52.51[in] = **-2.37**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -22.5[kip*ft]/(52.51[in]^2/6) = **-0.588**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.601[kip/in] + 0.588[kip/in])^2 + 2.37[kip/in]^2)$^{1/2}$ = **2.65**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.601[kip/in] - 0.588[kip/in])^2 + 2.37[kip/in]^2)$^{1/2}$ + ((0.601[kip/in] + 0.588[kip/in])^2 + 2.37[kip/in]^2)$^{1/2}$) = **2.51**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 52.51[in]*max(2.65[kip/in], 1.25*2.51[kip/in]) = **165**[kip]						9
Beam						
Weld block shear	[Kip]	425.85	124.63	DL	0.29	Eq. J4-5
$A_{gv} = l*t_w$ = 52.51[in]*0.355[in] = **18.64**[in2]						Sec. J4.3
$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2]						8
$A_{nv} = A_{gv}$ = **18.64**[in2]						Sec. J4.3
$A_{nt} = A_{gt}$ = **4.5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*18.64[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*18.64[in2] + 1*65000[lb/in2]*4.5[in2]) = **425.85**[kip]						Eq. J4-5

Web crippling	[Kip]	407.76	31.54	DL	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{52.51}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.355$[in]$^2*(1 + 3*(52.51$[in]$/18$[in]$)*(0.355$[in]$/0.57$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.57[in]$/0.355$[in]$)^{1/2} = \mathbf{407.76}$[kip] Eq. J10-4

Local web yielding	[Kip]	678.84	31.54	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N = \mathbf{52.51}$[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*0.972$[in] $+ 52.51$[in]$)*50000$[lb/in2]$*$
0.355[in] $= \mathbf{678.84}$[kip] Eq. J10-2

Ratio **0.33**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-36.79	-28.85	0.00	0.00	0.00	Design
DL1	36.79	28.85	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.50	5.81	11.61	✔	p. 10-104

$L_{min} = T/2 = 11.61$[in]$/2 = \mathbf{5.81}$[in] p. 10-104

$L_{max} = L = \mathbf{11.61}$[in]

Thickness	[in]	0.50	--	1.24	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*15.79$[in] $= \mathbf{77.46}$[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*77.46$[kip*ft]$)/(50000$[lb/in2]$*9.5$[in]$^2) = \mathbf{1.24}$[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $= \mathbf{1.25}$[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.81	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	54.07	46.75	DL1	0.86	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 3.2*16.87[kip]*1 = **54.07**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	76.15	36.79	DL1	0.48	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **47.53**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.2*min(47.53[kip], 75.56[kip]) = **76.15**[kip] p. 7-18

Shear yielding	[Kip]	95.00	36.79	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.75[in2] = **95**[kip] Eq. J4-3

Shear rupture	[Kip]	59.72	36.79	DL	0.62	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9.5[in] - 3*1.13[in] = **6.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.13[in]*0.5[in] = **3.06**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.06[in2] = **59.72**[kip] Eq. J4-4

Block shear	[Kip]	75.05	36.79	DL	0.49	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (3 - 1)*3[in])*0.5[in] = **3.88**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.47**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.47[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.88[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **75.05**[kip] Eq. J4-5

Flexural rupture	[Kip]	87.58	36.79	DL	0.42	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9.5[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9.5[in]) = **8.08**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*8.08[in3]/3[in] = **87.58**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	91.77	28.85	DL1	0.31	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.2*min(57.28[kip], 75.56[kip]) = **91.77**[kip] p. 7-18

Tension yielding	[Kip]	142.22	28.85	DL1	0.20	Eq. J4-1
$A_g = L_p*t_p$ = 9.5[in]*0.5[in] = **4.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.75[in2] = **142.22**[kip]						Eq. J4-1
Tension rupture	[Kip]	99.53	28.85	DL1	0.29	Eq. J4-2
$A_g = L_p*t_p$ = 9.5[in]*0.5[in] = **4.75**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (9.5[in] - 3*1.13[in])*0.5[in] = **3.06**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*4.75[in2], 3.06[in2]) = **3.06**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.06[in2] = **99.53**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	125.53	28.85	DL1	0.23	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
n>1 → 3>1 → **True**						
$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2]						Sec. J4-3
$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2]						Sec. J4-3
$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	109.53	46.75	DL1	0.43	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.61[kip/in]*1*5*9.5[in] = **109.53**[kip]						Tables 8-4 .. 8-11
Flexure with the Von-Mises shear reduction	[Kip*ft]	25.16	9.20	DL	0.37	p. 10-103
$A_g = L_p*t_p$ = 9.5[in]*0.5[in] = **4.75**[in2]						Sec. D3-1
$f_v = V/A_g$ = -36.79[kip]/4.75[in2] = **-7746.04**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr}$ = (max(0, $((1/\Omega)*F_y)^2$ - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*-7746.04[lb/in2]^2))$^{1/2}$ = **26765.79**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.5[in]*9.5[in]^2/4 = **11.28**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 26765.79[lb/in2]*11.28[in3] = **25.16**[kip*ft]						p. 10-103
Web crippling	[Kip]	277.17	28.85	DL	0.10	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **6**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.515[in]^2*(1 + 3*(6[in]/12.5[in])*(0.515[in]/0.81[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])$^{1/2}$ = **277.17**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	121.06	36.79	DL1	0.30	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.81[in] - 1.06[in]/2) = **2.27**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*2.27[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **78**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.2*min(78[kip], 75.56[kip]) = **121.06**[kip] p. 7-18

Shear yielding	[Kip]	116.11	36.79	DL	0.32	Eq. J4-3

A_g = L_p*t_p = 11.61[in]*0.5[in] = **5.81**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.81[in2] = **116.11**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	28.85	DL1	0.13	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*3 = **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	173.81	28.85	DL1	0.17	Eq. J4-1

A_g = L_p*t_p = 11.61[in]*0.5[in] = **5.81**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*5.81[in2] = **173.81**[kip] Eq. J4-1

Tension rupture	[Kip]	133.83	28.85	DL1	0.22	Eq. J4-2

A_g = L_p*t_p = 11.61[in]*0.5[in] = **5.81**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (11.61[in] - 3*1.13[in])*0.5[in] = **4.12**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.81[in2], 4.12[in2]) = **4.12**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*4.12[in2] = **133.83**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	28.85	DL1	0.22	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	47.54	DL1	0.13	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] =$ **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 46.75[kip]/(0.5*4.61[kip/in]*1*9.5[in]) =$ **2.13** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*2.13/16$ [in] = **3.96**[kip/in] p. 9-5

Ratio **0.86**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + 121.21[kip] + -124.63[kip] =$ **-3.42**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35[kip] - 32.89[kip] + -31.54[kip] =$ **-29.43**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -121.21[kip] + 124.63[kip] =$ **3.42**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35[kip] - -32.89[kip] + 31.54[kip] =$ **99.43**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-29.43	-3.42	0.00	0.00	0.00	Design
DL1	99.43	3.42	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.50	8.03	16.06	✔	p. 10-104

$L_{min} = T/2 = 16.06[in]/2 =$ **8.03**[in] p. 10-104

$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18[in] - \max(0.972[in], 0[in]) -$
$\max(0.972[in], 0[in]) =$ **16.06**[in] p. 10-49

Thickness	[in]	0.75	--	1.14	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*38.67[in] =$ **189.72**[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*189.72[kip*ft])/(50000[lb/in2]*15.5[in]^2) =$ **1.14**[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	8	8	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.75$[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	107.93	99.49	DL1	0.92	Tables (7-1..14)
(*n*>=10) and (*n*<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6.4*16.87$[kip]$*1 =$ **107.93**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	228.02	99.43	DL1	0.44	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **71.3**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.4*min(71.3[kip], 113.34[kip]) = **228.02**[kip] p. 7-18

Shear yielding	[Kip]	232.50	99.43	DL1	0.43	Eq. J4-3

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.63[in2] = **232.5**[kip] Eq. J4-3

Shear rupture	[Kip]	144.42	99.43	DL1	0.69	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 15.5[in] - 5*1.13[in] = **9.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 9.88[in]*0.75[in] = **7.41**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*7.41[in2] = **144.42**[kip] Eq. J4-4

Block shear	[Kip]	167.43	99.43	DL1	0.59	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (5 - 1)*3[in])*0.75[in] = **10.31**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **6.52**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*6.52[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*10.31[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **167.43**[kip] Eq. J4-5

Flexural rupture	[Kip]	328.78	99.43	DL1	0.30	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75[in]/4*(15.5[in]^2 - 3[in]^2*5*(5^2 - 1)*1.13[in]/15.5[in]) = **30.35**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*30.35[in3]/3[in] = **328.78**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	274.79	3.42	DL1	0.01	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.4*min(85.92[kip], 113.34[kip]) = **274.79**[kip] p. 7-18

Tension yielding	[Kip]	348.05	3.42	DL1	0.01	Eq. J4-1

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*11.63[in2] = **348.05**[kip] Eq. J4-1

Tension rupture	[Kip]	240.70	3.42	DL1	0.01	Eq. J4-2

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (15.5[in] - 5*1.13[in])*0.75[in] = **7.41**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*11.63[in2], 7.41[in2]) = **7.41**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*7.41[in2] = **240.7**[kip] Eq. J4-2

Tear out under axial load	[Kip]	279.70	3.42	DL1	0.01	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.75[in] = **5.63**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*5.63[in2]) = **279.7**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	230.90	99.49	DL1	0.43	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.72[kip/in]*1*8*15.5[in] = **230.9**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	97.67	24.86	DL1	0.25	p. 10-103

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

f_v = V/A_g = 99.43[kip]/11.63[in2] = **8553.12**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*8553.12[lb/in2]^2))$^{1/2}$ = **26018.13**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*15.5[in]^2/4 = **45.05**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 26018.13[lb/in2]*45.05[in3] = **97.67**[kip*ft] p. 10-103

Web crippling	[Kip]	394.14	3.42	DL	0.01	Eq. J10-4

IsBeamReaction → **False**

N = N = **12**[in] Sec. J10-2

(1/Ω)R_n = *(1/Ω)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ = 0.5*

$0.80*0.515_{[in]}^2*(1 + 3*(12_{[in]}/12.5_{[in]})*(0.515_{[in]}/0.81_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*0.81_{[in]}/0.515_{[in]})^{1/2}$ = **394.14**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	171.58	99.43	DL1	0.58	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3[in] - 1.06[in]/2) = **2.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*2.47[in]*0.355[in]*65000[lb/in2], 2.4*1[in]*0.355[in]*65000[lb/in2]) = **55.38**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.355[in]*65000[lb/in2], 2.4*1[in]*0.355[in]*65000[lb/in2]) = **53.65**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.4*min(55.38[kip], 53.65[kip]) = **171.58**[kip] p. 7-18

Shear yielding	[Kip]	127.80	99.43	DL1	0.78	Eq. J4-3

A_g = L_p*t_p = 18[in]*0.355[in] = **6.39**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.39[in2] = **127.8**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	253.10	3.42	DL1	0.01	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.355[in]*65000[lb/in2]*5 = **253.1**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	3.42	DL1	0.01	Eq. D2-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*14.7[in2] = **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	334.45	3.42	DL1	0.01	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 14.7[in2] - 5*0.355[in]*1.13[in] = **12.7**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.14[in]/6[in] = **0.81** Table D3.1

A_e = U*A_n = 0.81*12.7[in2] = **10.29**[in2] Sec. D3-3

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*10.29[in2] = **334.45**[kip] Eq. J4-2

Tear out under axial load	[Kip]	135.85	3.42	DL1	0.03	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.355[in] = **3.73**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.355[in] = **2.53**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.355[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*2.53[in2] + 1*65000[lb/in2]*2.66[in2], 0.6*50000[lb/in2]*3.73[in2] + 1*65000[lb/in2]*2.66[in2]) =$ **135.85**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	76.78	DL1	0.20	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] =$ **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 99.49[kip]/(0.5*3.72[kip/in]*1*15.5[in]) =$ **3.45** tables 8-4..11

$HasWeldsOnBothSides \rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*3.45/16$ [in] = **6.4**[kip/in] p. 9-5

Ratio **0.92**

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : VB-02-3

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18x50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	147.00	0.00	0.00	-168.00	Design
DL1	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	-147.00	0.00	0.00	168.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
147.00	DL	Design
-147.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	147.00	DL	0.57	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$) =$ **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$) =$ **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	147.00	DL	0.26	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.581$[in] = **16.27**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*16.27$[in2]$) =$ **566.13**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	147.00	DL	0.54	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	363.75	147.00	DL	0.40	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2]$) =$ **363.75**[kip] Eq. J4-5

Ratio **0.57**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	515.09	147.00	DL	0.29	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*18.7$[in2] = **515.09**[kip] Eq. J4-1

Tension rupture	[Kip]	395.58	147.00	DL	0.37	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 18.7$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.581$[in] = **17.97**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3.38_{[in]}/14_{[in]} = \mathbf{0.759}$ Table D3.1

$A_e = A_n*U = 17.97_{[in2]}*0.759 = \mathbf{13.64}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*13.64_{[in2]} = \mathbf{395.58}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	322.63	147.00	DL	0.46	Eq. J4-1

$A_g = L_w*t_p = 21.55_{[in]}*0.5_{[in]} = \mathbf{10.78}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*10.78_{[in2]} = \mathbf{322.63}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	203.56	147.00	DL1	0.72	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*17.9_{[in]}/0.144_{[in]})^2 = \mathbf{44056.29}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 44056.29_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/44056.29_{[lb/in2]})}*50000_{[lb/in2]} =$

$\mathbf{31093.7}_{[lb/in2]}$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*31093.7_{[lb/in2]}*10.93_{[in2]} = \mathbf{203.56}_{[kip]}$ Eq. E3-1

Ratio **0.72**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{6.15}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (6.15_{[in]} + 9_{[in]})*2.05 - 6.15_{[in]} = \mathbf{24.91}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((24.91_{[in]} + 6.15_{[in]})^2 + (6.15_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{34.56}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 24.91_{[in]}*147_{[kip]}/34.56_{[in]} = \mathbf{105.96}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.15_{[in]}*147_{[kip]}/34.56_{[in]} = \mathbf{26.16}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*147_{[kip]}/34.56_{[in]} - 10_{[kip]} = \mathbf{28.28}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 6.15_{[in]}*147_{[kip]}/34.56_{[in]} + 10_{[kip]} = \mathbf{36.16}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(28.28_{[kip]}*(24.91_{[in]} - 24.91_{[in]})) + abs(10_{[kip]}*24.91_{[in]}) = \mathbf{20.76}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(26.16_{[kip]}*(6.15_{[in]} - 6.15_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{6.15}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (6.15_{[in]} + 9_{[in]})*2.05 - 6.15_{[in]} = \mathbf{24.91}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((24.91_{[in]} + 6.15_{[in]})^2 + (6.15_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{34.56}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 24.91_{[in]}*-147_{[kip]}/34.56_{[in]} = \mathbf{-105.96}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.15_{[in]}*-147_{[kip]}/34.56_{[in]} = \mathbf{-26.16}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*-147_{[kip]}/34.56_{[in]} - -10_{[kip]} = \mathbf{-28.28}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 6.15_{[in]}*-147_{[kip]}/34.56_{[in]} + -10_{[kip]} = \mathbf{-36.16}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-28.28_{[kip]}*(24.91_{[in]} - 24.91_{[in]})) + abs(-$

10[kip]*24.91[in]) = **20.76**[kip*ft] p. 13-10

M_c = abs(H_c*(β - $β_{bar}$)) = abs(-26.16[kip]*(6.15[in] - 6.15[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	105.96	28.28	20.76	0.00	0.00	0.00	Design
DL1	-105.96	-28.28	-20.76	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	723.46	59.21	DL	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 48.33[in]*0.5[in] = **24.16**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)*F_y*A_g$ = 0.599*50000[lb/in2]*24.16[in2] = **723.46**[kip]						Eq. J4-1
Shear yielding	[Kip]	483.27	105.96	DL	0.22	Eq. J4-3
$A_g = L_p*t_p$ = 48.33[in]*0.5[in] = **24.16**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*24.16[in2] = **483.27**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	168532.10	DL	0.04	J4-1
$(1/Ω)F_n = (1/Ω)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 28.28[kip]/(0.5[in]*48.33[in]) = **1170.36**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	631489.30	DL	0.22	J4-1
$(1/Ω)F_n = (1/Ω)$*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 105.96[kip]/(0.5[in]*48.33[in]) = **4385.34**[lb/in2]						9
Weld capacity	[Kip]	464.75	142.11	DL	0.31	Tables 8-4 .. 8-11
$(1/Ω)R_n$ = 2 * $((1/Ω)*C*C_1*D*L)$ = 2 * (0.5*1.92[kip/in]*1*5*48.33[in]) = **464.75**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 28.28[kip]/48.33[in] = **0.585**[kip/in]						9
$f_{uv} = H_b/l$ = 105.96[kip]/48.33[in] = **2.19**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 20.76[kip*ft]/(48.33[in]^2/6) = **0.64**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.585[kip/in] + 0.64[kip/in])^2 + 2.19[kip/in]^2)$^{1/2}$ = **2.51**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.585[kip/in] - 0.64[kip/in])^2 + 2.19[kip/in]^2)$^{1/2}$ + ((0.585[kip/in] + 0.64[kip/in])^2 + 2.19[kip/in]^2)$^{1/2}$) = **2.35**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 48.33[in]*max(2.51[kip/in], 1.25*2.35[kip/in]) =						

142.11[kip] 9

Beam

Weld block shear	[Kip]	403.59	105.96	DL	0.26	Eq. J4-5

$A_{gv} = l*t_w$ = 48.33[in]*0.355[in] = **17.16**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2] 8

$A_{nv} = A_{gv}$ = **17.16**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*17.16[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*17.16[in2] + 1*65000[lb/in2]*4.5[in2]) = **403.59**[kip] Eq. J4-5

Web crippling	[Kip]	368.37	28.34	DL1	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **46.26**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E*F_{yw}*t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.355[in]^2*(1 + 3*(46.26[in]/18[in])*(0.355[in]/0.57[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.57[in]/0.355[in])$^{1/2}$ = **368.37**[kip] Eq. J10-4

Local web yielding	[Kip]	604.87	28.34	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **46.26**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)$*(5*$k$ + N)*F_{yw}*t_w = 0.667*(5*0.972[in] + 46.26[in])*50000[lb/in2]*
0.355[in] = **604.87**[kip] Eq. J10-2

Ratio **0.31**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	36.16	26.16	0.00	0.00	0.00	Design
DL1	-36.16	-26.16	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.50	6.15	12.30	✔	p. 10-104

L_{min} = T/2 = 12.3[in]/2 = **6.15**[in] p. 10-104

L_{max} = L = **12.3**[in]

Thickness	[in]	0.50	--	1.24	✔	p. 10-103

M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*15.79[in] = **77.46**[kip*ft] p. 10-103

t_{max} = (6*M_{max})/(F_y*d^2) = (6*77.46[kip*ft])/(50000[lb/in2]*9.5[in]^2) = **1.24**[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in] Sec. J3.5

Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	3.15	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101

w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	53.33	44.63	DL	0.84	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 3.16*16.87[kip]*1 = **53.33**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	75.11	36.16	DL	0.48	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **47.53**[kip] — Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] — Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.16*min(47.53[kip], 75.56[kip]) = **75.11**[kip] — p. 7-18

Shear yielding	[Kip]	95.00	36.16	DL	0.38	Eq. J4-3

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.75[in2] = **95**[kip] — Eq. J4-3

Shear rupture	[Kip]	59.72	36.16	DL	0.61	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 9.5[in] - 3*1.13[in] = **6.13**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.13[in]*0.5[in] = **3.06**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.06[in2] = **59.72**[kip] — Eq. J4-4

Block shear	[Kip]	75.05	36.16	DL	0.48	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (3 - 1)*3[in])*0.5[in] = **3.88**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.47**[in2] — Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.47[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.88[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **75.05**[kip] — Eq. J4-5

Flexural rupture	[Kip]	87.58	36.16	DL	0.41	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9.5[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9.5[in]) = **8.08**[in3] — 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*8.08[in3]/3[in] = **87.58**[kip] — p. 9-6

Bolt bearing under axial load	[Kip]	90.52	26.16	DL	0.29	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.16*min(57.28[kip], 75.56[kip]) = **90.52**[kip] p. 7-18

Tension yielding	[Kip]	142.22	26.16	DL	0.18	Eq. J4-1

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.75[in2] = **142.22**[kip] Eq. J4-1

Tension rupture	[Kip]	99.53	26.16	DL	0.26	Eq. J4-2

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9.5[in] - 3*1.13[in])*0.5[in] = **3.06**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.75[in2], 3.06[in2]) = **3.06**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*3.06[in2] = **99.53**[kip] Eq. J4-2

Tear out under axial load	[Kip]	125.53	26.16	DL	0.21	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	107.95	44.63	DL	0.41	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.55[kip/in]*1*5*9.5[in] = **107.95**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	25.27	9.04	DL	0.36	p. 10-103

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

f_v = V/A_g = 36.16[kip]/4.75[in2] = **7612.77**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*7612.77[lb/in2]^2))$^{1/2}$ = **26880.26**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.5$[in]$*9.5$[in]$^2/4 =$ **11.28**[in3] T. 17-27

(1/Ω)$M_n = (1/\Omega)F_{cr}*Z = 26880.26$[lb/in2]$*11.28$[in3] = **25.27**[kip*ft] p. 10-103

Web crippling	[Kip]	194.81	26.16	DL1	0.13	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **6**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43$[in]$^2*(1 + 3*(6$[in]$/12.3$[in]$)*(0.43$[in]$/0.67$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.67[in]$/0.43$[in]$)^{1/2} =$ **194.81**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	119.40	36.16	DL	0.30	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.15$[in]$ - 1.06$[in]$/2) =$ **2.62**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.62$[in]$*0.5$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **78**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.5$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **75.56**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*3.16*\min(78$[kip]$, 75.56$[kip]$) =$ **119.4**[kip] p. 7-18

Shear yielding	[Kip]	123.01	36.16	DL	0.29	Eq. J4-3

$A_g = L_p*t_p = 12.3$[in]$*0.5$[in]$ =$ **6.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*6.15$[in2] = **123.01**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	26.16	DL	0.12	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in]$ - 1.06$[in]$/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(2 - 1))*0.5$[in]$*$
65000[lb/in2]$*3 =$ **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	184.15	26.16	DL	0.14	Eq. J4-1

$A_g = L_p*t_p = 12.3$[in]$*0.5$[in]$ =$ **6.15**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*6.15$[in2] = **184.15**[kip] Eq. J4-1

Tension rupture	[Kip]	145.05	26.16	DL	0.18	Eq. J4-2

$A_g = L_p*t_p = 12.3$[in]$*0.5$[in]$ =$ **6.15**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (12.3$[in]$ - 3*1.13$[in]$)*0.5$[in]$ =$ **4.46**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*6.15$[in2]$, 4.46$[in2]$) =$ **4.46**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*4.46$[in2] = **145.05**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	26.16	DL	0.20	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in]$ + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25$[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25$[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	46.04	DL	0.15	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 44.63$[kip]/(0.5*4.55[kip/in]*1*9.5[in]) = **2.07** tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.07/16 [in] = **3.84**[kip/in] p. 9-5

Ratio **0.84**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-168.00	DL	Design
168.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	259.86	168.00	DL	0.65	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*$L = (2)^{1/2}$/2*5/16 [in]*14[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*3.09[in2]) = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*$L = (2)^{1/2}$/2*5/16 [in]*14[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*3.09[in2]) = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	453.10	168.00	DL	0.37	Eq. J4-4
$L_e = L_t + L_h$ = 14[in] + 14[in] = **28**[in]						
$A_{nv} = L_e * t_p$ = 28[in]*0.465[in] = **13.02**[in2]						Sec. J4-2
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*13.02[in2]) = **453.1**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	273.00	168.00	DL	0.62	Eq. J4-4
$L_e = L_t + L_h$ = 14[in] + 14[in] = **28**[in]						
$A_{nv} = L_e * t_p$ = 28[in]*0.5[in] = **14**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u$*$A_{nv}$ = 0.5*0.60*65000[lb/in2]*14[in2] = **273**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	380.00	168.00	DL1	0.44	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(14[in], 14[in])$ = **14**[in]						
$L = L_{max} + d_w$ = 14[in] + 0.5[in] = **14.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p$ = 2*14.5[in]*0.5[in] = **14.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv}$ = **14.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p$ = 10[in]*0.5[in] = **5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*14.5[in2] + 1*65000[lb/in2]*5[in2], 0.6*50000[lb/in2]*14.5[in2] + 1*65000[lb/in2]*5[in2]) = **380**[kip]						Eq. J4-5

Ratio	**0.65**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	473.77	168.00	DL1	0.35	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*17.2[in2] = **473.77**[kip]						Eq. J4-1
Tension rupture	[Kip]	352.85	168.00	DL1	0.48	Eq. J4-2
$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 17.2[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **16.62**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3.75[in]/14[in] = **0.732**						Table D3.1
$A_e = A_n*U$ = 16.62[in2]*0.732 = **12.17**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*12.17[in2] = **352.85**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	336.68	168.00	DL1	0.50	Eq. J4-1
$A_g = L_w*t_p$ = 22.49[in]*0.5[in] = **11.25**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*11.25[in2] = **336.68**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	205.50	168.00	DL	0.82	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*18.5$[in]$/0.144$[in]$)^2 =$ **41235.1**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 41235.1$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/41235.1$[lb/in2]$)*50000$[lb/in2] =

30099.42[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*30099.42$[lb/in2]$*11.4$[in2] = **205.5**[kip] Eq. E3-1

Ratio **0.82**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} =$ **6.43**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (6.43$[in]$ + 9$[in]$)*2.05 - 6.15$[in] = **25.48**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((25.48$[in]$ + 6.15$[in]$)^2 + (6.43$[in]$ + 9$[in]$)^2)^{1/2} =$ **35.2**[in] p. 13-5

$H_b = \alpha*P/r = 25.48$[in]$*-168$[kip]$/35.2$[in] = **-121.64**[kip] p. 13-5

$H_c = e_c*P/r = 6.15$[in]$*-168$[kip]$/35.2$[in] = **-29.36**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 9$[in]$*-168$[kip]$/35.2$[in] $- -10$[kip] = **-32.96**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 6.43$[in]$*-168$[kip]$/35.2$[in] $+ -10$[kip] = **-40.69**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-32.96$[kip]$*(25.48$[in]$ - 25.48$[in]$)) + abs(-10$[kip]$*25.48$[in]$) =$ **21.24**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-29.36$[kip]$*(6.43$[in]$ - 6.43$[in]$)) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} =$ **6.43**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (6.43$[in]$ + 9$[in]$)*2.05 - 6.15$[in] = **25.48**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((25.48$[in]$ + 6.15$[in]$)^2 + (6.43$[in]$ + 9$[in]$)^2)^{1/2} =$ **35.2**[in] p. 13-5

$H_b = \alpha*P/r = 25.48$[in]$*168$[kip]$/35.2$[in] = **121.64**[kip] p. 13-5

$H_c = e_c*P/r = 6.15$[in]$*168$[kip]$/35.2$[in] = **29.36**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 9$[in]$*168$[kip]$/35.2$[in] $- 10$[kip] = **32.96**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 6.43$[in]$*168$[kip]$/35.2$[in] $+ 10$[kip] = **40.69**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(32.96$[kip]$*(25.48$[in]$ - 25.48$[in]$)) +$ $abs(10$[kip]$*25.48$[in]$) =$ **21.24**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(29.36$[kip]$*(6.43$[in]$ - 6.43$[in]$)) =$ **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	

DL	-121.64	-32.96	-21.24	0.00	0.00	0.00	Design
DL1	121.64	32.96	21.24	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	740.53	63.87	DL1	0.09	Eq. J4-1
$A_g = L_p*t_p$ = 49.47[in]*0.5[in] = **24.73**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*24.73[in2] = **740.53**[kip]						Eq. J4-1
Shear yielding	[Kip]	494.67	121.64	DL	0.25	Eq. J4-3
$A_g = L_p*t_p$ = 49.47[in]*0.5[in] = **24.73**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*24.73[in2] = **494.67**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	191892.40	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = -32.96[kip]/(0.5[in]*49.47[in]) = **-1332.59**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	708199.20	DL	0.25	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -121.64[kip]/(0.5[in]*49.47[in]) = **-4918.05**[lb/in2]						9
Weld capacity	[Kip]	475.21	161.91	DL	0.34	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.92[kip/in]*1*5*49.47[in]) = **475.21**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = -32.96[kip]/49.47[in] = **-0.666**[kip/in]						9
$f_{uv} = H_b/l$ = -121.64[kip]/49.47[in] = **-2.46**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -21.24[kip*ft]/(49.47[in]^2/6) = **-0.625**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.666[kip/in] + 0.625[kip/in])^2 + 2.46[kip/in]^2)$^{1/2}$ = **2.78**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.666[kip/in] - 0.625[kip/in])^2 + 2.46[kip/in]^2)$^{1/2}$ + ((0.666[kip/in] + 0.625[kip/in])^2 + 2.46[kip/in]^2)$^{1/2}$) = **2.62**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 49.47[in]*max(2.78[kip/in], 1.25*2.62[kip/in]) = **161.91**[kip]						9
Beam						
Weld block shear	[Kip]	409.67	121.64	DL	0.30	Eq. J4-5
$A_{gv} = l*t_w$ = 49.47[in]*0.355[in] = **17.56**[in2]						Sec. J4.3
$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2]						8
$A_{nv} = A_{gv}$ = **17.56**[in2]						Sec. J4.3
$A_{nt} = A_{gt}$ = **4.5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*17.56[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*17.56[in2] + 1*65000[lb/						

in2]*4.5[in2]) = **409.67**[kip] Eq. J4-5

Web crippling	[Kip]	388.61	32.96	DL	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **49.47**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
0.80*0.355[in]^2*(1 + 3*(49.47[in]/18[in])*(0.355[in]/0.57[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.57[in]/0.355[in])$^{1/2}$ = **388.61**[kip] Eq. J10-4

Local web yielding	[Kip]	642.87	32.96	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **49.47**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.972[in] + 49.47[in])*50000[lb/in2]*
0.355[in] = **642.87**[kip] Eq. J10-2

Ratio **0.34**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-40.69	-29.36	0.00	0.00	0.00	Design
DL1	40.69	29.36	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	6.43	12.86	✔	p. 10-104

$L_{min} = T/2$ = 12.86[in]/2 = **6.43**[in] p. 10-104

$L_{max} = L$ = **12.86**[in]

Thickness	[in]	0.50	--	1.38	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C'$ = 1.25*60000[lb/in2]*0.785[in2]*15.79[in] = **77.46**[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2)$ = (6*77.46[kip*ft])/(50000[lb/in2]*9[in]^2) = **1.38**[in] p. 10-103

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4,

						J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.43	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	53.31	50.17	DL1	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 3.16*16.87[kip]*1 = **53.31**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	59.68	40.69	DL1	0.68	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **37.78**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.16*min(37.78[kip], 75.56[kip]) = **59.68**[kip] p. 7-18

Shear yielding	[Kip]	90.00	40.69	DL	0.45	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.5[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.5[in2] = **90**[kip] Eq. J4-3

Shear rupture	[Kip]	54.84	40.69	DL	0.74	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.5[in] = **2.81**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.81[in2] = **54.84**[kip] Eq. J4-4

Block shear	[Kip]	72.62	40.69	DL	0.56	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.5[in] = **3.75**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.34**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.34[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.75[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **72.62**[kip] Eq. J4-5

Flexural rupture	[Kip]	73.13	40.69	DL	0.56	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9[in]) = **6.75**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*6.75[in3]/3[in] = **73.13**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	90.48	29.36	DL1	0.32	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.16*min(57.28[kip], 75.56[kip]) = **90.48**[kip] p. 7-18

Tension yielding	[Kip]	134.73	29.36	DL1	0.22	Eq. J4-1
$A_g = L_p*t_p$ = 9[in]*0.5[in] = **4.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.5[in2] = **134.73**[kip]						Eq. J4-1
Tension rupture	[Kip]	91.41	29.36	DL1	0.32	Eq. J4-2
$A_g = L_p*t_p$ = 9[in]*0.5[in] = **4.5**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (9[in] - 3*1.13[in])*0.5[in] = **2.81**[in2]						Sec. D3-2
$A_e = \min(0.85*A_g, A_n) = \min(0.85*4.5[in2], 2.81[in2])$ = **2.81**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.81[in2] = **91.41**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	125.53	29.36	DL1	0.23	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$n>1 \rightarrow 3>1$ → **True**						
$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2]						Sec. J4-3
$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2]						Sec. J4-3
$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	102.22	50.17	DL	0.49	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.54[kip/in]*1*5*9[in] = **102.22**[kip]						Tables 8-4 .. 8-11
Flexure with the Von-Mises shear reduction	[Kip*ft]	21.53	10.17	DL	0.47	p. 10-103
$A_g = L_p*t_p$ = 9[in]*0.5[in] = **4.5**[in2]						Sec. D3-1
$f_v = V/A_g$ = -40.69[kip]/4.5[in2] = **-9041.46**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000[lb/in2])^2 - 3*-9041.46[lb/in2]^2))^{1/2}$ = **25517.97**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.5[in]*9[in]^2/4 = **10.13**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 25517.97[lb/in2]*10.13[in3] = **21.53**[kip*ft]						p. 10-103
Web crippling	[Kip]	194.81	29.36	DL	0.15	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **6**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.43[in]^2*(1 + 3*(6[in]/12.3[in])*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.67[in]/0.43[in])$^{1/2}$ = **194.81**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	119.35	40.69	DL1	0.34	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3.43[in] - 1.06[in]/2) = **2.9**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*2.9[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **78**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.16*min(78[kip], 75.56[kip]) = **119.35**[kip] p. 7-18

Shear yielding	[Kip]	128.58	40.69	DL	0.32	Eq. J4-3

A_g = L_p*t_p = 12.86[in]*0.5[in] = **6.43**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.43[in2] = **128.58**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	29.36	DL1	0.14	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*3 = **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	192.48	29.36	DL1	0.15	Eq. J4-1

A_g = L_p*t_p = 12.86[in]*0.5[in] = **6.43**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*6.43[in2] = **192.48**[kip] Eq. J4-1

Tension rupture	[Kip]	154.09	29.36	DL1	0.19	Eq. J4-2

A_g = L_p*t_p = 12.86[in]*0.5[in] = **6.43**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (12.86[in] - 3*1.13[in])*0.5[in] = **4.74**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*6.43[in2], 4.74[in2]) = **4.74**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*4.74[in2] = **154.09**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	29.36	DL1	0.23	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/

in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	54.66	DL	0.17	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 50.17$[kip]$/(0.5*4.54$[kip/in]$*1*9$[in]$) =$ **2.45** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.45/16$ [in] = **4.56**[kip/in] p. 9-5

Ratio **0.94**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] $+ 105.96$[kip] $+ -121.64$[kip] = **-15.68**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip] $- 28.28$[kip] $+ -32.96$[kip] = **-26.24**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] $+ -105.96$[kip] $+ 121.64$[kip] = **15.68**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip] $- -28.28$[kip] $+ 32.96$[kip] = **96.24**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-26.24	-15.68	0.00	0.00	0.00	Design
DL1	96.24	15.68	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.50	8.03	16.06	✓	p. 10-104

$L_{min} = T/2 = 16.06$[in]$/2 =$ **8.03**[in] p. 10-104

$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18$[in] $- \max(0.972$[in]$, 0$[in]$) -$
$\max(0.972$[in]$, 0$[in]$) =$ **16.06**[in] p. 10-49

Thickness	[in]	0.75	--	1.14	✓	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*38.67$[in] = **189.72**[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*189.72$[kip*ft]$)/(50000$[lb/in2]$*15.5$[in]^2) = **1.14**[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	8	8	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.75$[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	107.55	97.51	DL1	0.91 ●	Tables (7-1..14)
(*n*>=10) and (*n*<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6.37*16.87$[kip]$*1 =$ **107.55**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	227.20	96.24	DL1	0.42	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **71.3**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.37*min(71.3[kip], 113.34[kip]) = **227.2**[kip] p. 7-18

Shear yielding	[Kip]	232.50	96.24	DL1	0.41	Eq. J4-3

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.63[in2] = **232.5**[kip] Eq. J4-3

Shear rupture	[Kip]	144.42	96.24	DL1	0.67	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 15.5[in] - 5*1.13[in] = **9.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 9.88[in]*0.75[in] = **7.41**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*7.41[in2] = **144.42**[kip] Eq. J4-4

Block shear	[Kip]	167.43	96.24	DL1	0.57	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (5 - 1)*3[in])*0.75[in] = **10.31**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **6.52**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*6.52[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*10.31[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **167.43**[kip] Eq. J4-5

Flexural rupture	[Kip]	328.78	96.24	DL1	0.29	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75[in]/4*(15.5[in]^2 - 3[in]^2*5*(5^2 - 1)*1.13[in]/15.5[in]) = **30.35**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*30.35[in3]/3[in] = **328.78**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	273.81	15.68	DL1	0.06	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/

in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.37*min(85.92[kip], 113.34[kip]) = **273.81**[kip] p. 7-18

Tension yielding	[Kip]	348.05	15.68	DL1	0.05	Eq. J4-1

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*11.63[in2] = **348.05**[kip] Eq. J4-1

Tension rupture	[Kip]	240.70	15.68	DL1	0.07	Eq. J4-2

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (15.5[in] - 5*1.13[in])*0.75[in] = **7.41**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*11.63[in2], 7.41[in2]) = **7.41**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*7.41[in2] = **240.7**[kip] Eq. J4-2

Tear out under axial load	[Kip]	279.70	15.68	DL1	0.06	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.75[in] = **5.63**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*5.63[in2]) = **279.7**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	237.58	97.51	DL1	0.41	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.83[kip/in]*1*8*15.5[in] = **237.58**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	98.66	24.06	DL1	0.24	p. 10-103

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

f_v = V/A_g = 96.24[kip]/11.63[in2] = **8278.68**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω*)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*8278.68[lb/in2]^2))$^{1/2}$ = **26283.09**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*15.5[in]^2/4 = **45.05**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 26283.09[lb/in2]*45.05[in3] = **98.66**[kip*ft] p. 10-103

Web crippling	[Kip]	278.46	15.68	DL	0.06	Eq. J10-4

IsBeamReaction → **False**

N = N = **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43[in]^2*(1 + 3*(12[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.67[in]/0.43[in])^{1/2} =$ **278.46**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	170.96	96.24	DL1	0.56	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3[in] - 1.06[in]/2) =$ **2.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \text{min}(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*2.47[in]*0.355[in]*65000[lb/in2], 2.4*1[in]*0.355[in]*65000[lb/in2]) =$ **55.38**[kip] Eq. J3-6

$r_{n2} = \text{min}(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*1.94[in]*0.355[in]*65000[lb/in2], 2.4*1[in]*0.355[in]*65000[lb/in2]) =$ **53.65**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\text{min}(r_{n1}, r_{n2}) = 0.5*6.37*\text{min}(55.38[kip], 53.65[kip]) =$ **170.96**[kip] p. 7-18

Shear yielding	[Kip]	127.80	96.24	DL1	0.75	Eq. J4-3

$A_g = L_p*t_p = 18[in]*0.355[in] =$ **6.39**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.39[in2] =$ **127.8**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	253.10	15.68	DL1	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.72[in], 2.4*1[in]) + \text{min}(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.355[in]*$
$65000[lb/in2]*5 =$ **253.1**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	15.68	DL1	0.04	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*14.7[in2] =$ **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	334.45	15.68	DL1	0.05	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] =$ **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 14.7[in2] - 5*0.355[in]*1.13[in] =$ **12.7**[in2] Sec. D3-2

$U = 1 - x/l = 1 - 1.14[in]/6[in] =$ **0.81** Table D3.1

$A_e = U*A_n = 0.81*12.7[in2] =$ **10.29**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*10.29[in2] =$ **334.45**[kip] Eq. J4-2

Tear out under axial load	[Kip]	135.85	15.68	DL1	0.12	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] =$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] =$ **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.355[in] =$ **3.73**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.355[in] =$ **2.53**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.355[in] =$ **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*2.53[in2] + 1*65000[lb/in2]*2.66[in2], 0.6*50000[lb/in2]*3.73[in2] + 1*65000[lb/in2]*2.66[in2]) = **135.85**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	73.13	DL1	0.23	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

D_{min} = $P/((1/\Omega)*C*C_1*L)$ = 97.51[kip]/(0.5*3.83[kip/in]*1*15.5[in]) = **3.28** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*3.28/16 [in] = **6.09**[kip/in] p. 9-5

Ratio **0.91**

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : VB-02-4

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18x50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	0.00	0.00	-147.00	Design
DL1	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	-52.00	0.00	0.00	147.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
52.00	DL	Design
-52.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	52.00	DL	0.28	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	52.00	DL	0.21	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	52.00	DL	0.27	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	303.75	52.00	DL	0.17	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2]$)$ = **303.75**[kip] Eq. J4-5

Ratio **0.28**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	325.03	52.00	DL	0.16	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*11.8$[in2] = **325.03**[kip] Eq. J4-1

Tension rupture	[Kip]	218.33	52.00	DL	0.24	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 11.8$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.349$[in] = **11.36**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3.38_{[in]}/10_{[in]} = \mathbf{0.663}$ Table D3.1

$A_e = A_n*U = 11.36_{[in2]}*0.663 = \mathbf{7.53}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*7.53_{[in2]} = \mathbf{218.33}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	280.64	52.00	DL	0.19	Eq. J4-1

$A_g = L_w*t_p = 18.75_{[in]}*0.5_{[in]} = \mathbf{9.37}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*9.37_{[in2]} = \mathbf{280.64}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	169.07	52.00	DL1	0.31	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*18.49_{[in]}/0.144_{[in]})^2 = \mathbf{41299.9}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 41299.9_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}{}_{[lb/in2]}{}^{/41299.9}{}_{[lb/in2])}*50000_{[lb/in2]} =$

$\mathbf{30123.4}_{[lb/in2]}$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*30123.4_{[lb/in2]}*9.37_{[in2]} = \mathbf{169.07}_{[kip]}$ Eq. E3-1

Ratio **0.31**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.88}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.88_{[in]} + 9_{[in]})*1.88 - 6.25_{[in]} = \mathbf{21.74}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((21.74_{[in]} + 6.25_{[in]})^2 + (5.88_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{31.7}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 21.74_{[in]}*52_{[kip]}/31.7_{[in]} = \mathbf{35.66}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.25_{[in]}*52_{[kip]}/31.7_{[in]} = \mathbf{10.25}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*52_{[kip]}/31.7_{[in]} - 10_{[kip]} = \mathbf{4.76}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.88_{[in]}*52_{[kip]}/31.7_{[in]} + 10_{[kip]} = \mathbf{19.65}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(4.76_{[kip]}*(21.74_{[in]} - 21.74_{[in]})) + abs(10_{[kip]}*21.74_{[in]}) = \mathbf{18.12}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(10.25_{[kip]}*(5.88_{[in]} - 5.88_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.88}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.88_{[in]} + 9_{[in]})*1.88 - 6.25_{[in]} = \mathbf{21.74}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((21.74_{[in]} + 6.25_{[in]})^2 + (5.88_{[in]} + 9_{[in]})^2)^{1/2} = \mathbf{31.7}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 21.74_{[in]}*-52_{[kip]}/31.7_{[in]} = \mathbf{-35.66}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.25_{[in]}*-52_{[kip]}/31.7_{[in]} = \mathbf{-10.25}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9_{[in]}*-52_{[kip]}/31.7_{[in]} - -10_{[kip]} = \mathbf{-4.76}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.88_{[in]}*-52_{[kip]}/31.7_{[in]} + -10_{[kip]} = \mathbf{-19.65}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-4.76_{[kip]}*(21.74_{[in]} - 21.74_{[in]})) + abs(-$

10[kip]*21.74[in]) = **18.12**[kip*ft] p. 13-10

M_c = abs(H_c*(β - $β_{bar}$)) = abs(-10.25[kip]*(5.88[in] - 5.88[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.66	4.76	18.12	0.00	0.00	0.00	Design
DL1	-35.66	-4.76	-18.12	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	628.50	35.83	DL	0.06	Eq. J4-1
$A_g = L_p*t_p$ = 41.98[in]*0.5[in] = **20.99**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)*F_y*A_g$ = 0.599*50000[lb/in2]*20.99[in2] = **628.5**[kip]						Eq. J4-1
Shear yielding	[Kip]	419.84	35.66	DL	0.08	Eq. J4-3
$A_g = L_p*t_p$ = 41.98[in]*0.5[in] = **20.99**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*20.99[in2] = **419.84**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	32666.82	DL	0.01	J4-1
$(1/Ω)F_n = (1/Ω)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 4.76[kip]/(0.5[in]*41.98[in]) = **226.85**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	244632.10	DL	0.08	J4-1
$(1/Ω)F_n = (1/Ω)$*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 35.66[kip]/(0.5[in]*41.98[in]) = **1698.83**[lb/in2]						9
Weld capacity	[Kip]	394.51	59.29	DL	0.15	Tables 8-4 .. 8-11
$(1/Ω)R_n$ = 2 * $((1/Ω)*C*C_1*D*L)$ = 2 * (0.5*1.88[kip/in]*1*5*41.98[in]) = **394.51**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 4.76[kip]/41.98[in] = **0.113**[kip/in]						9
$f_{uv} = H_b/l$ = 35.66[kip]/41.98[in] = **0.849**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 18.12[kip*ft]/(41.98[in]^2/6) = **0.74**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.113[kip/in] + 0.74[kip/in])^2 + 0.849[kip/in]^2)$^{1/2}$ = **1.2**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.113[kip/in] - 0.74[kip/in])^2 + 0.849[kip/in]^2)$^{1/2}$ + ((0.113[kip/in] + 0.74[kip/in])^2 + 0.849[kip/in]^2)$^{1/2}$) = **1.13**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 41.98[in]*max(1.2[kip/in], 1.25*1.13[kip/in]) = **59.29**[kip]						9

Beam

Weld block shear	[Kip]	369.82	35.66	DL	0.10	Eq. J4-5

$A_{gv} = l*t_w = 41.98$[in]$*0.355$[in] = **14.9**[in2] — Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2 = (14.7$[in2] $- 0.355$[in]$*16.06$[in]$)/2 =$ **4.5**[in2] — 8

$A_{nv} = A_{gv} =$ **14.9**[in2] — Sec. J4.3

$A_{nt} = A_{gt} =$ **4.5**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*14.9$[in2] $+ 1*65000$[lb/in2]$*4.5$[in2]$, 0.6*50000$[lb/in2]$*14.9$[in2] $+ 1*65000$[lb/in2]$*4.5$[in2]$) =$ **369.82**[kip] — Eq. J4-5

Web crippling	[Kip]	229.46	10.33	DL1	0.05	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **24.21**[in] — Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$

$0.80*0.355$[in]$^2*(1 + 3*(24.21$[in]$/18$[in]$)*(0.355$[in]$/0.57$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$

0.57[in]$/0.355$[in]$)^{1/2} =$ **229.46**[kip] — Eq. J10-4

Local web yielding	[Kip]	343.99	10.33	DL	0.03	Eq. J10-2

IsBeamReaction → **False**

$N = N =$ **24.21**[in] — Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*0.972$[in] $+ 24.21$[in]$)*50000$[lb/in2]$*$

0.355[in] = **343.99**[kip] — Eq. J10-2

Ratio **0.15**

Upper right gusset interface - column

Single plate

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	19.65	10.25	0.00	0.00	0.00	Design
DL1	-19.65	-10.25	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	9.50	5.88	11.77	✔	p. 10-104
$L_{min} = T/2 = 11.77$[in]$/2 =$ **5.88**[in]						p. 10-104

$L_{max} = L =$ **11.77**[in]

Thickness	[in]	0.50	--	1.24	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*15.79$[in] = **77.46**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*77.46$[kip*ft]$)/(50000$[lb/in2]$*9.5$[in]$^2) =$ **1.24**[in]						p. 10-103
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.88	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	50.95	22.16	DL	0.43	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(*1/Ω*)R_n*BoltFactor* = 3.02*16.87[kip]*1 = **50.95**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	71.76	19.65	DL	0.27	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **47.53**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.02*min(47.53[kip], 75.56[kip]) = **71.76**[kip] p. 7-18

Shear yielding	[Kip]	95.00	19.65	DL	0.21	Eq. J4-3

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.75[in2] = **95**[kip] Eq. J4-3

Shear rupture	[Kip]	59.72	19.65	DL	0.33	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9.5[in] - 3*1.13[in] = **6.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.13[in]*0.5[in] = **3.06**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.06[in2] = **59.72**[kip] Eq. J4-4

Block shear	[Kip]	75.05	19.65	DL	0.26	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (3 - 1)*3[in])*0.5[in] = **3.88**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.47**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.47[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.88[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **75.05**[kip] Eq. J4-5

Flexural rupture	[Kip]	87.58	19.65	DL	0.22	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9.5[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9.5[in]) = **8.08**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*8.08[in3]/3[in] = **87.58**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	86.48	10.25	DL	0.12	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.02*min(57.28[kip], 75.56[kip]) = **86.48**[kip] p. 7-18

Tension yielding	[Kip]	142.22	10.25	DL	0.07	Eq. J4-1

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.75[in2] = **142.22**[kip] Eq. J4-1

Tension rupture	[Kip]	99.53	10.25	DL	0.10	Eq. J4-2

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (9.5[in] - 3*1.13[in])*0.5[in] = **3.06**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.75[in2], 3.06[in2]) = **3.06**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*3.06[in2] = **99.53**[kip] Eq. J4-2

Tear out under axial load	[Kip]	125.53	10.25	DL	0.08	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	102.03	22.16	DL	0.22	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.3[kip/in]*1*5*9.5[in] = **102.03**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	27.33	4.91	DL	0.18	p. 10-103

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

f_v = V/A_g = 19.65[kip]/4.75[in2] = **4136.93**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*4136.93[lb/in2]^2))$^{1/2}$ = **29070.06**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.5[in]*9.5[in]^2/4 = **11.28**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 29070.06[lb/in2]*11.28[in3] = **27.33**[kip*ft] p. 10-103

Web crippling	[Kip]	277.17	10.25	DL1	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **6**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.515[in]^2*(1 + 3*(6[in]/12.5[in])*(0.515[in]/0.81[in])^1.5)*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])^1/2 = **277.17**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	114.08	19.65	DL	0.17	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.88[in] - 1.06[in]/2)$ = **2.35**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in])$ = **1.94**[in] Sec. J4.10

$r_{n1} = \text{min}(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*2.35[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2])$ = **78**[kip] Eq. J3-6

$r_{n2} = \text{min}(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2])$ = **75.56**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\text{min}(r_{n1}, r_{n2}) = 0.5*3.02*\text{min}(78[kip], 75.56[kip])$ = **114.08**[kip] p. 7-18

Shear yielding	[Kip]	117.67	19.65	DL	0.17	Eq. J4-3

$A_g = L_p*t_p$ = 11.77[in]*0.5[in] = **5.88**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*5.88[in2] = **117.67**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	10.25	DL	0.05	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2)$ = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in])$ = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*1.72[in], 2.4*1[in]) + \text{min}(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*3$ = **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	176.16	10.25	DL	0.06	Eq. J4-1

$A_g = L_p*t_p$ = 11.77[in]*0.5[in] = **5.88**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*5.88[in2] = **176.16**[kip] Eq. J4-1

Tension rupture	[Kip]	136.37	10.25	DL	0.08	Eq. J4-2

$A_g = L_p*t_p$ = 11.77[in]*0.5[in] = **5.88**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (11.77[in] - 3*1.13[in])*0.5[in]$ = **4.2**[in2] Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*5.88[in2], 4.2[in2])$ = **4.2**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4.2[in2] = **136.37**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	10.25	DL	0.08	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.5[in] =$ **5.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] =$ **3.56**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] =$ **1.88**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*1.88[in2]) =$ **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	24.19	DL	0.06	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] =$ **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 22.16[kip]/(0.5*4.3[kip/in]*1*9.5[in]) =$ **1.09** tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*1.09/16$ [in] $=$ **2.02**[kip/in] p. 9-5

Ratio **0.43**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-147.00	DL	Design
147.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	259.86	147.00	DL	0.57	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000[lb/in2] =$ **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14[in] =$ **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000[lb/in2]*3.09[in2]) =$ **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000[lb/in2] =$ **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14[in] =$ **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000[lb/in2]*3.09[in2]) =$ **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93[kip] + 129.93[kip] =$ **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	147.00	DL	0.26	Eq. J4-4
$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]						
$A_{nv} = L_e * t_p = 28$[in]*0.581[in] = **16.27**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]*16.27[in2]) = **566.13**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	273.00	147.00	DL	0.54	Eq. J4-4
$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]						
$A_{nv} = L_e * t_p = 28$[in]*0.5[in] = **14**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]*14[in2] = **273**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	363.75	147.00	DL1	0.40	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]) = **14**[in]						
$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*14.5$[in]*0.5[in] = **14.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **14.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 9$[in]*0.5[in] = **4.5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]*14.5[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*14.5[in2] + 1*65000[lb/in2]*4.5[in2]) = **363.75**[kip]						Eq. J4-5
Ratio	**0.57**					

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	515.09	147.00	DL1	0.29	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]*18.7[in2] = **515.09**[kip]						Eq. J4-1
Tension rupture	[Kip]	395.58	147.00	DL1	0.37	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in])$*t = 18.7$[in2] - 2*(0.5[in] + 1/8 [in])*0.581[in] = **17.97**[in2]						Sec. D3.2
$U = 1 - x/l = 1 - 3.38$[in]/14[in] = **0.759**						Table D3.1
$A_e = A_n*U = 17.97$[in2]*0.759 = **13.64**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]*13.64[in2] = **395.58**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	322.77	147.00	DL1	0.46	Eq. J4-1
$A_g = L_w*t_p = 21.56$[in]*0.5[in] = **10.78**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]*10.78[in2] = **322.77**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	204.04	147.00	DL	0.72	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]/(0.65*17.86[in]/0.144[in])^2 = **44239.43**[lb/in2]						Eq. E3-4

F_e>=0.44*Q*F_y → 44239.43[lb/in2]>=0.44*1*50000[lb/in2] → **True**

F_{cr} = 0.658$^{(Q*Fy/Fe)}$*F_y = 0.658$^{(1*50000[lb/in2]/44239.43[lb/in2])}$*50000[lb/in2] =

31154.91[lb/in2] Eq. E7-2

(1/Ω)P_n = *(1/Ω)*F_{cr}*A_g = 0.599*31154.91[lb/in2]*10.94[in2] = **204.04**[kip] Eq. E3-1

Ratio **0.72**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

β = β_{bar} = **6.18**[in] p. 13-10

α = (β + e_b)*tanθ - e_c = (6.18[in] + 9[in])*2.05 - 6.25[in] = **24.86**[in] p. 13-10

r = ((α + e_c)^2 + (β + e_b)^2)$^{1/2}$ = ((24.86[in] + 6.25[in])^2 + (6.18[in] + 9[in])^2)$^{1/2}$ = **34.62**[in] p. 13-5

H_b = α*P/r = 24.86[in]*-147[kip]/34.62[in] = **-105.58**[kip] p. 13-5

H_c = e_c*P/r = 6.25[in]*-147[kip]/34.62[in] = **-26.54**[kip] p. 13-5

V_b = e_b*P/r - ΔV = 9[in]*-147[kip]/34.62[in] - -10[kip] = **-28.22**[kip] p. 13-5

V_c = β*P/r + ΔV = 6.18[in]*-147[kip]/34.62[in] + -10[kip] = **-36.22**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-28.22[kip]*(24.86[in] - 24.86[in])) + abs(-10[kip]*24.86[in]) = **20.72**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-26.54[kip]*(6.18[in] - 6.18[in])) = **0**[kip*ft] p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

β = β_{bar} = **6.18**[in] p. 13-10

α = (β + e_b)*tanθ - e_c = (6.18[in] + 9[in])*2.05 - 6.25[in] = **24.86**[in] p. 13-10

r = ((α + e_c)^2 + (β + e_b)^2)$^{1/2}$ = ((24.86[in] + 6.25[in])^2 + (6.18[in] + 9[in])^2)$^{1/2}$ = **34.62**[in] p. 13-5

H_b = α*P/r = 24.86[in]*147[kip]/34.62[in] = **105.58**[kip] p. 13-5

H_c = e_c*P/r = 6.25[in]*147[kip]/34.62[in] = **26.54**[kip] p. 13-5

V_b = e_b*P/r - ΔV = 9[in]*147[kip]/34.62[in] - 10[kip] = **28.22**[kip] p. 13-5

V_c = β*P/r + ΔV = 6.18[in]*147[kip]/34.62[in] + 10[kip] = **36.22**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(28.22[kip]*(24.86[in] - 24.86[in])) + abs(10[kip]*24.86[in]) = **20.72**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(26.54[kip]*(6.18[in] - 6.18[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	

DL	-105.58	-28.22	-20.72	0.00	0.00	0.00	Design
DL1	105.58	28.22	20.72	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	721.96	59.15	DL1	0.08	Eq. J4-1
$A_g = L_p*t_p$ = 48.23[in]*0.5[in] = **24.11**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*24.11[in2] = **721.96**[kip]						Eq. J4-1
Shear yielding	[Kip]	482.27	105.58	DL	0.22	Eq. J4-3
$A_g = L_p*t_p$ = 48.23[in]*0.5[in] = **24.11**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*24.11[in2] = **482.27**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	168514.20	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = -28.22[kip]/(0.5[in]*48.23[in]) = **-1170.24**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	630513.80	DL	0.22	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -105.58[kip]/(0.5[in]*48.23[in]) = **-4378.57**[lb/in2]						9
Weld capacity	[Kip]	463.88	141.65	DL	0.31	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.92[kip/in]*1*5*48.23[in]) = **463.88**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = -28.22[kip]/48.23[in] = **-0.585**[kip/in]						9
$f_{uv} = H_b/l$ = -105.58[kip]/48.23[in] = **-2.19**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -20.72[kip*ft]/(48.23[in]^2/6) = **-0.641**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.585[kip/in] + 0.641[kip/in])^2 + 2.19[kip/in]^2)$^{1/2}$ = **2.51**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.585[kip/in] - 0.641[kip/in])^2 + 2.19[kip/in]^2)$^{1/2}$ + ((0.585[kip/in] + 0.641[kip/in])^2 + 2.19[kip/in]^2)$^{1/2}$) = **2.35**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 48.23[in]*max(2.51[kip/in], 1.25*2.35[kip/in]) = **141.65**[kip]						9
Beam						
Weld block shear	[Kip]	403.06	105.58	DL	0.26	Eq. J4-5
$A_{gv} = l*t_w$ = 48.23[in]*0.355[in] = **17.12**[in2]						Sec. J4.3
$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.355[in]*16.06[in])/2 = **4.5**[in2]						8
$A_{nv} = A_{gv}$ = **17.12**[in2]						Sec. J4.3
$A_{nt} = A_{gt}$ = **4.5**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*17.12[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*17.12[in2] + 1*65000[lb/in2]*4.5[in2]) = **403.06**[kip]						Eq. J4-5

Web crippling	[Kip]	367.46	28.28	DL	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{46.11}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.355$[in]$^2*(1 + 3*(46.11$[in]$/18$[in]$)*(0.355$[in]$/0.57$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.57[in]$/0.355$[in]$)^{1/2} = \mathbf{367.46}$[kip] Eq. J10-4

Local web yielding	[Kip]	603.15	28.28	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N = \mathbf{46.11}$[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*0.972$[in] $+ 46.11$[in]$)*50000$[lb/in2]$*$
0.355[in] $= \mathbf{603.15}$[kip] Eq. J10-2

Ratio **0.31**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-36.22	-26.54	0.00	0.00	0.00	Design
DL1	36.22	26.54	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.50	6.18	12.35	✔	p. 10-104

$L_{min} = T/2 = 12.35$[in]$/2 = \mathbf{6.18}$[in] p. 10-104

$L_{max} = L = \mathbf{12.35}$[in]

Thickness	[in]	0.50	--	1.24	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*15.79$[in] $= \mathbf{77.46}$[kip*ft] p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*77.46$[kip*ft]$)/(50000$[lb/in2]$*9.5$[in]$^2) = \mathbf{1.24}$[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $= \mathbf{1.25}$[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.18	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	53.44	44.90	DL1	0.84	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 3.17*16.87[kip]*1 = **53.44**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	75.27	36.22	DL1	0.48	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **47.53**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.17*min(47.53[kip], 75.56[kip]) = **75.27**[kip] p. 7-18

Shear yielding	[Kip]	95.00	36.22	DL	0.38	Eq. J4-3

A_g = L_p*t_p = 9.5[in]*0.5[in] = **4.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.75[in2] = **95**[kip] Eq. J4-3

Shear rupture	[Kip]	59.72	36.22	DL	0.61	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9.5[in] - 3*1.13[in] = **6.13**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 6.13[in]*0.5[in] = **3.06**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.06[in2] = **59.72**[kip] Eq. J4-4

Block shear	[Kip]	75.05	36.22	DL	0.48	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (3 - 1)*3[in])*0.5[in] = **3.88**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **2.47**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*2.47[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*3.88[in2] + 0.5*65000[lb/in2]*1.66[in2]) = **75.05**[kip] Eq. J4-5

Flexural rupture	[Kip]	87.58	36.22	DL	0.41	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(9.5[in]^2 - 3[in]^2*3*(3^2 - 1)*1.13[in]/9.5[in]) = **8.08**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*8.08[in3]/3[in] = **87.58**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	90.71	26.54	DL1	0.29	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.17*min(57.28[kip], 75.56[kip]) = **90.71**[kip] p. 7-18

Tension yielding	[Kip]	142.22	26.54	DL1	0.19	Eq. J4-1
$A_g = L_p*t_p$ = 9.5[in]*0.5[in] = **4.75**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.75[in2] = **142.22**[kip]						Eq. J4-1
Tension rupture	[Kip]	99.53	26.54	DL1	0.27	Eq. J4-2
$A_g = L_p*t_p$ = 9.5[in]*0.5[in] = **4.75**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (9.5[in] - 3*1.13[in])*0.5[in] = **3.06**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*4.75[in2], 3.06[in2]) = **3.06**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.06[in2] = **99.53**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	125.53	26.54	DL1	0.21	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
n>1 → 3>1 → **True**						
A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = **5**[in2]						Sec. J4-3
A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.31**[in2]						Sec. J4-3
A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*1.88[in2]) = **125.53**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	108.20	44.90	DL	0.42	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.56[kip/in]*1*5*9.5[in] = **108.2**[kip]						Tables 8-4 .. 8-11
Flexure with the Von-Mises shear reduction	[Kip*ft]	25.26	9.06	DL	0.36	p. 10-103
$A_g = L_p*t_p$ = 9.5[in]*0.5[in] = **4.75**[in2]						Sec. D3-1
$f_v = V/A_g$ = -36.22[kip]/4.75[in2] = **-7625.72**[lb/in2]						p. 10-103
$(1/\Omega)F_{cr}$ = (max(0, $((1/\Omega)*F_y)^2$ - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*-7625.72[lb/in2]^2))$^{1/2}$ = **26869.24**[lb/in2]						p. 10-103
$Z_x = t_p*L^2/4$ = 0.5[in]*9.5[in]^2/4 = **11.28**[in3]						T. 17-27
$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z$ = 26869.24[lb/in2]*11.28[in3] = **25.26**[kip*ft]						p. 10-103
Web crippling	[Kip]	277.17	26.54	DL	0.10	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **6**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E*F_{yw}*t_f/t_w$)$^{1/2}$ = 0.5*0.80*0.515[in]^2*(1 + 3*(6[in]/12.5[in])*(0.515[in]/0.81[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])$^{1/2}$ = **277.17**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	119.66	36.22	DL1	0.30	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3.18[in] - 1.06[in]/2) = **2.64**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*2.64[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **78**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.5[in]*65000[lb/in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*3.17*min(78[kip], 75.56[kip]) = **119.66**[kip] p. 7-18

Shear yielding	[Kip]	123.50	36.22	DL	0.29	Eq. J4-3

A_g = L_p*t_p = 12.35[in]*0.5[in] = **6.18**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.18[in2] = **123.5**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	213.89	26.54	DL1	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*3 = **213.89**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	184.88	26.54	DL1	0.14	Eq. J4-1

A_g = L_p*t_p = 12.35[in]*0.5[in] = **6.18**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*6.18[in2] = **184.88**[kip] Eq. J4-1

Tension rupture	[Kip]	145.84	26.54	DL1	0.18	Eq. J4-2

A_g = L_p*t_p = 12.35[in]*0.5[in] = **6.18**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (12.35[in] - 3*1.13[in])*0.5[in] = **4.49**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*6.18[in2], 4.49[in2]) = **4.49**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*4.49[in2] = **145.84**[kip] Eq. J4-2

Tear out under axial load	[Kip]	130.41	26.54	DL1	0.20	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = **3.56**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.56[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*1.88[in2]) = **130.41**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	46.22	DL	0.12	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.81$[in] = **31.59**[kip/in] — p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 44.9$[kip]$/(0.5*4.56$[kip/in]$*1*9.5$[in]$) =$ **2.08** — tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.08/16$ [in] = **3.85**[kip/in] — p. 9-5

Ratio **0.84**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] $+ 35.66$[kip] $+ -105.58$[kip] = **-69.92**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip] $- 4.76$[kip] $+ -28.22$[kip] = **2.02**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] $+ -35.66$[kip] $+ 105.58$[kip] = **69.92**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip] $- -4.76$[kip] $+ 28.22$[kip] = **67.98**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	2.02	-69.92	0.00	0.00	0.00	Design
DL1	67.98	69.92	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.50	8.03	16.06	✔	p. 10-104

$L_{min} = T/2 = 16.06$[in]$/2 =$ **8.03**[in] — p. 10-104

$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18$[in] $- \max(0.972$[in]$, 0$[in]$) -$ $\max(0.972$[in]$, 0$[in]$) =$ **16.06**[in] — p. 10-49

Thickness	[in]	0.75	--	1.14	✔	p. 10-103

$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*38.67$[in] = **189.72**[kip*ft] — p. 10-103

$t_{max} = (6*M_{max})/(F_y*d^2) = (6*189.72$[kip*ft]$)/(50000$[lb/in2]$*15.5$[in]^2) = **1.14**[in] — p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	8.52	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.355$[in], 12 [in]$) =$ **8.52**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	8	8	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.75$[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	115.78	97.52	DL1	0.84	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6.86*16.87$[kip]$*1 =$ **115.78**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	244.59	67.98	DL1	0.28	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **71.3**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.86*min(71.3[kip], 113.34[kip]) = **244.59**[kip] p. 7-18

Shear yielding	[Kip]	232.50	67.98	DL1	0.29	Eq. J4-3

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.63[in2] = **232.5**[kip] Eq. J4-3

Shear rupture	[Kip]	144.42	67.98	DL1	0.47	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 15.5[in] - 5*1.13[in] = **9.88**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 9.88[in]*0.75[in] = **7.41**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*7.41[in2] = **144.42**[kip] Eq. J4-4

Block shear	[Kip]	167.43	67.98	DL1	0.41	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (5 - 1)*3[in])*0.75[in] = **10.31**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **6.52**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*6.52[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*10.31[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **167.43**[kip] Eq. J4-5

Flexural rupture	[Kip]	328.78	67.98	DL1	0.21	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75[in]/4*(15.5[in]^2 - 3[in]^2*5*(5^2 - 1)*1.13[in]/15.5[in]) = **30.35**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*30.35[in3]/3[in] = **328.78**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	294.76	69.92	DL1	0.24	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.86*min(85.92[kip], 113.34[kip]) = **294.76**[kip] p. 7-18

Tension yielding	[Kip]	348.05	69.92	DL1	0.20	Eq. J4-1

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*11.63[in2] = **348.05**[kip] Eq. J4-1

Tension rupture	[Kip]	240.70	69.92	DL1	0.29	Eq. J4-2

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (15.5[in] - 5*1.13[in])*0.75[in] = **7.41**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*11.63[in2], 7.41[in2]) = **7.41**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*7.41[in2] = **240.7**[kip] Eq. J4-2

Tear out under axial load	[Kip]	279.70	69.92	DL1	0.25	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.75[in] = **5.63**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*5.63[in2]) = **279.7**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	300.03	97.52	DL1	0.33	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.84[kip/in]*1*8*15.5[in] = **300.03**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	105.77	17.00	DL1	0.16	p. 10-103

A_g = L_p*t_p = 15.5[in]*0.75[in] = **11.63**[in2] Sec. D3-1

f_v = V/A_g = 67.98[kip]/11.63[in2] = **5847.78**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*5847.78[lb/in2]^2))$^{1/2}$ = **28174.83**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*15.5[in]^2/4 = **45.05**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 28174.83[lb/in2]*45.05[in3] = **105.77**[kip*ft] p. 10-103

Web crippling	[Kip]	394.14	69.92	DL	0.18	Eq. J10-4

IsBeamReaction → **False**

N = N = **12**[in] Sec. J10-2

(1/Ω)R_n = *(1/Ω)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ = 0.5*

$0.80*0.515_{[in]}^2*(1 + 3*(12_{[in]}/12.5_{[in]})*(0.515_{[in]}/0.81_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*0.81_{[in]}/0.515_{[in]})^{1/2}$ = **394.14**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	184.05	67.98	DL1	0.37	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3[in] - 1.06[in]/2) = **2.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*2.47[in]*0.355[in]*65000[lb/in2], 2.4*1[in]*0.355[in]*65000[lb/in2]) = **55.38**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.355[in]*65000[lb/in2], 2.4*1[in]*0.355[in]*65000[lb/in2]) = **53.65**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*6.86*min(55.38[kip], 53.65[kip]) = **184.05**[kip] p. 7-18

Shear yielding	[Kip]	127.80	67.98	DL1	0.53	Eq. J4-3

A_g = L_p*t_p = 18[in]*0.355[in] = **6.39**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.39[in2] = **127.8**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	253.10	69.92	DL1	0.28	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.355[in]*65000[lb/in2]*5 = **253.1**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	69.92	DL1	0.16	Eq. D2-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*14.7[in2] = **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	334.45	69.92	DL1	0.21	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 14.7[in2] - 5*0.355[in]*1.13[in] = **12.7**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.14[in]/6[in] = **0.81** Table D3.1

A_e = U*A_n = 0.81*12.7[in2] = **10.29**[in2] Sec. D3-3

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*10.29[in2] = **334.45**[kip] Eq. J4-2

Tear out under axial load	[Kip]	135.85	69.92	DL1	0.51	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.355[in] = **3.73**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.355[in] = **2.53**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.355[in] = **2.66**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*2.53[in2] + 1*65000[lb/in2]*2.66[in2], 0.6*50000[lb/in2]*3.73[in2] + 1*65000[lb/in2]*2.66[in2]) =$ **135.85**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	57.92	DL1	0.15	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] =$ **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 97.52[kip]/(0.5*4.84[kip/in]*1*15.5[in]) =$ **2.6** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*2.6/16$ [in] = **4.83**[kip/in] p. 9-5

Ratio **0.84**

Global critical strength ratio **0.84**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 1:37 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : CBB_DA

Connection ID : VB-02-5

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21x50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	38.00	0.00	0.00	0.00	0.00	0.00	0.00	60.00	0.00	0.00	-100.00	Design
DL1	0.00	38.00	0.00	0.00	0.00	0.00	0.00	0.00	-60.00	0.00	0.00	100.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
60.00	DL	Design
-60.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	60.00	DL	0.32	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	323.64	60.00	DL	0.19	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.465$[in] = **9.3**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.64**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	60.00	DL	0.31	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	60.00	DL	0.21	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.32**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	60.00	DL	0.16	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	262.25	60.00	DL	0.23	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 13.5[in2] - 2*(0.5[in] + 1/8\ [in])*0.465[in] = \mathbf{12.92}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/10[in] = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 12.92[in2]*0.7 = \mathbf{9.04}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*9.04[in2] = \mathbf{262.25}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	256.99	60.00	DL	0.23	Eq. J4-1

$A_g = L_w*t_p = 17.17[in]*0.5[in] = \mathbf{8.58}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.58[in2] = \mathbf{256.99}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	138.45	60.00	DL1	0.43	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*20.42[in]/0.144[in])^2 = \mathbf{33834.15}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 33834.15[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/33834.15[lb/in2])}*50000[lb/in2] =$

26936.73[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*26936.73[lb/in2]*8.58[in2] = \mathbf{138.45}[kip]$ Eq. E3-1

Ratio **0.43**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 10.4[in]*2.07 - 5[in] = \mathbf{16.48}[in]$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 24.68[in]*(2.07 + 24.68[in]/3.97[in]) = \mathbf{204.51}[in]$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (2.07)^2 + (24.68[in]/3.97[in])^2 = \mathbf{42.95}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (204.51[in]*2.07 + 16.48[in]*(24.68[in]/$
$3.97[in])^2)/42.95 = \mathbf{24.68}[in]$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (204.51[in] - 16.48[in]*2.07)/42.95 = \mathbf{3.97}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((24.68[in] + 5[in])^2 + (3.97[in] + 10.4[in])^2)^{1/}$
$^2 = \mathbf{32.98}[in]$ p. 13-5

$H_b = \alpha*P/r = 24.68[in]*60[kip]/32.98[in] = \mathbf{44.91}[kip]$ p. 13-5

$H_c = e_c*P/r = 5[in]*60[kip]/32.98[in] = \mathbf{9.1}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*60[kip]/32.98[in] - 0[kip] = \mathbf{18.92}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 3.97[in]*60[kip]/32.98[in] + 0[kip] = \mathbf{7.22}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(18.92[kip]*(24.68[in] - 24.68[in])) +$
$abs(0[kip]*24.68[in]) = \mathbf{8.40E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.1[kip]*(3.97[in] - 3.97[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 10.4[in]*2.07 - 5[in] = \mathbf{16.48}[in]$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 24.68[in]*(2.07 + 24.68[in]/3.97[in]) = \mathbf{204.51}[in]$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (2.07)^2 + (24.68[in]/3.97[in])^2 = \mathbf{42.95}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (204.51[in]*2.07 + 16.48[in]*(24.68[in]/$

$3.97_{[in]})^2)/42.95$ = **24.68**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D = (204.51_{[in]} - 16.48_{[in]}*2.07)/42.95$ = **3.97**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((24.68_{[in]} + 5_{[in]})^2 + (3.97_{[in]} + 10.4_{[in]})^2)^{1/2}$ = **32.98**[in] p. 13-5

$H_b = \alpha*P/r = 24.68_{[in]}*-60_{[kip]}/32.98_{[in]}$ = **-44.91**[kip] p. 13-5

$H_c = e_c*P/r = 5_{[in]}*-60_{[kip]}/32.98_{[in]}$ = **-9.1**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4_{[in]}*-60_{[kip]}/32.98_{[in]} - 0_{[kip]}$ = **-18.92**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 3.97_{[in]}*-60_{[kip]}/32.98_{[in]} + 0_{[kip]}$ = **-7.22**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-18.92_{[kip]}*(24.68_{[in]} - 24.68_{[in]})) + abs(0_{[kip]}*24.68_{[in]})$ = **8.40E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-9.1_{[kip]}*(3.97_{[in]} - 3.97_{[in]}))$ = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	44.91	18.92	0.00	0.00	0.00	0.00	Design
DL1	-44.91	-18.92	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	716.56	18.92	DL	0.03	Eq. J4-1
$A_g = L_p*t_p = 47.87_{[in]}*0.5_{[in]}$ = **23.93**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*23.93_{[in2]}$ = **716.56**[kip]						Eq. J4-1
Shear yielding	[Kip]	478.66	44.91	DL	0.09	Eq. J4-3
$A_g = L_p*t_p = 47.87_{[in]}*0.5_{[in]}$ = **23.93**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*23.93_{[in2]}$ = **478.66**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	113849.10	DL	0.03	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000_{[lb/in2]}$ = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l) = 18.92_{[kip]}/(0.5_{[in]}*47.87_{[in]})$ = **790.62**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	270205.10	DL	0.09	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y = 0.667*0.6*50000_{[lb/in2]}$ = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l) = 44.91_{[kip]}/(0.5_{[in]}*47.87_{[in]})$ = **1876.42**[lb/in2]						9
Weld capacity	[Kip]	497.97	60.91	DL	0.12	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.08_{[kip/in]}*1*5*47.87_{[in]})$ = **497.97**[kip]						Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = 18.92[kip]/47.87[in] = **0.395**[kip/in] 9

$f_{uv} = H_b/l$ = 44.91[kip]/47.87[in] = **0.938**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = 8.40E-15[kip*ft]/(47.87[in]^2/6) = **2.64E-16**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.395[kip/in] + 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$ = **1.02**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.395[kip/in] - 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$ + ((0.395[kip/in] + 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$) = **1.02**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 47.87[in]*max(1.02[kip/in], 1.25*1.02[kip/in]) = **60.91**[kip] 9

Beam

Weld block shear	[Kip]	396.11	44.91	DL	0.11	Eq. J4-5

$A_{gv} = l*t_w$ = 47.87[in]*0.38[in] = **18.19**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **18.19**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*18.19[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*18.19[in2] + 1*65000[lb/in2]*3.79[in2]) = **396.11**[kip] Eq. J4-5

Web crippling	[Kip]	423.58	18.92	DL1	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **47.87**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.38[in]^2*(1 + 3*(47.87[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.535[in]/0.38[in])$^{1/2}$ = **423.58**[kip] Eq. J10-4

Local web yielding	[Kip]	672.17	18.92	DL	0.03	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **47.87**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.04[in] + 47.87[in])*50000[lb/in2]*0.38[in] = **672.17**[kip] Eq. J10-2

Ratio **0.12**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	7.22	9.10	0.00	0.00	0.00	Design

DL1	-7.22	-9.10	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.50	3.97	7.94	✔	p. 10-104
$L_{min} = T/2 = 7.94$[in]$/2 =$ **3.97**[in]						p. 10-104
$L_{max} = L =$ **7.94**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p,$ 12 [in]$) = \min(24*0.5$[in]$,$ 12 [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.47	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $=$ **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	11.61	DL	0.34	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 2*16.87[kip]*1 = **33.75**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	61.55	7.22	DL	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*
65000[lb/in2]*1 = **61.55**[kip] Eq. J3-6

Shear yielding	[Kip]	65.00	7.22	DL	0.11	Eq. J4-3

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.25[in2] = **65**[kip] Eq. J4-3

Shear rupture	[Kip]	41.44	7.22	DL	0.17	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6.5[in] - 2*1.13[in] = **4.25**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 4.25[in]*0.5[in] = **2.13**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.13[in2] = **41.44**[kip] Eq. J4-4

Block shear	[Kip]	53.22	7.22	DL	0.14	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (2 - 1)*3[in])*0.5[in] = **2.38**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **1.53**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*2.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **53.22**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	57.28	9.10	DL	0.16	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **57.28**[kip] Eq. J3-6

Tension yielding	[Kip]	97.31	9.10	DL	0.09	Eq. J4-1

$A_g = L_p * t_p = 6.5[in] * 0.5[in] = \mathbf{3.25}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 50000[lb/in2] * 3.25[in2] = \mathbf{97.31}[kip]$ Eq. J4-1

Tension rupture	[Kip]	69.06	9.10	DL	0.13	Eq. J4-2

$A_g = L_p * t_p = 6.5[in] * 0.5[in] = \mathbf{3.25}[in2]$ Sec. D3-1

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_n = (l - n * L_h) * t_p = (6.5[in] - 2 * 1.13[in]) * 0.5[in] = \mathbf{2.13}[in2]$ Sec. D3-2

$A_e = \min(0.85 * A_g, A_n) = \min(0.85 * 3.25[in2], 2.13[in2]) = \mathbf{2.13}[in2]$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 65000[lb/in2] * 2.13[in2] = \mathbf{69.06}[kip]$ Eq. J4-2

Tear out under axial load	[Kip]	58.50	9.10	DL	0.16	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow \mathbf{True}$

$A_{gv} = 2 * (L + (n_c - 1) * g) * t_p = 2 * (2[in] + (1 - 1) * 3[in]) * 0.5[in] = \mathbf{2}[in2]$ Sec. J4-3

$A_{nv} = 2 * (L + (n_c - 1) * g - dh_h * (n_c - 0.5)) * t_p = 2 * (2[in] + (1 - 1) * 3[in] - 1.13[in] * (1 - 0.5)) * 0.5[in] = \mathbf{1.44}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v) * (n - 1) * t_p = (3[in] - 1.13[in]) * (2 - 1) * 0.5[in] = \mathbf{0.938}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) = 0.5 * \min(0.6 * 65000[lb/in2] * 1.44[in2] + 1 * 65000[lb/in2] * 0.938[in2], 0.6 * 50000[lb/in2] * 2[in2] + 1 * 65000[lb/in2] * 0.938[in2]) = \mathbf{58.5}[kip]$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	81.23	11.61	DL	0.14	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega) * C * C_1 * D * L = 0.5 * 5[kip/in] * 1 * 5 * 6.5[in] = \mathbf{81.23}[kip]$ Tables 8-4 .. 8-11

Web crippling	[Kip]	101.88	9.10	DL1	0.09	Eq. J10-4

$IsBeamReaction \rightarrow \mathbf{False}$

$N = N = \mathbf{3}[in]$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega) * 0.80 * t_w^2 * (1 + 3 * (N/d) * (t_w/t_f)^{1.5}) * (E * F_{yw} * t_f/t_w)^{1/2} = 0.5 * 0.80 * 0.34[in]^2 * (1 + 3 * (3[in]/10[in]) * (0.34[in]/0.56[in])^{1.5}) * (2.90E+07[lb/in2] * 50000[lb/in2] * 0.56[in]/0.34[in])^{1/2} = \mathbf{101.88}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	75.56	7.22	DL	0.10	Eq. J3-6

$L_{c\text{-}end} = \mathrm{Max}(0.0, L_e - d_h/2) = \mathrm{Max}(0.0, 2.47[in] - 1.06[in]/2) = \mathbf{1.94}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \mathrm{Max}(0.0, s - d_h) = \mathrm{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega) * (\min(k_1 * L_{c\text{-}end}, k_2 * d) + \min(k_1 * L_{c\text{-}spa}, k_2 * d) * (n - 1)) * t_p * F_u * n_c = 0.5 * (\min(1.2 * 1.94[in], 2.4 * 1[in]) + \min(1.2 * 1.94[in], 2.4 * 1[in]) * (2 - 1)) * 0.5[in] * 65000[lb/in2] * 1 = \mathbf{75.56}[kip]$ Eq. J3-6

Shear yielding	[Kip]	79.37	7.22	DL	0.09	Eq. J4-3

$A_g = L_p * t_p$ = 7.94[in]*0.5[in] = **3.97**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*3.97[in2] = **79.37**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	9.10	DL	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2)$ = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in])$ = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*

65000[lb/in2]*2 = **67.03**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	118.82	9.10	DL	0.08	Eq. J4-1

$A_g = L_p * t_p$ = 7.94[in]*0.5[in] = **3.97**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*3.97[in2] = **118.82**[kip] Eq. J4-1

Tension rupture	[Kip]	92.41	9.10	DL	0.10	Eq. J4-2

$A_g = L_p * t_p$ = 7.94[in]*0.5[in] = **3.97**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (7.94[in] - 2*1.13[in])*0.5[in] = **2.84**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*3.97[in2], 2.84[in2])$ = **2.84**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.84[in2] = **92.41**[kip] Eq. J4-2

Tear out under axial load	[Kip]	63.38	9.10	DL	0.14	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1$ → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -

0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	15.92	DL	0.06	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 11.61[kip]/(0.5*5[kip/in]*1*6.5[in]) = **0.715** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.715/16 [in] = **1.33**[kip/in] p. 9-5

Ratio **0.34**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-100.00	DL	Design
100.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	100.00	DL	0.45	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	485.25	100.00	DL	0.21	Eq. J4-4
$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]						
$A_{nv} = L_e*t_p = 24$[in]$*0.581$[in] = **13.94**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*13.94$[in2]$)$ = **485.25**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	234.00	100.00	DL	0.43	Eq. J4-4
$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]						
$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	317.50	100.00	DL1	0.31	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) = **12**$[in]						
$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **12.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip]						Eq. J4-5

Ratio	**0.45**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	451.74	100.00	DL1	0.22	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*16.4[in2] = **451.74**[kip]						Eq. J4-1
Tension rupture	[Kip]	340.90	100.00	DL1	0.29	Eq. J4-2
$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 16.4[in2] - 2*(0.5[in] + 1/8 [in])*0.581[in] = **15.67**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3[in]/12[in] = **0.75**						Table D3.1
$A_e = A_n*U$ = 15.67[in2]*0.75 = **11.76**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*11.76[in2] = **340.9**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	281.63	100.00	DL1	0.36	Eq. J4-1
$A_g = L_w*t_p$ = 18.81[in]*0.5[in] = **9.41**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.41[in2] = **281.63**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	196.91	100.00	DL	0.51	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*15.79[in]/0.144[in])^2 = **56582.86**[lb/in2]						Eq. E3-4
F_e>=0.44*Q*F_y → 56582.86[lb/in2]>=0.44*1*50000[lb/in2] → **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = 0.658$^{(1*50000[lb/in2]/56582.86[lb/in2])}$*50000[lb/in2] = **34541.69**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*34541.69[lb/in2]*9.52[in2] = **196.91**[kip]						Eq. E3-1

Ratio	**0.51**

Calculation of the brace interface forces

Load condition :DL

General case	DG29 p. 24-33
$K = e_b*\tan\theta - e_c$ = 10.4[in]*1.88 - 5[in] = **14.56**[in]	p. 13-10
$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar})$ = 22.71[in]*(1.88 + 22.71[in]/4.33[in]) = **161.72**[in]	p. 13-10
$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = (1.88)^2 + (22.71[in]/4.33[in])^2 = **31**	p. 13-10
$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (161.72[in]*1.88 + 14.56[in]*(22.71[in]/4.33[in])^2)/31 = **22.71**[in]	p. 13-10
$\beta = (K' - K*\tan\theta)/D$ = (161.72[in] - 14.56[in]*1.88)/31 = **4.33**[in]	p. 13-10
$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((22.71[in] + 5[in])^2 + (4.33[in] + 10.4[in])^2)$^{1/2}$ = **31.38**[in]	p. 13-5
$H_b = \alpha*P/r$ = 22.71[in]*-100[kip]/31.38[in] = **-72.36**[kip]	p. 13-5

$H_c = e_c*P/r = 5[in]*-100[kip]/31.38[in] = \mathbf{-15.93}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*-100[kip]/31.38[in] - 0[kip] = \mathbf{-33.14}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.33[in]*-100[kip]/31.38[in] + 0[kip] = \mathbf{-13.81}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-33.14[kip]*(22.71[in] - 22.71[in])) +$
$abs(0[kip]*22.71[in]) = \mathbf{7.36E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-15.93[kip]*(4.33[in] - 4.33[in])) = \mathbf{8.84E-16}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 10.4[in]*1.88 - 5[in] = \mathbf{14.56}[in]$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 22.71[in]*(1.88 + 22.71[in]/4.33[in]) = \mathbf{161.72}[in]$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.88)^2 + (22.71[in]/4.33[in])^2 = \mathbf{31}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (161.72[in]*1.88 + 14.56[in]*(22.71[in]/$
$4.33[in])^2)/31 = \mathbf{22.71}[in]$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (161.72[in] - 14.56[in]*1.88)/31 = \mathbf{4.33}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((22.71[in] + 5[in])^2 + (4.33[in] + 10.4[in])^2)^{1/}$
$^2 = \mathbf{31.38}[in]$ p. 13-5

$H_b = \alpha*P/r = 22.71[in]*100[kip]/31.38[in] = \mathbf{72.36}[kip]$ p. 13-5

$H_c = e_c*P/r = 5[in]*100[kip]/31.38[in] = \mathbf{15.93}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*100[kip]/31.38[in] - 0[kip] = \mathbf{33.14}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.33[in]*100[kip]/31.38[in] + 0[kip] = \mathbf{13.81}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(33.14[kip]*(22.71[in] - 22.71[in])) +$
$abs(0[kip]*22.71[in]) = \mathbf{7.36E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(15.93[kip]*(4.33[in] - 4.33[in])) = \mathbf{8.84E-16}[kip*ft]$ p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-72.36	-33.14	0.00	0.00	0.00	0.00	Design
DL1	72.36	33.14	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	657.47	33.14	DL1	0.05	Eq. J4-1
$A_g = L_p*t_p = 43.92[in]*0.5[in] = \mathbf{21.96}[in2]$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*21.96[in2] = \mathbf{657.47}[kip]$						Eq. J4-1
Shear yielding	[Kip]	439.19	72.36	DL	0.16	Eq. J4-3

$A_g = L_p*t_p$ = 43.92[in]*0.5[in] = **21.96**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*21.96[in2] = **439.19**[kip] Eq. J4-3

Gusset edge tension stress	[Lb/ft2]	4311377.00	217310.50	DL	0.05	J4-1

$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2] J4-1

$f_{ua} = V_b/(t_p*l)$ = -33.14[kip]/(0.5[in]*43.92[in]) = **-1509.1**[lb/in2] 9

Gusset edge shear stress	[Lb/ft2]	2880000.00	474519.90	DL	0.16	J4-1

$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2] J4-1

$f_{uv} = H_b/(t_p*l)$ = -72.36[kip]/(0.5[in]*43.92[in]) = **-3295.28**[lb/in2] 9

Weld capacity	[Kip]	462.36	99.49	DL	0.22	Tables 8-4 .. 8-11

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.11[kip/in]*1*5*43.92[in]) = **462.36**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = -33.14[kip]/43.92[in] = **-0.755**[kip/in] 9

$f_{uv} = H_b/l$ = -72.36[kip]/43.92[in] = **-1.65**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -7.36E-15[kip*ft]/(43.92[in]^2/6) = **-2.75E-16**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.755[kip/in] + 2.75E-16[kip/in])^2 + 1.65[kip/in^2])$^{1/2}$ = **1.81**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*
(((0.755[kip/in] - 2.75E-16[kip/in])^2 + 1.65[kip/in^2])$^{1/2}$ + ((0.755[kip/in] + 2.75E-16[kip/in])^2 + 1.65[kip/in^2])$^{1/2}$) = **1.81**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 43.92[in]*max(1.81[kip/in], 1.25*1.81[kip/in]) = **99.49**[kip] 9

Beam

Weld block shear	[Kip]	373.62	72.36	DL	0.19	Eq. J4-5

$A_{gv} = l*t_w$ = 43.92[in]*0.38[in] = **16.69**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **16.69**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*16.69[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*16.69[in2] + 1*
65000[lb/in2]*3.79[in2]) = **373.62**[kip] Eq. J4-5

Web crippling	[Kip]	395.46	33.14	DL	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **43.92**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*
0.80*0.38[in]^2*(1 + 3*(43.92[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.535[in]/0.38[in])$^{1/2}$ = **395.46**[kip] Eq. J10-4

Local web yielding	[Kip]	622.17	33.14	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **43.92**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.04[in] + 43.92[in])*50000[lb/in2]*0.38[in] =
622.17[kip] Eq. J10-2

Ratio	**0.22**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-13.81	-15.93	0.00	0.00	0.00	Design
DL1	13.81	15.93	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.50	4.33	8.67	✔	p. 10-104
$L_{min} = T/2 = 8.67$[in]$/2 =$ **4.33**[in]						p. 10-104
$L_{max} = L =$ **8.67**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.83	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	21.08	DL	0.62	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 2*16.87[kip]*1 = **33.75**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	61.55	13.81	DL	0.22	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]* 65000[lb/in2]*1 = **61.55**[kip]						Eq. J3-6
Shear yielding	[Kip]	65.00	13.81	DL	0.21	Eq. J4-3
A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.25[in2] = **65**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.44	13.81	DL	0.33	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 6.5[in] - 2*1.13[in] = **4.25**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 4.25[in]*0.5[in] = **2.13**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.13[in2] = **41.44**[kip]						Eq. J4-4
Block shear	[Kip]	53.22	13.81	DL	0.26	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (2 - 1)*3[in])*0.5[in] = **2.38**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (2 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **1.53**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*2.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **53.22**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	57.28	15.93	DL1	0.28	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **57.28**[kip] Eq. J3-6

Tension yielding	[Kip]	97.31	15.93	DL1	0.16	Eq. J4-1

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*3.25[in2] = **97.31**[kip] Eq. J4-1

Tension rupture	[Kip]	69.06	15.93	DL1	0.23	Eq. J4-2

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (6.5[in] - 2*1.13[in])*0.5[in] = **2.13**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.25[in2], 2.13[in2]) = **2.13**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*2.13[in2] = **69.06**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.50	15.93	DL1	0.27	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*0.938[in2]) = **58.5**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	80.14	21.08	DL	0.26	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*4.93[kip/in]*1*5*6.5[in] = **80.14**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	101.88	15.93	DL	0.16	Eq. J10-4

IsBeamReaction → **False**

N = N = **3**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34[in]^2*(1 + 3*(3[in]/10[in])*(0.34[in]/0.56[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.56[in]/0.34[in])^{1/2} =$ **101.88**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	13.81	DL	0.18	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.83[in] - 1.06[in]/2) =$ **2.3**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*2.3[in], 2.4*1[in]) + \text{min}(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*$
$65000[lb/in2]*1 =$ **76.78**[kip] Eq. J3-6

Shear yielding	[Kip]	86.67	13.81	DL	0.16	Eq. J4-3

$A_g = L_p*t_p = 8.67[in]*0.5[in] =$ **4.33**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.33[in2] =$ **86.67**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	15.93	DL1	0.24	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.72[in], 2.4*1[in]) + \text{min}(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*$
$65000[lb/in2]*2 =$ **67.03**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	129.74	15.93	DL1	0.12	Eq. J4-1

$A_g = L_p*t_p = 8.67[in]*0.5[in] =$ **4.33**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*4.33[in2] =$ **129.74**[kip] Eq. J4-1

Tension rupture	[Kip]	104.27	15.93	DL1	0.15	Eq. J4-2

$A_g = L_p*t_p = 8.67[in]*0.5[in] =$ **4.33**[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 1.06[in] + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (8.67[in] - 2*1.13[in])*0.5[in] =$ **3.21**[in2] Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*4.33[in2], 3.21[in2]) =$ **3.21**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*3.21[in2] =$ **104.27**[kip] Eq. J4-2

Tear out under axial load	[Kip]	63.38	15.93	DL1	0.25	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06[in] + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06[in] + 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] =$ **2.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -$
$0.5))*0.5[in] =$ **1.69**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] =$ **0.938**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	29.30	DL	0.11	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.56[in] =$ **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 21.08[kip]/(0.5*4.93[kip/in]*1*6.5[in]) =$ **1.32** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.32/16 [in] = **2.44**[kip/in] p. 9-5

Ratio **0.62**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + 44.91[kip] + -72.36[kip] =$ **-27.45**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 38[kip] - 18.92[kip] + -33.14[kip] =$ **-14.06**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -44.91[kip] + 72.36[kip] =$ **27.45**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 38[kip] - -18.92[kip] + 33.14[kip] =$ **90.06**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-14.06	-27.45	0.00	0.00	0.00	Design
DL1	90.06	27.45	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.50	9.36	18.72	✔	p. 10-104

$L_{min} = T/2 = 18.72[in]/2 =$ **9.36**[in] p. 10-104

$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 20.8[in] - \max(1.04[in], 0[in]) - \max(1.04[in], 0[in]) =$ **18.72**[in] p. 10-49

Thickness	[in]	0.50	--	0.56	✔	p. 10-102

$t_{pmax} = d/2 + 1/16$ [in] = 1[in]/2 + 1/16 [in] = **0.563**[in] p. 10-102

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.12	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.38$[in], 12 [in]$) =$ **9.12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.90	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	101.25	94.15	DL1	0.93	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6*16.87$[kip]$*1 =$ **101.25**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	212.67	90.06	DL1	0.42	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) =$ **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$						
$F_u*n_c = 0.5*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(6 - 1))*0.5$[in]$*$						

65000[lb/in2]*1 = **212.67**[kip] Eq. J3-6

Shear yielding	[Kip]	185.00	90.06	DL1	0.49	Eq. J4-3

$A_g = L_p*t_p$ = 18.5[in]*0.5[in] = **9.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9.25[in2] = **185**[kip] Eq. J4-3

Shear rupture	[Kip]	114.56	90.06	DL1	0.79	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 18.5[in] - 6*1.13[in] = **11.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 11.75[in]*0.5[in] = **5.88**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*5.88[in2] = **114.56**[kip] Eq. J4-4

Block shear	[Kip]	126.34	90.06	DL1	0.71	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (6 - 1)*3[in])*0.5[in] = **8.38**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **5.28**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*5.28[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*8.38[in2] + 1*65000[lb/
in2]*0.719[in2]) = **126.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	171.84	27.45	DL1	0.16	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*6 = **171.84**[kip] Eq. J3-6

Tension yielding	[Kip]	276.95	27.45	DL1	0.10	Eq. J4-1

$A_g = L_p*t_p$ = 18.5[in]*0.5[in] = **9.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*9.25[in2] = **276.95**[kip] Eq. J4-1

Tension rupture	[Kip]	190.94	27.45	DL1	0.14	Eq. J4-2

$A_g = L_p*t_p$ = 18.5[in]*0.5[in] = **9.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (18.5[in] - 6*1.13[in])*0.5[in] = **5.88**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*9.25[in2], 5.88[in2]) = **5.88**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*5.88[in2] = **190.94**[kip] Eq. J4-2

Tear out under axial load	[Kip]	180.38	27.45	DL1	0.15	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = \mathbf{2}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = \mathbf{1.44}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.5[in] = \mathbf{4.69}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*1.44$[in2]$ + 1*65000$[lb/in2]$*4.69$[in2]$, 0.6*50000$[lb/in2]$*2$[in2]$ + 1*65000$[lb/in2]$*4.69$[in2]$) = \mathbf{180.38}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	185.21	94.15	DL1	0.51	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4$[kip/in]$*1*5*18.5$[in] = **185.21**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	223.59	27.45	DL	0.12	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **15**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34$[in]$^2*(1 + 3*(15$[in]$/10$[in]$)*(0.34$[in]$/0.56$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.56[in]$/0.34$[in]$)^{1/2} = \mathbf{223.59}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	173.21	90.06	DL1	0.52	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.9$[in]$ - 1.06$[in]$/2) = \mathbf{2.37}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.37$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(6 - 1))*0.38$[in]$*$
65000[lb/in2]$*1 = \mathbf{173.21}$[kip] Eq. J3-6

Shear yielding	[Kip]	158.08	90.06	DL1	0.57	Eq. J4-3

$A_g = L_p*t_p = 20.8$[in]$*0.38$[in]$ = \mathbf{7.9}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*7.9$[in2] = **158.08**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	152.83	27.45	DL1	0.18	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in]$ - 1.06$[in]$/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(1 - 1))*0.38$[in]$*$
65000[lb/in2]$*6 = \mathbf{152.83}$[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	27.45	DL1	0.06	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*14.7$[in2] = **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	284.40	27.45	DL1	0.10	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 14.7[in2] - 6*0.38[in]*1.13[in] = **12.14**[in2] Sec. D3-2

$U = 1 - x/l$ = 1 - 0.837[in]/3[in] = **0.721** Table D3.1

$A_e = U*A_n$ = 0.721*12.14[in2] = **8.75**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*8.75[in2] = **284.4**[kip] Eq. J4-2

Tear out under axial load	[Kip]	140.79	27.45	DL1	0.20	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.38[in] = **1.71**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.38[in] = **1.28**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(6 - 1)*0.38[in] = **3.56**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.28[in2] + 1*65000[lb/in2]*3.56[in2], 0.6*50000[lb/in2]*1.71[in2] + 1*65000[lb/in2]*3.56[in2]) = **140.79**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	56.61	DL1	0.22	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 94.15[kip]/(0.5*4[kip/in]*1*18.5[in]) = **2.54** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.54/16 [in] = **4.72**[kip/in] p. 9-5

Ratio **0.93**

Global critical strength ratio **0.93**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

Current Date: 2016-05-25 1:46 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : **VB-02-6**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21x50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	38.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	-60.00	Design
DL1	0.00	38.00	0.00	0.00	0.00	0.00	0.00	0.00	-25.00	0.00	0.00	60.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
25.00	DL	Design
-25.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	25.00	DL	0.13	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	25.00	DL	0.10	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	25.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	25.00	DL	0.09	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.13**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	25.00	DL	0.09	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	25.00	DL	0.12	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.349$[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 9.96_{[in2]}*0.7 = \mathbf{6.97}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*6.97_{[in2]} = \mathbf{202.26}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	259.24	25.00	DL	0.10	Eq. J4-1

$A_g = L_w*t_p = 17.32_{[in]}*0.5_{[in]} = \mathbf{8.66}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*8.66_{[in2]} = \mathbf{259.24}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	143.74	25.00	DL1	0.17	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*19.94_{[in]}/0.144_{[in]})^2 = \mathbf{35486.13}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 35486.13_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}{}_{[lb/in2]}{}^{/35486.13}{}_{[lb/in2]}{}^{)}*50000_{[lb/in2]} =$

27723.63[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*27723.63_{[lb/in2]}*8.66_{[in2]} = \mathbf{143.74}_{[kip]}$ Eq. E3-1

Ratio **0.17**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 10.4_{[in]}*1.98 - 5_{[in]} = \mathbf{15.56}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 23.95_{[in]}*(1.98 + 23.95_{[in]}/4.24_{[in]}) = \mathbf{182.54}_{[in]}$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.98)^2 + (23.95_{[in]}/4.24_{[in]})^2 = \mathbf{35.76}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (182.54_{[in]}*1.98 + 15.56_{[in]}*(23.95_{[in]}/$
$4.24_{[in]})^2)/35.76 = \mathbf{23.95}_{[in]}$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (182.54_{[in]} - 15.56_{[in]}*1.98)/35.76 = \mathbf{4.24}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((23.95_{[in]} + 5_{[in]})^2 + (4.24_{[in]} + 10.4_{[in]})^2)^{1/}$
$^2 = \mathbf{32.45}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 23.95_{[in]}*25_{[kip]}/32.45_{[in]} = \mathbf{18.46}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 5_{[in]}*25_{[kip]}/32.45_{[in]} = \mathbf{3.85}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4_{[in]}*25_{[kip]}/32.45_{[in]} - 0_{[kip]} = \mathbf{8.01}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.24_{[in]}*25_{[kip]}/32.45_{[in]} + 0_{[kip]} = \mathbf{3.27}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(8.01_{[kip]}*(23.95_{[in]} - 23.95_{[in]})) +$
$abs(0_{[kip]}*23.95_{[in]}) = \mathbf{5.34E-15}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(3.85_{[kip]}*(4.24_{[in]} - 4.24_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 10.4_{[in]}*1.98 - 5_{[in]} = \mathbf{15.56}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 23.95_{[in]}*(1.98 + 23.95_{[in]}/4.24_{[in]}) = \mathbf{182.54}_{[in]}$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.98)^2 + (23.95_{[in]}/4.24_{[in]})^2 = \mathbf{35.76}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (182.54_{[in]}*1.98 + 15.56_{[in]}*(23.95_{[in]}/$
$4.24_{[in]})^2)/35.76 = \mathbf{23.95}_{[in]}$ p. 13-10

$\beta = (K' - K*\tan\theta)/D = (182.54[in] - 15.56[in]*1.98)/35.76 =$ **4.24**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((23.95[in] + 5[in])^2 + (4.24[in] + 10.4[in])^2)^{1/2} =$ **32.45**[in] p. 13-5

$H_b = \alpha*P/r = 23.95[in]*-25[kip]/32.45[in] =$ **-18.46**[kip] p. 13-5

$H_c = e_c*P/r = 5[in]*-25[kip]/32.45[in] =$ **-3.85**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*-25[kip]/32.45[in] - 0[kip] =$ **-8.01**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 4.24[in]*-25[kip]/32.45[in] + 0[kip] =$ **-3.27**[kip] p. 13-5

$M_b = \text{abs}(V_b*(\alpha - \alpha_{bar})) + \text{abs}(\Delta V*\alpha) = \text{abs}(-8.01[kip]*(23.95[in] - 23.95[in])) + \text{abs}(0[kip]*23.95[in]) =$ **5.34E-15**[kip*ft] p. 13-10

$M_c = \text{abs}(H_c*(\beta - \beta_{bar})) = \text{abs}(-3.85[kip]*(4.24[in] - 4.24[in])) =$ **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	18.46	8.01	0.00	0.00	0.00	0.00	Design
DL1	-18.46	-8.01	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	694.70	8.01	DL	0.01	Eq. J4-1
$A_g = L_p*t_p = 46.41[in]*0.5[in] =$ **23.2**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*23.2[in2] =$ **694.7**[kip]						Eq. J4-1
Shear yielding	[Kip]	464.06	18.46	DL	0.04	Eq. J4-3
$A_g = L_p*t_p = 46.41[in]*0.5[in] =$ **23.2**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*23.2[in2] =$ **464.06**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	49731.83	DL	0.01	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000[lb/in2] =$ **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l) = 8.01[kip]/(0.5[in]*46.41[in]) =$ **345.36**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	114540.80	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y = 0.667*0.6*50000[lb/in2] =$ **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l) = 18.46[kip]/(0.5[in]*46.41[in]) =$ **795.42**[lb/in2]						9
Weld capacity	[Kip]	484.81	25.15	DL1	0.05	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.09[kip/in]*1*5*46.41[in]) =$ **484.81**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l = -8.01[kip]/46.41[in] =$ **-0.173**[kip/in]						9

$f_{uv} = H_b/l$ = -18.46[kip]/46.41[in] = **-0.398**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -5.34E-15[kip*ft]/(46.41[in]^2/6) = **-1.78E-16**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.173[kip/in] + 1.78E-16[kip/in])^2 + 0.398[kip/in]^2)$^{1/2}$ = **0.434**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.173[kip/in] - 1.78E-16[kip/in])^2 + 0.398[kip/in]^2)$^{1/2}$ + ((0.173[kip/in] + 1.78E-16[kip/in])^2 + 0.398[kip/in]^2)$^{1/2}$) = **0.434**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 46.41[in]*max(0.434[kip/in], 1.25*0.434[kip/in]) = **25.15**[kip] 9

Beam

Weld block shear	[Kip]	387.79	18.46	DL	0.05	Eq. J4-5

$A_{gv} = l*t_w$ = 46.41[in]*0.38[in] = **17.63**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **17.63**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*17.63[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*17.63[in2] + 1*65000[lb/in2]*3.79[in2]) = **387.79**[kip] Eq. J4-5

Web crippling	[Kip]	413.18	8.01	DL1	0.02	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **46.41**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.38[in]^2*(1 + 3*(46.41[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.535[in]/0.38[in])$^{1/2}$ = **413.18**[kip] Eq. J10-4

Local web yielding	[Kip]	653.68	8.01	DL	0.01	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **46.41**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.04[in] + 46.41[in])*50000[lb/in2]*0.38[in] = **653.68**[kip] Eq. J10-2

Ratio **0.05**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	3.27	3.85	0.00	0.00	0.00	Design

DL1	-3.27	-3.85	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length $L_{min} = T/2 = 8.49$[in]$/2 =$ **4.24**[in] $L_{max} = L =$ **8.49**[in]	[in]	6.50	4.24	8.49	✔	p. 10-104 p. 10-104
Thickness $t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]	[in]	0.50	--	0.56	✔	p. 10-102 p. 10-102
Vertical edge distance $L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5 Tables J3.4, J3.5
Horizontal edge distance $L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]	[in]	2.00	2.00	--	✔	p. 10-102 p. 10-102
Vertical center-to-center spacing (pitch) $s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in] *IsCorrosionConsidered* → **False** $s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5 Sec. J3.3 Sec. J3.5
Beam						
Vertical edge distance $L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]	[in]	2.74	1.25	--	✔	Tables J3.4, J3.5 Tables J3.4, J3.5
Horizontal edge distance $L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]	[in]	2.25	2.00	--	✔	p. 10-102 p. 10-102
Support						
Weld size $w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $=$ **0.026**	[1/16in]	5	5	--	✔	p. 10-101 p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	5.05	DL	0.15	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = C*(*1/Ω*)R_n*BoltFactor* = 2*16.87[kip]*1 = **33.75**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	61.55	3.27	DL	0.05	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*
65000[lb/in2]*1 = **61.55**[kip] — Eq. J3-6

Shear yielding	[Kip]	65.00	3.27	DL	0.05	Eq. J4-3

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.25[in2] = **65**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.44	3.27	DL	0.08	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 6.5[in] - 2*1.13[in] = **4.25**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 4.25[in]*0.5[in] = **2.13**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.13[in2] = **41.44**[kip] — Eq. J4-4

Block shear	[Kip]	53.22	3.27	DL	0.06	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (2 - 1)*3[in])*0.5[in] = **2.38**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **1.53**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*2.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **53.22**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	57.28	3.85	DL	0.07	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **57.28**[kip] — Eq. J3-6

Tension yielding	[Kip]	97.31	3.85	DL	0.04	Eq. J4-1
$A_g = L_p*t_p$ = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*3.25[in2] = **97.31**[kip]						Eq. J4-1
Tension rupture	[Kip]	69.06	3.85	DL	0.06	Eq. J4-2
$A_g = L_p*t_p$ = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (6.5[in] - 2*1.13[in])*0.5[in] = **2.13**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*3.25[in2], 2.13[in2]) = **2.13**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.13[in2] = **69.06**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	58.50	3.85	DL	0.07	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
n>1 → 2>1 → **True**						
A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2]						Sec. J4-3
A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2]						Sec. J4-3
A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*0.938[in2]) = **58.5**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	80.40	5.05	DL	0.06	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.95[kip/in]*1*5*6.5[in] = **80.4**[kip]						Tables 8-4 .. 8-11
Web crippling	[Kip]	101.88	3.85	DL1	0.04	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **3**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E*F_{yw}*t_f/t_w$)$^{1/2}$ = 0.5*0.80*0.34[in]^2*(1 + 3*(3[in]/10[in])*(0.34[in]/0.56[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.56[in]/0.34[in])$^{1/2}$ = **101.88**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	3.27	DL	0.04	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.74[in] - 1.06[in]/2) = **2.21**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)$*(min($k_1*L_{c\text{-}end}$, k_2*d) + min($k_1*L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.21[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*1 = **76.78**[kip]						Eq. J3-6
Shear yielding	[Kip]	84.88	3.27	DL	0.04	Eq. J4-3

$A_g = L_p*t_p$ = 8.49[in]*0.5[in] = **4.24**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.24[in2] = **84.88**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	3.85	DL	0.06	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **67.03**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	127.07	3.85	DL	0.03	Eq. J4-1

$A_g = L_p*t_p$ = 8.49[in]*0.5[in] = **4.24**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.24[in2] = **127.07**[kip] Eq. J4-1

Tension rupture	[Kip]	101.37	3.85	DL	0.04	Eq. J4-2

$A_g = L_p*t_p$ = 8.49[in]*0.5[in] = **4.24**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (8.49[in] - 2*1.13[in])*0.5[in] = **3.12**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.24[in2], 3.12[in2]) = **3.12**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*3.12[in2] = **101.37**[kip] Eq. J4-2

Tear out under axial load	[Kip]	63.38	3.85	DL	0.06	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	7.00	DL	0.03	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

D_{min} = P/(*(1/Ω)*C*C_1*L) = 5.05[kip]/(0.5*4.95[kip/in]*1*6.5[in]) = **0.314** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.314/16 [in] = **0.583**[kip/in] p. 9-5

Ratio **0.15**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-60.00	DL	Design
60.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	60.00	DL	0.32	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.64	60.00	DL	0.19	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.465$[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.64**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	195.00	60.00	DL	0.31	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	287.50	60.00	DL1	0.21	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in]$, 10$[in]$)$ = **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **10.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2]) = **287.5**[kip]						Eq. J4-5

Ratio	**0.32**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	60.00	DL1	0.16	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	262.25	60.00	DL1	0.23	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t$ = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3[in]/10[in] = **0.7**						Table D3.1
$A_e = A_n*U$ = 12.92[in2]*0.7 = **9.04**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.04[in2] = **262.25**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	256.99	60.00	DL1	0.23	Eq. J4-1
$A_g = L_w*t_p$ = 17.17[in]*0.5[in] = **8.58**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*8.58[in2] = **256.99**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	138.45	60.00	DL	0.43	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*20.42[in]/0.144[in])^2 = **33834.15**[lb/in2]						Eq. E3-4
F_e>=0.44*$Q*F_y$ → 33834.15[lb/in2]>=0.44*1*50000[lb/in2] → **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = 0.658$^{(1*50000}$[lb/in2]$^{/33834.15}$[lb/in2]$^{)}$*50000[lb/in2] = **26936.73**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*26936.73[lb/in2]*8.58[in2] = **138.45**[kip]						Eq. E3-1

Ratio	**0.43**

Calculation of the brace interface forces

Load condition :DL

General case	DG29 p. 24-33
$K = e_b*tan\theta - e_c$ = 10.4[in]*2.07 - 5[in] = **16.48**[in]	p. 13-10
$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 24.68[in]*(2.07 + 24.68[in]/3.97[in]) = **204.51**[in]	p. 13-10
$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = (2.07)^2 + (24.68[in]/3.97[in])^2 = **42.95**	p. 13-10
$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (204.51[in]*2.07 + 16.48[in]*(24.68[in]/ 3.97[in])^2)/42.95 = **24.68**[in]	p. 13-10
$\beta = (K' - K*tan\theta)/D$ = (204.51[in] - 16.48[in]*2.07)/42.95 = **3.97**[in]	p. 13-10
$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((24.68[in] + 5[in])^2 + (3.97[in] + 10.4[in])^2)$^{1/2}$ = **32.98**[in]	p. 13-5
$H_b = \alpha*P/r$ = 24.68[in]*-60[kip]/32.98[in] = **-44.91**[kip]	p. 13-5

$H_c = e_c*P/r$ = 5[in]*-60[kip]/32.98[in] = **-9.1**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.4[in]*-60[kip]/32.98[in] - 0[kip] = **-18.92**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 3.97[in]*-60[kip]/32.98[in] + 0[kip] = **-7.22**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-18.92[kip]*(24.68[in] - 24.68[in])) +$
$abs(0[kip]*24.68[in])$ = **8.40E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-9.1[kip]*(3.97[in] - 3.97[in]))$ = **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c$ = 10.4[in]*2.07 - 5[in] = **16.48**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 24.68[in]*(2.07 + 24.68[in]/3.97[in]) = **204.51**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = $(2.07)^2$ + $(24.68[in]/3.97[in])^2$ = **42.95** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (204.51[in]*2.07 + 16.48[in]*(24.68[in]/
$3.97[in])^2)/42.95$ = **24.68**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D$ = (204.51[in] - 16.48[in]*2.07)/42.95 = **3.97**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((24.68[in] + 5[in])^2 + (3.97[in] + 10.4[in])^2)^{1/}$
^{2} = **32.98**[in] p. 13-5

$H_b = \alpha*P/r$ = 24.68[in]*60[kip]/32.98[in] = **44.91**[kip] p. 13-5

$H_c = e_c*P/r$ = 5[in]*60[kip]/32.98[in] = **9.1**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.4[in]*60[kip]/32.98[in] - 0[kip] = **18.92**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 3.97[in]*60[kip]/32.98[in] + 0[kip] = **7.22**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(18.92[kip]*(24.68[in] - 24.68[in])) +$
$abs(0[kip]*24.68[in])$ = **8.40E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.1[kip]*(3.97[in] - 3.97[in]))$ = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-44.91	-18.92	0.00	0.00	0.00	0.00	Design
DL1	44.91	18.92	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	716.56	18.92	DL1	0.03	Eq. J4-1
$A_g = L_p*t_p$ = 47.87[in]*0.5[in] = **23.93**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*23.93[in2] = **716.56**[kip]						Eq. J4-1
Shear yielding	[Kip]	478.66	44.91	DL	0.09	Eq. J4-3

$A_g = L_p*t_p$ = 47.87[in]*0.5[in] = **23.93**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*23.93[in2] = **478.66**[kip] Eq. J4-3

Gusset edge tension stress	[Lb/ft2]	4311377.00	113849.10	DL	0.03	J4-1

$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2] J4-1

$f_{ua} = V_b/(t_p*l)$ = -18.92[kip]/(0.5[in]*47.87[in]) = **-790.62**[lb/in2] 9

Gusset edge shear stress	[Lb/ft2]	2880000.00	270205.10	DL	0.09	J4-1

$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2] J4-1

$f_{uv} = H_b/(t_p*l)$ = -44.91[kip]/(0.5[in]*47.87[in]) = **-1876.42**[lb/in2] 9

Weld capacity	[Kip]	497.97	60.91	DL	0.12	Tables 8-4 .. 8-11

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.08[kip/in]*1*5*47.87[in]) = **497.97**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = -18.92[kip]/47.87[in] = **-0.395**[kip/in] 9

$f_{uv} = H_b/l$ = -44.91[kip]/47.87[in] = **-0.938**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -8.40E-15[kip*ft]/(47.87[in]^2/6) = **-2.64E-16**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.395[kip/in] + 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$ = **1.02**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.395[kip/in] - 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$ + ((0.395[kip/in] + 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$) = **1.02**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 47.87[in]*max(1.02[kip/in], 1.25*1.02[kip/in]) = **60.91**[kip] 9

Beam

Weld block shear	[Kip]	396.11	44.91	DL	0.11	Eq. J4-5

$A_{gv} = l*t_w$ = 47.87[in]*0.38[in] = **18.19**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **18.19**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*18.19[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*18.19[in2] + 1*65000[lb/in2]*3.79[in2]) = **396.11**[kip] Eq. J4-5

Web crippling	[Kip]	423.58	18.92	DL	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **47.87**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.38[in]^2*(1 + 3*(47.87[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.535[in]/0.38[in])$^{1/2}$ = **423.58**[kip] Eq. J10-4

Local web yielding	[Kip]	672.17	18.92	DL	0.03	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **47.87**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.04[in] + 47.87[in])*50000[lb/in2]*0.38[in] = **672.17**[kip] Eq. J10-2

Ratio	**0.12**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-7.22	-9.10	0.00	0.00	0.00	Design
DL1	7.22	9.10	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.50	3.97	7.94	✔	p. 10-104
$L_{min} = T/2 = 7.94$[in]$/2 =$ **3.97**[in]						p. 10-104
$L_{max} = L =$ **7.94**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.47	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	33.75	11.61	DL	0.34	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 2*16.87[kip]*1 = **33.75**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	61.55	7.22	DL	0.12	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]* 65000[lb/in2]*1 = **61.55**[kip]						Eq. J3-6
Shear yielding	[Kip]	65.00	7.22	DL	0.11	Eq. J4-3
A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.25[in2] = **65**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.44	7.22	DL	0.17	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 6.5[in] - 2*1.13[in] = **4.25**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 4.25[in]*0.5[in] = **2.13**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.13[in2] = **41.44**[kip]						Eq. J4-4
Block shear	[Kip]	53.22	7.22	DL	0.14	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (2 - 1)*3[in])*0.5[in] = **2.38**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (2 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **1.53**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*2.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **53.22**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	57.28	9.10	DL1	0.16	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **57.28**[kip] Eq. J3-6

Tension yielding	[Kip]	97.31	9.10	DL1	0.09	Eq. J4-1

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*3.25[in2] = **97.31**[kip] Eq. J4-1

Tension rupture	[Kip]	69.06	9.10	DL1	0.13	Eq. J4-2

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (6.5[in] - 2*1.13[in])*0.5[in] = **2.13**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.25[in2], 2.13[in2]) = **2.13**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)**F_u*A_e = 0.5*65000[lb/in2]*2.13[in2] = **69.06**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.50	9.10	DL1	0.16	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*0.938[in2]) = **58.5**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	81.23	11.61	DL	0.14	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*5[kip/in]*1*5*6.5[in] = **81.23**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	101.88	9.10	DL	0.09	Eq. J10-4

IsBeamReaction → **False**

N = N = **3**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34\text{[in]}^2*(1 + 3*(3\text{[in]}/10\text{[in]})*(0.34\text{[in]}/0.56\text{[in]})^{1.5})*(2.90\text{E+07[lb/in2]}*50000\text{[lb/in2]}*$
$0.56\text{[in]}/0.34\text{[in]})^{1/2} = \mathbf{101.88}\text{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	75.56	7.22	DL	0.10	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.47\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]}) + \text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(2 - 1))*0.5\text{[in]}*$
$65000\text{[lb/in2]}*1 = \mathbf{75.56}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	79.37	7.22	DL	0.09	Eq. J4-3

$A_g = L_p*t_p = 7.94\text{[in]}*0.5\text{[in]} = \mathbf{3.97}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*3.97\text{[in2]} = \mathbf{79.37}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	9.10	DL1	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.72}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.72\text{[in]}, 2.4*1\text{[in]}) + \text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(1 - 1))*0.5\text{[in]}*$
$65000\text{[lb/in2]}*2 = \mathbf{67.03}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	118.82	9.10	DL1	0.08	Eq. J4-1

$A_g = L_p*t_p = 7.94\text{[in]}*0.5\text{[in]} = \mathbf{3.97}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*3.97\text{[in2]} = \mathbf{118.82}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	92.41	9.10	DL1	0.10	Eq. J4-2

$A_g = L_p*t_p = 7.94\text{[in]}*0.5\text{[in]} = \mathbf{3.97}\text{[in2]}$ Sec. D3-1

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$A_n = (l - n*L_h)*t_p = (7.94\text{[in]} - 2*1.13\text{[in]})*0.5\text{[in]} = \mathbf{2.84}\text{[in2]}$ Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*3.97\text{[in2]}, 2.84\text{[in2]}) = \mathbf{2.84}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*2.84\text{[in2]} = \mathbf{92.41}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	63.38	9.10	DL1	0.14	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]})*0.5\text{[in]} = \mathbf{2.25}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 -$
$0.5))*0.5\text{[in]} = \mathbf{1.69}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(2 - 1)*0.5\text{[in]} = \mathbf{0.938}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	15.92	DL	0.06	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.56[in] =$ **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 11.61[kip]/(0.5*5[kip/in]*1*6.5[in]) =$ **0.715** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.715/16 [in] = **1.33**[kip/in] p. 9-5

Ratio **0.34**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + 18.46[kip] + -44.91[kip] =$ **-26.45**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 38[kip] - 8.01[kip] + -18.92[kip] =$ **11.06**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -18.46[kip] + 44.91[kip] =$ **26.45**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 38[kip] - -8.01[kip] + 18.92[kip] =$ **64.94**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	11.06	-26.45	0.00	0.00	0.00	Design
DL1	64.94	26.45	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.50	9.36	18.72	✔	p. 10-104

$L_{min} = T/2 = 18.72[in]/2 =$ **9.36**[in] p. 10-104

$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.8[in] - max(1.04[in], 0[in]) - max(1.04[in], 0[in]) = **18.72**[in] p. 10-49

Thickness	[in]	0.50	--	0.56	✔	p. 10-102

$t_{pmax} = d/2 + 1/16$ [in] = 1[in]/2 + 1/16 [in] = **0.563**[in] p. 10-102

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.12	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.38$[in], 12 [in]$) =$ **9.12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.40	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	84.37	70.12	DL1	0.83	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 5*16.87$[kip]$*1 =$ **84.37**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	174.89	64.94	DL1	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) =$ **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$						
$F_u*n_c = 0.5*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(5 - 1))*0.5$[in]$*$						

65000[lb/in2]*1 = **174.89**[kip] Eq. J3-6

Shear yielding	[Kip]	155.00	64.94	DL1	0.42	Eq. J4-3

$A_g = L_p*t_p$ = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.75[in2] = **155**[kip] Eq. J4-3

Shear rupture	[Kip]	96.28	64.94	DL1	0.67	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 15.5[in] - 5*1.13[in] = **9.88**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 9.88[in]*0.5[in] = **4.94**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*4.94[in2] = **96.28**[kip] Eq. J4-4

Block shear	[Kip]	108.06	64.94	DL1	0.60	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (5 - 1)*3[in])*0.5[in] = **6.88**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **4.34**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*4.34[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*6.88[in2] + 1*65000[lb/
in2]*0.719[in2]) = **108.06**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	143.20	26.45	DL1	0.18	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*5 = **143.2**[kip] Eq. J3-6

Tension yielding	[Kip]	232.04	26.45	DL1	0.11	Eq. J4-1

$A_g = L_p*t_p$ = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*7.75[in2] = **232.04**[kip] Eq. J4-1

Tension rupture	[Kip]	160.47	26.45	DL1	0.16	Eq. J4-2

$A_g = L_p*t_p$ = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (15.5[in] - 5*1.13[in])*0.5[in] = **4.94**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*7.75[in2], 4.94[in2]) = **4.94**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*4.94[in2] = **160.47**[kip] Eq. J4-2

Tear out under axial load	[Kip]	149.91	26.45	DL1	0.18	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(5 - 1)*0.5[in] = **3.75**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*1.44$[in2] + 1*65000[lb/in2]*3.75[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*3.75[in2]) = **149.91**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	160.52	70.12	DL1	0.44	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.14$[kip/in]*1*5*15.5[in] = **160.52**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	193.16	26.45	DL	0.14	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34$[in]$^2*(1 + 3*(12$[in]$/10$[in]$)*(0.34$[in]$/0.56$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.56[in]$/0.34$[in]$)^{1/2} =$ **193.16**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	144.50	64.94	DL1	0.45	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.4$[in] - 1.06[in]$/2) =$ **3.87**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 1.06[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.87$[in], 2.4*1[in]$) + \min(1.2*1.94$[in], 2.4*1[in]$)*(5 - 1))*0.38$[in]$*$
65000[lb/in2]$*1 =$ **144.5**[kip] Eq. J3-6

Shear yielding	[Kip]	158.08	64.94	DL1	0.41	Eq. J4-3

$A_g = L_p*t_p = 20.8$[in]$*0.38$[in]$ =$ **7.9**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*7.9$[in2] = **158.08**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	127.36	26.45	DL1	0.21	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in] - 1.06[in]$/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 1.06[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72$[in], 2.4*1[in]$) + \min(1.2*1.94$[in], 2.4*1[in]$)*(1 - 1))*0.38$[in]$*$
65000[lb/in2]$*5 =$ **127.36**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	26.45	DL1	0.06	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*14.7$[in2] = **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	294.42	26.45	DL1	0.09	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 14.7[in2] - 5*0.38[in]*1.13[in] = **12.56**[in2] Sec. D3-2

$U = 1 - x/l$ = 1 - 0.837[in]/3[in] = **0.721** Table D3.1

$A_e = U*A_n$ = 0.721*12.56[in2] = **9.06**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*9.06[in2] = **294.42**[kip] Eq. J4-2

Tear out under axial load	[Kip]	117.63	26.45	DL1	0.22	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.38[in] = **1.71**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.38[in] = **1.28**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(5 - 1)*0.38[in] = **2.85**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.28[in2] + 1*65000[lb/in2]*2.85[in2], 0.6*50000[lb/in2]*1.71[in2] + 1*65000[lb/in2]*2.85[in2]) = **117.63**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	48.65	DL1	0.19	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 70.12[kip]/(0.5*4.14[kip/in]*1*15.5[in]) = **2.18** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.18/16 [in] = **4.05**[kip/in] p. 9-5

Ratio **0.83**

Global critical strength ratio **0.83**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

Current Date: 2016-05-25 1:48 PM

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : CBB_DA

Connection ID : VB-02-7

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21x50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	38.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	-60.00	Design
DL1	0.00	38.00	0.00	0.00	0.00	0.00	0.00	0.00	-25.00	0.00	0.00	60.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
25.00	DL	Design
-25.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	25.00	DL	0.13	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	25.00	DL	0.10	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	25.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	25.00	DL	0.09	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.13**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	25.00	DL	0.09	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	25.00	DL	0.12	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.349$[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 9.96_{[in2]}*0.7 = \mathbf{6.97}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*6.97_{[in2]} = \mathbf{202.26}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	261.43	25.00	DL	0.10	Eq. J4-1

$A_g = L_w*t_p = 17.46_{[in]}*0.5_{[in]} = \mathbf{8.73}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*8.73_{[in2]} = \mathbf{261.43}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	148.63	25.00	DL1	0.17	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*19.51_{[in]}/0.144_{[in]})^2 = \mathbf{37059.17}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 37059.17_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}{}_{[lb/in2]}{}^{/37059.17}{}_{[lb/in2]}{}^{)}*50000_{[lb/in2]} =$

28426.38[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*28426.38_{[lb/in2]}*8.73_{[in2]} = \mathbf{148.63}_{[kip]}$ Eq. E3-1

Ratio **0.17**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*\tan\theta - e_c = 10.4_{[in]}*1.9 - 5_{[in]} = \mathbf{14.75}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar}) = 23.3_{[in]}*(1.9 + 23.3_{[in]}/4.5_{[in]}) = \mathbf{164.83}_{[in]}$ p. 13-10

$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.9)^2 + (23.3_{[in]}/4.5_{[in]})^2 = \mathbf{30.37}$ p. 13-10

$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (164.83_{[in]}*1.9 + 14.75_{[in]}*(23.3_{[in]}/$
$4.5_{[in]})^2)/30.37 = \mathbf{23.3}_{[in]}$ p. 13-10

$\beta = (K' - K*\tan\theta)/D = (164.83_{[in]} - 14.75_{[in]}*1.9)/30.37 = \mathbf{4.5}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((23.3_{[in]} + 5_{[in]})^2 + (4.5_{[in]} + 10.4_{[in]})^2)^{1/2} =$
31.99[in] p. 13-5

$H_b = \alpha*P/r = 23.3_{[in]}*25_{[kip]}/31.99_{[in]} = \mathbf{18.21}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 5_{[in]}*25_{[kip]}/31.99_{[in]} = \mathbf{3.91}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4_{[in]}*25_{[kip]}/31.99_{[in]} - 0_{[kip]} = \mathbf{8.13}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.5_{[in]}*25_{[kip]}/31.99_{[in]} + 0_{[kip]} = \mathbf{3.52}_{[kip]}$ p. 13-5

$M_b = \text{abs}(V_b*(\alpha - \alpha_{bar})) + \text{abs}(\Delta V*\alpha) = \text{abs}(8.13_{[kip]}*(23.3_{[in]} - 23.3_{[in]})) +$
$\text{abs}(0_{[kip]}*23.3_{[in]}) = \mathbf{1.80E\text{-}15}_{[kip*ft]}$ p. 13-10

$M_c = \text{abs}(H_c*(\beta - \beta_{bar})) = \text{abs}(3.91_{[kip]}*(4.5_{[in]} - 4.5_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*\tan\theta - e_c = 10.4_{[in]}*1.9 - 5_{[in]} = \mathbf{14.75}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar}) = 23.3_{[in]}*(1.9 + 23.3_{[in]}/4.5_{[in]}) = \mathbf{164.83}_{[in]}$ p. 13-10

$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (1.9)^2 + (23.3_{[in]}/4.5_{[in]})^2 = \mathbf{30.37}$ p. 13-10

$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (164.83_{[in]}*1.9 + 14.75_{[in]}*(23.3_{[in]}/$
$4.5_{[in]})^2)/30.37 = \mathbf{23.3}_{[in]}$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (164.83[in] - 14.75[in]*1.9)/30.37 = \mathbf{4.5}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((23.3[in] + 5[in])^2 + (4.5[in] + 10.4[in])^2)^{1/2} =$
$\mathbf{31.99}[in]$ p. 13-5

$H_b = \alpha*P/r = 23.3[in]*-25[kip]/31.99[in] = \mathbf{-18.21}[kip]$ p. 13-5

$H_c = e_c*P/r = 5[in]*-25[kip]/31.99[in] = \mathbf{-3.91}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*-25[kip]/31.99[in] - 0[kip] = \mathbf{-8.13}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.5[in]*-25[kip]/31.99[in] + 0[kip] = \mathbf{-3.52}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-8.13[kip]*(23.3[in] - 23.3[in])) +$
$abs(0[kip]*23.3[in]) = \mathbf{1.80E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-3.91[kip]*(4.5[in] - 4.5[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	18.21	8.13	0.00	0.00	0.00	0.00	Design
DL1	-18.21	-8.13	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	675.28	8.13	DL	0.01	Eq. J4-1
$A_g = L_p*t_p = 45.11[in]*0.5[in] = \mathbf{22.55}[in2]$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*22.55[in2] = \mathbf{675.28}[kip]$						Eq. J4-1
Shear yielding	[Kip]	451.09	18.21	DL	0.04	Eq. J4-3
$A_g = L_p*t_p = 45.11[in]*0.5[in] = \mathbf{22.55}[in2]$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*22.55[in2] = \mathbf{451.09}[kip]$						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	51892.49	DL	0.01	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000[lb/in2] = \mathbf{29940.12}[lb/in2]$						J4-1
$f_{ua} = V_b/(t_p*l) = 8.13[kip]/(0.5[in]*45.11[in]) = \mathbf{360.36}[lb/in2]$						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	116281.60	DL	0.04	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y = 0.667*0.6*50000[lb/in2] = \mathbf{20000}[lb/in2]$						J4-1
$f_{uv} = H_b/(t_p*l) = 18.21[kip]/(0.5[in]*45.11[in]) = \mathbf{807.51}[lb/in2]$						9
Weld capacity	[Kip]	473.10	24.93	DL	0.05	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.1[kip/in]*1*5*45.11[in]) = \mathbf{473.1}[kip]$						Tables 8-4 .. 8-11
$f_{ua} = V_b/l = 8.13[kip]/45.11[in] = \mathbf{0.18}[kip/in]$						9

$f_{uv} = H_b/l$ = 18.21[kip]/45.11[in] = **0.404**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = 1.80E-15[kip*ft]/(45.11[in]^2/6) = **6.39E-17**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.18[kip/in] + 6.39E-17[kip/in])^2 + 0.404[kip/in]^2)$^{1/2}$ = **0.442**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.18[kip/in] - 6.39E-17[kip/in])^2 + 0.404[kip/in]^2)$^{1/2}$ + ((0.18[kip/in] + 6.39E-17[kip/in])^2 + 0.404[kip/in]^2)$^{1/2}$) = **0.442**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 45.11[in]*max(0.442[kip/in], 1.25*0.442[kip/in]) = **24.93**[kip] 9

Beam

Weld block shear	[Kip]	380.40	18.21	DL	0.05	Eq. J4-5

$A_{gv} = l*t_w$ = 45.11[in]*0.38[in] = **17.14**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **17.14**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*17.14[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*17.14[in2] + 1*65000[lb/in2]*3.79[in2]) = **380.4**[kip] Eq. J4-5

Web crippling	[Kip]	403.94	8.13	DL1	0.02	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **45.11**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.38[in]^2*(1 + 3*(45.11[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.535[in]/0.38[in])$^{1/2}$ = **403.94**[kip] Eq. J10-4

Local web yielding	[Kip]	637.25	8.13	DL	0.01	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **45.11**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.04[in] + 45.11[in])*50000[lb/in2]*0.38[in] = **637.25**[kip] Eq. J10-2

Ratio **0.05**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	3.52	3.91	0.00	0.00	0.00	Design

DL1	-3.52	-3.91	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	6.50	4.50	9.01	✔	p. 10-104
$L_{min} = T/2 = 9.01$[in]$/2 =$ **4.5**[in]						p. 10-104
$L_{max} = L =$ **9.01**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	3.00	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $=$ **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	5.26	DL	0.16	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor* = 2*16.87[kip]*1 = **33.75**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	61.55	3.52	DL	0.06	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*
65000[lb/in2]*1 = **61.55**[kip] — Eq. J3-6

Shear yielding	[Kip]	65.00	3.52	DL	0.05	Eq. J4-3

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.25[in2] = **65**[kip] — Eq. J4-3

Shear rupture	[Kip]	41.44	3.52	DL	0.08	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 6.5[in] - 2*1.13[in] = **4.25**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 4.25[in]*0.5[in] = **2.13**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.13[in2] = **41.44**[kip] — Eq. J4-4

Block shear	[Kip]	53.22	3.52	DL	0.07	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (2 - 1)*3[in])*0.5[in] = **2.38**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **1.53**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*2.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **53.22**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	57.28	3.91	DL	0.07	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **57.28**[kip] — Eq. J3-6

Tension yielding	[Kip]	97.31	3.91	DL	0.04	Eq. J4-1
$A_g = L_p*t_p$ = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*3.25[in2] = **97.31**[kip]						Eq. J4-1
Tension rupture	[Kip]	69.06	3.91	DL	0.06	Eq. J4-2
$A_g = L_p*t_p$ = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (6.5[in] - 2*1.13[in])*0.5[in] = **2.13**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*3.25[in2], 2.13[in2]) = **2.13**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.13[in2] = **69.06**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	58.50	3.91	DL	0.07	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
n>1 → 2>1 → **True**						
A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2]						Sec. J4-3
A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2]						Sec. J4-3
A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*0.938[in2]) = **58.5**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	79.64	5.26	DL	0.07	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.9[kip/in]*1*5*6.5[in] = **79.64**[kip]						Tables 8-4 .. 8-11
Web crippling	[Kip]	101.88	3.91	DL1	0.04	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **3**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*0.80*0.34[in]^2*(1 + 3*(3[in]/10[in])*(0.34[in]/0.56[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.56[in]/0.34[in])$^{1/2}$ = **101.88**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	3.52	DL	0.05	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 3[in] - 1.06[in]/2) = **2.47**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*1 = **76.78**[kip]						Eq. J3-6
Shear yielding	[Kip]	90.09	3.52	DL	0.04	Eq. J4-3

$A_g = L_p*t_p$ = 9.01[in]*0.5[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.5[in2] = **90.09**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	3.91	DL	0.06	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **67.03**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	134.86	3.91	DL	0.03	Eq. J4-1

$A_g = L_p*t_p$ = 9.01[in]*0.5[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.5[in2] = **134.86**[kip] Eq. J4-1

Tension rupture	[Kip]	109.83	3.91	DL	0.04	Eq. J4-2

$A_g = L_p*t_p$ = 9.01[in]*0.5[in] = **4.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (9.01[in] - 2*1.13[in])*0.5[in] = **3.38**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.5[in2], 3.38[in2]) = **3.38**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*3.38[in2] = **109.83**[kip] Eq. J4-2

Tear out under axial load	[Kip]	63.38	3.91	DL	0.06	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	7.35	DL	0.03	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 5.26[kip]/(0.5*4.9[kip/in]*1*6.5[in]) = **0.33** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.33/16 [in] = **0.613**[kip/in] p. 9-5

Ratio **0.16**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-60.00	DL	Design
60.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	60.00	DL	0.32	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.64	60.00	DL	0.19	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.465$[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.64**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	195.00	60.00	DL	0.31	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	287.50	60.00	DL1	0.21	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in]$, 10$[in]$)$ = **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **10.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2]) = **287.5**[kip]						Eq. J4-5

Ratio	**0.32**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	60.00	DL1	0.16	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	262.25	60.00	DL1	0.23	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t$ = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3[in]/10[in] = **0.7**						Table D3.1
$A_e = A_n*U$ = 12.92[in2]*0.7 = **9.04**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.04[in2] = **262.25**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	256.99	60.00	DL1	0.23	Eq. J4-1
$A_g = L_w*t_p$ = 17.17[in]*0.5[in] = **8.58**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*8.58[in2] = **256.99**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	138.45	60.00	DL	0.43	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*20.42[in]/0.144[in])^2 = **33834.15**[lb/in2]						Eq. E3-4
F_e>=0.44*$Q*F_y$ → 33834.15[lb/in2]>=0.44*1*50000[lb/in2] → **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = 0.658$^{(1*50000}$[lb/in2]$^{/33834.15}$[lb/in2]$^{)}$*50000[lb/in2] = **26936.73**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*26936.73[lb/in2]*8.58[in2] = **138.45**[kip]						Eq. E3-1

Ratio	**0.43**

Calculation of the brace interface forces

Load condition :DL

General case	DG29 p. 24-33
$K = e_b*tan\theta - e_c$ = 10.4[in]*2.07 - 5[in] = **16.48**[in]	p. 13-10
$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 24.68[in]*(2.07 + 24.68[in]/3.97[in]) = **204.51**[in]	p. 13-10
$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = (2.07)^2 + (24.68[in]/3.97[in])^2 = **42.95**	p. 13-10
$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (204.51[in]*2.07 + 16.48[in]*(24.68[in]/ 3.97[in])^2)/42.95 = **24.68**[in]	p. 13-10
$\beta = (K' - K*tan\theta)/D$ = (204.51[in] - 16.48[in]*2.07)/42.95 = **3.97**[in]	p. 13-10
$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((24.68[in] + 5[in])^2 + (3.97[in] + 10.4[in])^2)$^{1/2}$ = **32.98**[in]	p. 13-5
$H_b = \alpha*P/r$ = 24.68[in]*-60[kip]/32.98[in] = **-44.91**[kip]	p. 13-5

$H_c = e_c*P/r$ = 5[in]*-60[kip]/32.98[in] = **-9.1**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.4[in]*-60[kip]/32.98[in] - 0[kip] = **-18.92**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 3.97[in]*-60[kip]/32.98[in] + 0[kip] = **-7.22**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-18.92[kip]*(24.68[in] - 24.68[in])) +$
$abs(0[kip]*24.68[in])$ = **8.40E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-9.1[kip]*(3.97[in] - 3.97[in]))$ = **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c$ = 10.4[in]*2.07 - 5[in] = **16.48**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 24.68[in]*(2.07 + 24.68[in]/3.97[in]) = **204.51**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = $(2.07)^2$ + $(24.68[in]/3.97[in])^2$ = **42.95** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (204.51[in]*2.07 + 16.48[in]*(24.68[in]/
$3.97[in])^2)/42.95$ = **24.68**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D$ = (204.51[in] - 16.48[in]*2.07)/42.95 = **3.97**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((24.68[in] + 5[in])^2 + (3.97[in] + 10.4[in])^2)^{1/}$
^{2} = **32.98**[in] p. 13-5

$H_b = \alpha*P/r$ = 24.68[in]*60[kip]/32.98[in] = **44.91**[kip] p. 13-5

$H_c = e_c*P/r$ = 5[in]*60[kip]/32.98[in] = **9.1**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.4[in]*60[kip]/32.98[in] - 0[kip] = **18.92**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 3.97[in]*60[kip]/32.98[in] + 0[kip] = **7.22**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(18.92[kip]*(24.68[in] - 24.68[in])) +$
$abs(0[kip]*24.68[in])$ = **8.40E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.1[kip]*(3.97[in] - 3.97[in]))$ = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-44.91	-18.92	0.00	0.00	0.00	0.00	Design
DL1	44.91	18.92	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	716.56	18.92	DL1	0.03	Eq. J4-1
$A_g = L_p*t_p$ = 47.87[in]*0.5[in] = **23.93**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*23.93[in2] = **716.56**[kip]						Eq. J4-1
Shear yielding	[Kip]	478.66	44.91	DL	0.09	Eq. J4-3

$A_g = L_p*t_p$ = 47.87[in]*0.5[in] = **23.93**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*23.93[in2] = **478.66**[kip] Eq. J4-3

Gusset edge tension stress	[Lb/ft2]	4311377.00	113849.10	DL	0.03	J4-1

$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2] J4-1

$f_{ua} = V_b/(t_p*l)$ = -18.92[kip]/(0.5[in]*47.87[in]) = **-790.62**[lb/in2] 9

Gusset edge shear stress	[Lb/ft2]	2880000.00	270205.10	DL	0.09	J4-1

$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2] J4-1

$f_{uv} = H_b/(t_p*l)$ = -44.91[kip]/(0.5[in]*47.87[in]) = **-1876.42**[lb/in2] 9

Weld capacity	[Kip]	497.97	60.91	DL	0.12	Tables 8-4 .. 8-11

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.08[kip/in]*1*5*47.87[in]) = **497.97**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = -18.92[kip]/47.87[in] = **-0.395**[kip/in] 9

$f_{uv} = H_b/l$ = -44.91[kip]/47.87[in] = **-0.938**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -8.40E-15[kip*ft]/(47.87[in]^2/6) = **-2.64E-16**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.395[kip/in] + 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$ = **1.02**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.395[kip/in] - 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$ + ((0.395[kip/in] + 2.64E-16[kip/in])^2 + 0.938[kip/in]^2)$^{1/2}$) = **1.02**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 47.87[in]*max(1.02[kip/in], 1.25*1.02[kip/in]) = **60.91**[kip] 9

Beam

Weld block shear	[Kip]	396.11	44.91	DL	0.11	Eq. J4-5

$A_{gv} = l*t_w$ = 47.87[in]*0.38[in] = **18.19**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **18.19**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*18.19[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*18.19[in2] + 1*65000[lb/in2]*3.79[in2]) = **396.11**[kip] Eq. J4-5

Web crippling	[Kip]	423.58	18.92	DL	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **47.87**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.38[in]^2*(1 + 3*(47.87[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.535[in]/0.38[in])$^{1/2}$ = **423.58**[kip] Eq. J10-4

Local web yielding	[Kip]	672.17	18.92	DL	0.03	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **47.87**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*1.04[in] + 47.87[in])*50000[lb/in2]*0.38[in] = **672.17**[kip] Eq. J10-2

Ratio	**0.12**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-7.22	-9.10	0.00	0.00	0.00	Design
DL1	7.22	9.10	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.50	3.97	7.94	✔	p. 10-104
$L_{min} = T/2 = 7.94$[in]$/2 =$ **3.97**[in]						p. 10-104
$L_{max} = L =$ **7.94**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered $\rightarrow$ **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.47	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	33.75	11.61	DL	0.34	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 2*16.87[kip]*1 = **33.75**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	61.55	7.22	DL	0.12	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]* 65000[lb/in2]*1 = **61.55**[kip]						Eq. J3-6
Shear yielding	[Kip]	65.00	7.22	DL	0.11	Eq. J4-3
A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.25[in2] = **65**[kip]						Eq. J4-3
Shear rupture	[Kip]	41.44	7.22	DL	0.17	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 6.5[in] - 2*1.13[in] = **4.25**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 4.25[in]*0.5[in] = **2.13**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.13[in2] = **41.44**[kip]						Eq. J4-4
Block shear	[Kip]	53.22	7.22	DL	0.14	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (2 - 1)*3[in])*0.5[in] = **2.38**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (2 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **1.53**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.53[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*2.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **53.22**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	57.28	9.10	DL1	0.16	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **57.28**[kip] Eq. J3-6

Tension yielding	[Kip]	97.31	9.10	DL1	0.09	Eq. J4-1

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*3.25[in2] = **97.31**[kip] Eq. J4-1

Tension rupture	[Kip]	69.06	9.10	DL1	0.13	Eq. J4-2

A_g = L_p*t_p = 6.5[in]*0.5[in] = **3.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (6.5[in] - 2*1.13[in])*0.5[in] = **2.13**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.25[in2], 2.13[in2]) = **2.13**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*2.13[in2] = **69.06**[kip] Eq. J4-2

Tear out under axial load	[Kip]	58.50	9.10	DL1	0.16	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*0.938[in2]) = **58.5**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	81.23	11.61	DL	0.14	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*5[kip/in]*1*5*6.5[in] = **81.23**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	101.88	9.10	DL	0.09	Eq. J10-4

IsBeamReaction → **False**

N = N = **3**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34\text{[in]}^2*(1 + 3*(3\text{[in]}/10\text{[in]})*(0.34\text{[in]}/0.56\text{[in]})^{1.5})*(2.90\text{E+07[lb/in2]}*50000\text{[lb/in2]}*$
$0.56\text{[in]}/0.34\text{[in]})^{1/2} = \mathbf{101.88}\text{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	75.56	7.22	DL	0.10	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.47\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]}) + \text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(2 - 1))*0.5\text{[in]}*$
$65000\text{[lb/in2]}*1 = \mathbf{75.56}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	79.37	7.22	DL	0.09	Eq. J4-3

$A_g = L_p*t_p = 7.94\text{[in]}*0.5\text{[in]} = \mathbf{3.97}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*3.97\text{[in2]} = \mathbf{79.37}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	9.10	DL1	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.72}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.72\text{[in]}, 2.4*1\text{[in]}) + \text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(1 - 1))*0.5\text{[in]}*$
$65000\text{[lb/in2]}*2 = \mathbf{67.03}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	118.82	9.10	DL1	0.08	Eq. J4-1

$A_g = L_p*t_p = 7.94\text{[in]}*0.5\text{[in]} = \mathbf{3.97}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*3.97\text{[in2]} = \mathbf{118.82}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	92.41	9.10	DL1	0.10	Eq. J4-2

$A_g = L_p*t_p = 7.94\text{[in]}*0.5\text{[in]} = \mathbf{3.97}\text{[in2]}$ Sec. D3-1

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$A_n = (l - n*L_h)*t_p = (7.94\text{[in]} - 2*1.13\text{[in]})*0.5\text{[in]} = \mathbf{2.84}\text{[in2]}$ Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*3.97\text{[in2]}, 2.84\text{[in2]}) = \mathbf{2.84}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*2.84\text{[in2]} = \mathbf{92.41}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	63.38	9.10	DL1	0.14	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]})*0.5\text{[in]} = \mathbf{2.25}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 -$
$0.5))*0.5\text{[in]} = \mathbf{1.69}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(2 - 1)*0.5\text{[in]} = \mathbf{0.938}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	15.92	DL	0.06	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.56[in] =$ **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 11.61[kip]/(0.5*5[kip/in]*1*6.5[in]) =$ **0.715** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.715/16 [in] = **1.33**[kip/in] p. 9-5

Ratio **0.34**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + 18.21[kip] + -44.91[kip] =$ **-26.7**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 38[kip] - 8.13[kip] + -18.92[kip] =$ **10.95**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -18.21[kip] + 44.91[kip] =$ **26.7**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 38[kip] - -8.13[kip] + 18.92[kip] =$ **65.05**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	10.95	-26.70	0.00	0.00	0.00	Design
DL1	65.05	26.70	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.50	9.36	18.72	✔	p. 10-104

$L_{min} = T/2 = 18.72[in]/2 =$ **9.36**[in] p. 10-104

$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.8[in] - max(1.04[in], 0[in]) - max(1.04[in], 0[in]) = **18.72**[in] p. 10-49

Thickness	[in]	0.50	--	0.56	✔	p. 10-102

$t_{pmax} = d/2 + 1/16$ [in] = 1[in]/2 + 1/16 [in] = **0.563**[in] p. 10-102

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.12	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.38$[in], 12 [in]$) =$ **9.12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.40	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	84.37	70.31	DL1	0.83	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 5*16.87$[kip]$*1 =$ **84.37**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	174.89	65.05	DL1	0.37	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in]$ - 1.06$[in]$/2) =$ **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$						
$F_u*n_c = 0.5*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(5 - 1))*0.5$[in]$*$						

65000[lb/in2]*1 = **174.89**[kip] Eq. J3-6

Shear yielding	[Kip]	155.00	65.05	DL1	0.42	Eq. J4-3

$A_g = L_p*t_p$ = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.75[in2] = **155**[kip] Eq. J4-3

Shear rupture	[Kip]	96.28	65.05	DL1	0.68	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 15.5[in] - 5*1.13[in] = **9.88**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 9.88[in]*0.5[in] = **4.94**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*4.94[in2] = **96.28**[kip] Eq. J4-4

Block shear	[Kip]	108.06	65.05	DL1	0.60	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (5 - 1)*3[in])*0.5[in] = **6.88**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **4.34**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*4.34[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*6.88[in2] + 1*65000[lb/
in2]*0.719[in2]) = **108.06**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	143.20	26.70	DL1	0.19	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*5 = **143.2**[kip] Eq. J3-6

Tension yielding	[Kip]	232.04	26.70	DL1	0.12	Eq. J4-1

$A_g = L_p*t_p$ = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*7.75[in2] = **232.04**[kip] Eq. J4-1

Tension rupture	[Kip]	160.47	26.70	DL1	0.17	Eq. J4-2

$A_g = L_p*t_p$ = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (15.5[in] - 5*1.13[in])*0.5[in] = **4.94**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*7.75[in2], 4.94[in2]) = **4.94**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*4.94[in2] = **160.47**[kip] Eq. J4-2

Tear out under axial load	[Kip]	149.91	26.70	DL1	0.18	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = \mathbf{2}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = \mathbf{1.44}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.5[in] = \mathbf{3.75}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*1.44$[in2]$ + 1*65000$[lb/in2]$*3.75$[in2]$, 0.6*50000$[lb/in2]$*2$[in2]$ + 1*65000$[lb/in2]$*3.75$[in2]$) = \mathbf{149.91}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	160.68	70.31	DL1	0.44	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.15$[kip/in]$*1*5*15.5$[in] = **160.68**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	193.16	26.70	DL	0.14	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{12}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34$[in]$^2*(1 + 3*(12$[in]$/10$[in]$)*(0.34$[in]$/0.56$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.56[in]$/0.34$[in]$)^{1/2} = \mathbf{193.16}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	144.50	65.05	DL1	0.45	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.4$[in]$ - 1.06$[in]$/2) = \mathbf{3.87}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.87$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(5 - 1))*0.38$[in]$*$
65000[lb/in2]$*1 = \mathbf{144.5}$[kip] Eq. J3-6

Shear yielding	[Kip]	158.08	65.05	DL1	0.41	Eq. J4-3

$A_g = L_p*t_p = 20.8$[in]$*0.38$[in]$ = \mathbf{7.9}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*7.9$[in2] = **158.08**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	127.36	26.70	DL1	0.21	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in]$ - 1.06$[in]$/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(1 - 1))*0.38$[in]$*$
65000[lb/in2]$*5 = \mathbf{127.36}$[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	26.70	DL1	0.06	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*14.7$[in2] = **440.12**[kip] Eq. D2-1

Tension rupture	[Kip]	294.42	26.70	DL1	0.09	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 14.7[in2] - 5*0.38[in]*1.13[in] = **12.56**[in2] Sec. D3-2

$U = 1 - x/l$ = 1 - 0.837[in]/3[in] = **0.721** Table D3.1

$A_e = U*A_n$ = 0.721*12.56[in2] = **9.06**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*9.06[in2] = **294.42**[kip] Eq. J4-2

Tear out under axial load	[Kip]	117.63	26.70	DL1	0.23	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.38[in] = **1.71**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.38[in] = **1.28**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(5 - 1)*0.38[in] = **2.85**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.28[in2] + 1*65000[lb/in2]*2.85[in2], 0.6*50000[lb/in2]*1.71[in2] + 1*65000[lb/in2]*2.85[in2]) = **117.63**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	48.74	DL1	0.19	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 70.31[kip]/(0.5*4.15[kip/in]*1*15.5[in]) = **2.19** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.19/16 [in] = **4.06**[kip/in] p. 9-5

Ratio **0.83**

Global critical strength ratio **0.83**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : **VB-02-8**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	102.00	0.00	0.00	-152.00	Design
DL1	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	-102.00	0.00	0.00	152.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
102.00	DL	Design
-102.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	102.00	DL	0.55	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	102.00	DL	0.42	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	102.00	DL	0.52	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	102.00	DL	0.35	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.55**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	102.00	DL	0.36	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	102.00	DL	0.50	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.349$[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 9.96_{[in2]}*0.7 = \mathbf{6.97}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*6.97_{[in2]} = \mathbf{202.26}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	289.42	102.00	DL	0.35	Eq. J4-1

$A_g = L_w*t_p = 19.33_{[in]}*0.5_{[in]} = \mathbf{9.67}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*9.67_{[in2]} = \mathbf{289.42}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	287.42	102.00	DL1	0.35	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*3.48_{[in]}/0.144_{[in]})^2 = \mathbf{1.17E+06}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.17E+06_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/1.17E+06_{[lb/in2]})}*50000_{[lb/in2]} =$

49111.11[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*49111.11_{[lb/in2]}*9.77_{[in2]} = \mathbf{287.42}_{[kip]}$ Eq. E3-1

Ratio **0.50**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{8.41}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (8.41_{[in]} + 10.35_{[in]})*0.696 - 0.22_{[in]} = \mathbf{12.84}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((12.84_{[in]} + 0.22_{[in]})^2 + (8.41_{[in]} +$

$10.35_{[in]})^2)^{1/2} = \mathbf{22.86}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 12.84_{[in]}*102_{[kip]}/22.86_{[in]} = \mathbf{57.27}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 0.22_{[in]}*102_{[kip]}/22.86_{[in]} = \mathbf{0.982}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35_{[in]}*102_{[kip]}/22.86_{[in]} - 15_{[kip]} = \mathbf{31.18}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 8.41_{[in]}*102_{[kip]}/22.86_{[in]} + 15_{[kip]} = \mathbf{52.54}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(31.18_{[kip]}*(12.84_{[in]} - 12.84_{[in]})) +$

$abs(15_{[kip]}*12.84_{[in]}) = \mathbf{16.05}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(0.982_{[kip]}*(8.41_{[in]} - 8.41_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{8.41}_{[in]}$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (8.41_{[in]} + 10.35_{[in]})*0.696 - 0.22_{[in]} = \mathbf{12.84}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((12.84_{[in]} + 0.22_{[in]})^2 + (8.41_{[in]} +$

$10.35_{[in]})^2)^{1/2} = \mathbf{22.86}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 12.84_{[in]}*-102_{[kip]}/22.86_{[in]} = \mathbf{-57.27}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 0.22_{[in]}*-102_{[kip]}/22.86_{[in]} = \mathbf{-0.982}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35_{[in]}*-102_{[kip]}/22.86_{[in]} - -15_{[kip]} = \mathbf{-31.18}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 8.41_{[in]}*-102_{[kip]}/22.86_{[in]} + -15_{[kip]} = \mathbf{-52.54}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-31.18_{[kip]}*(12.84_{[in]} - 12.84_{[in]})) + abs(-$

15[kip]*12.84[in]) = **16.05**[kip*ft] p. 13-10

M_c = abs(H_c*(β - $β_{bar}$)) = abs(-0.982[kip]*(8.41[in] - 8.41[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	57.27	31.18	16.05	0.00	0.00	0.00	Design
DL1	-57.27	-31.18	-16.05	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	361.86	78.97	DL	0.22	Eq. J4-1
$A_g = L_p*t_p$ = 24.17[in]*0.5[in] = **12.09**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)*F_y*A_g$ = 0.599*50000[lb/in2]*12.09[in2] = **361.86**[kip]						Eq. J4-1
Shear yielding	[Kip]	241.72	57.27	DL	0.24	Eq. J4-3
$A_g = L_p*t_p$ = 24.17[in]*0.5[in] = **12.09**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*12.09[in2] = **241.72**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	371514.00	DL	0.09	J4-1
$(1/Ω)F_n = (1/Ω)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 31.18[kip]/(0.5[in]*24.17[in]) = **2579.96**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	682400.70	DL	0.24	J4-1
$(1/Ω)F_n = (1/Ω)$*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 57.27[kip]/(0.5[in]*24.17[in]) = **4738.89**[lb/in2]						9
Weld capacity	[Kip]	201.20	98.24	DL1	0.49	Tables 8-4 .. 8-11
$(1/Ω)R_n$ = 2 * ($(1/Ω)*C*C_1*D*L$) = 2 * (0.5*2.08[kip/in]*1*4*24.17[in]) = **201.2**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = -31.18[kip]/24.17[in] = **-1.29**[kip/in]						9
$f_{uv} = H_b/l$ = -57.27[kip]/24.17[in] = **-2.37**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -16.05[kip*ft]/(24.17[in]^2/6) = **-1.98**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((1.29[kip/in] + 1.98[kip/in])^2 + 2.37[kip/in]^2)$^{1/2}$ = **4.04**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((1.29[kip/in] - 1.98[kip/in])^2 + 2.37[kip/in]^2)$^{1/2}$ + ((1.29[kip/in] + 1.98[kip/in])^2 + 2.37[kip/in]^2)$^{1/2}$) = **3.25**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 24.17[in]*max(4.04[kip/in], 1.25*3.25[kip/in]) = **98.24**[kip]						9

Beam

Weld block shear	[Kip]	231.23	57.27	DL	0.25	Eq. J4-5
$A_{gv} = l*t_w$ = 24.17[in]*0.35[in] = **8.46**[in2]						Sec. J4.3
$A_{gt} = (A_g - t_w*T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2]						8
$A_{nv} = A_{gv}$ = **8.46**[in2]						Sec. J4.3
$A_{nt} = A_{gt}$ = **3.21**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*8.46[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*8.46[in2] + 1*65000[lb/in2]*3.21[in2]) = **231.23**[kip]						Eq. J4-5
Web crippling	[Kip]	199.74	32.63	DL1	0.16	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **19.97**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5* 0.80*0.35[in]^2*(1 + 3*(19.97[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]* 0.45[in]/0.35[in])$^{1/2}$ = **199.74**[kip]						Eq. J10-4
Local web yielding	[Kip]	260.71	32.63	DL	0.13	Eq. J10-3
IsBeamReaction → **False**						
$N = N$ = **19.97**[in]						Sec. J10-2
IsMemberEnd → **True**						
$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w$ = 0.667*(2.5*0.95[in] + 19.97[in])*50000[lb/in2]* 0.35[in] = **260.71**[kip]						Eq. J10-3

Ratio	**0.49**

Upper right gusset interface - column

Angles

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	52.54	0.98	Design
DL1	-52.54	-0.98	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle (Gusset side)						
Weld size	[1/16in]	4	3	4	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min}$ = **0.0156**						table J2.4

t_p<1/4 [in] → 0.313[in]<1/4 [in] → **False**

w_{max} = t_p - 1/16 [in] = 0.313[in] - 1/16 [in] = **0.0208** Sec. J2.2b

Angle (Column side)

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.13	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.50	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in] Sec. J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Angle (Gusset side)

Weld capacity	[Kip]	142.59	52.55	DL	0.37	Tables 8-4 .. 8-11

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*C*C_1*D*L) = 2 * (0.5*2.85[kip/in]*1*4*12.5[in]) = **142.59**[kip] Tables 8-4 .. 8-11

Shear yielding	[Kip]	112.50	52.54	DL	0.47	Eq. J4-3

A_g = L_p*t_p = 12.5[in]*0.313[in] = **3.91**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*3.91[in2]) = **112.5**[kip] Eq. J4-3

Leg tensile yielding	[Kip]	168.41	0.98	DL	0.01	Eq. J4-1

A_g = L_p*t_p = 12.5[in]*0.313[in] = **3.91**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*3.91[in2]) = **168.41**[kip] Eq. J4-1

Angle (Column side)

Bolts shear	[Kip]	134.65	52.54	DL	0.39	Tables (7-1..14)

k_s = max(1 - T_u/($(1/\Omega)$*D_u*T_b*N_b), 0.0) = max(1 - 0.982[kip]/(0.667*1.13*64[kip]*8), 0.0) = **0.997** Eq. J3-5

$(1/\Omega)R_n$ = $(1/\Omega)$*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*0.997 = **16.83**[kip] Eq. J3-4

$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (4*16.83[kip]) = **134.65**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	152.93	52.54	DL	0.34	p. 7-18,

Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(4/(1*4))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.313[in]*58000[lb/in2]*1) = **152.93**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	112.50	52.54	DL	0.47	Eq. J4-3

A_g = L_p*t_p = 12.5[in]*0.313[in] = **3.91**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*3.91[in2]) = **112.5**[kip] Eq. J4-3

Shear rupture	[Kip]	87.00	52.54	DL	0.60	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 12.5[in] - 4*1.13[in] = **8**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.313[in] = **2.5**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*2.5[in2]) = **87**[kip] Eq. J4-4

Block shear	[Kip]	100.88	52.54	DL	0.52	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.13[in] + (1 - 1)*3[in] - (1 - 0.5)*1.13[in])*0.313[in] = **0.488**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (4 - 1)*3[in])*0.313[in] = **3.36**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.313[in] = **2.13**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*2.13[in2] + 1*58000[lb/in2]*0.488[in2], 0.6*36000[lb/in2]*3.36[in2] + 1*58000[lb/in2]*0.488[in2])) = **100.88**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	15.91	0.98	DL	0.06	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 52.54[kip]/(0.785[in2]*8) = **8367.03**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*8367.03[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **1.13E+05**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*1.13E+05[lb/in2]*0.785[in2] = **44.16**[kip] Eq. J3-2

f_v = F/(A_b*N_{bolts}) = 52.54[kip]/(0.785[in2]*8) = **8367.03**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/($(1/\Omega)$*F_{nv}), 0.0), F_{nt}) = min(max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*8367.03[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **1.13E+05**[lb/in2] Eq. J3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F'_{nt}*A_b = 0.5*1.13E+05[lb/in2]*0.785[in2] = **44.16**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(2.13[in] + 1[in]/2, 1.25*2.72[in] + 1[in]/2) = **2.63**[in] p. 9-12

b' = b - d/2 = 2.72[in] - 1[in]/2 = **2.22**[in] p. 9-12

ρ = b'/a' = 2.22[in]/2.63[in] = **0.845** p. 9-12

δ = 1 - d'/p = 1 - 1.06[in]/3[in] = **0.646** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*44.16\text{[kip]}*2.22\text{[in]})/(0.5*3\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.94}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.646*(1 + 0.845)))*((1.94\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{31.38}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.94\text{[in]})^2*(1 + 0.646) = \mathbf{0.0429}$ p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(2.13\text{[in]} + 1\text{[in]}/2, 1.25*2.72\text{[in]} + 1\text{[in]}/2) = \mathbf{2.63}\text{[in]}$ p. 9-12

$b' = b - d/2 = 2.72\text{[in]} - 1\text{[in]}/2 = \mathbf{2.22}\text{[in]}$ p. 9-12

$\rho = b'/a' = 2.22\text{[in]}/2.63\text{[in]} = \mathbf{0.845}$ p. 9-12

$\delta = 1 - d'/p = 1 - 1.06\text{[in]}/3.25\text{[in]} = \mathbf{0.673}$ p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*44.16\text{[kip]}*2.22\text{[in]})/(0.5*3.25\text{[in]}*58000\text{[lb/in2]}))^{0.5} = \mathbf{1.86}\text{[in]}$ p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.673*(1 + 0.845)))*((1.86\text{[in]}/0.313\text{[in]})^2 - 1) = \mathbf{27.73}$ p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313\text{[in]}/1.86\text{[in]})^2*(1 + 0.673) = \mathbf{0.0472}$ p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0472 + (4 - 2)*0.0429)/4 = \mathbf{0.045}$ p. 9-13

$T_{avail} = 8 * (B*Q) = 8 * (44.16\text{[kip]}*0.045) = \mathbf{15.91}\text{[kip]}$ p. 9-10

Gusset

Welds rupture	[Kip/ft]	234.00	65.68	DL	0.28	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.5\text{[in]} = \mathbf{19.5}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 26.28\text{[kip]}/(0.5*2.85\text{[kip/in]}*1*12.5\text{[in]}) = \mathbf{1.47}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 2 * (0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]}) = 2 * (0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*1.47/16\text{ [in]}) = \mathbf{5.47}\text{[kip/in]}$ p. 9-5

Shear yielding	[Kip]	168.29	52.54	DL	0.31	Eq. J4-3

$A_g = L_p*t_p = 16.83\text{[in]}*0.5\text{[in]} = \mathbf{8.41}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*8.41\text{[in2]} = \mathbf{168.29}\text{[kip]}$ Eq. J4-3

Tear out under axial load	[Kip]	266.88	0.98	DL	0.00	Eq. J4-5

$A_{gv} = 2.0*(b - c)*t_p = 2.0*(5\text{[in]} - 0.75\text{[in]})*0.5\text{[in]} = \mathbf{4.25}\text{[in2]}$ Sec. J4-3

$A_{nv} = A_{gv} = \mathbf{4.25}\text{[in2]}$ Sec. J4-3

$A_{nt} = L*t_p = 12.5\text{[in]}*0.5\text{[in]} = \mathbf{6.25}\text{[in2]}$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\text{min}(0.6*65000\text{[lb/in2]}*4.25\text{[in2]} + 1*65000\text{[lb/in2]}*6.25\text{[in2]}, 0.6*50000\text{[lb/in2]}*4.25\text{[in2]} + 1*65000\text{[lb/in2]}*6.25\text{[in2]}) = \mathbf{266.88}\text{[kip]}$ Eq. J4-5

Column

Bolt bearing under shear load	[Kip]	268.13	52.54	DL	0.20	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.20E+31\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.20E+31}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(\text{min}(1.2*1.20E+31\text{[in]}, 2.4*1\text{[in]}) + \text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(4 - 1))*0.44\text{[in]}*65000\text{[lb/in2]}*1) = \mathbf{268.13}\text{[kip]}$ Eq. J3-6

Ratio	0.60

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-152.00	DL	Design
152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	152.00	DL	0.82	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.64	152.00	DL	0.47	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.465$[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.64**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	195.00	152.00	DL	0.78	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	287.50	152.00	DL1	0.53	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **10.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$						

0.5*min(0.6*65000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2]) = **287.5**[kip] Eq. J4-5

Ratio **0.82**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	152.00	DL1	0.41	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	262.25	152.00	DL1	0.58	Eq. J4-2
$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2]						Sec. D3.2
U = 1 - x/l = 1 - 3[in]/10[in] = **0.7**						Table D3.1
$A_e = A_n*U$ = 12.92[in2]*0.7 = **9.04**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.04[in2] = **262.25**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	289.27	152.00	DL1	0.53	Eq. J4-1
$A_g = L_w*t_p$ = 19.32[in]*0.5[in] = **9.66**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.66[in2] = **289.27**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	287.25	152.00	DL	0.53	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*3.53[in]/0.144[in])^2 = **1.13E+06**[lb/in2]						Eq. E3-4
F_e>=0.44*Q*F_y → 1.13E+06[lb/in2]>=0.44*1*50000[lb/in2] → **True**						
F_{cr} = 0.658$^{(Q*Fy/Fe)}$*F_y = 0.658$^{(1*50000[lb/in2]/1.13E+06[lb/in2])}$*50000[lb/in2] = **49083.18**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*49083.18[lb/in2]*9.77[in2] = **287.25**[kip]						Eq. E3-1

Ratio **0.58**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar}$ = **8.41**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c$ = (8.41[in] + 10.35[in])*0.701 - 0.22[in] = **12.93**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((12.93[in] + 0.22[in])^2 + (8.41[in] + 10.35[in])^2)$^{1/2}$ = **22.92**[in] p. 13-5

$H_b = \alpha*P/r$ = 12.93[in]*-152[kip]/22.92[in] = **-85.79**[kip] p. 13-5

$H_c = e_c*P/r$ = 0.22[in]*-152[kip]/22.92[in] = **-1.46**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35$[in]$*-152$[kip]$/22.92$[in] $- -15$[kip] $= \mathbf{-53.65}$[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 8.41$[in]$*-152$[kip]$/22.92$[in] $+ -15$[kip] $= \mathbf{-70.81}$[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-53.65$[kip]$*(12.93$[in] $- 12.93$[in]$)) + abs(-15$[kip]$*12.93$[in]$) = \mathbf{16.17}$[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-1.46$[kip]$*(8.41$[in] $- 8.41$[in]$)) = \mathbf{0}$[kip*ft] p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{8.41}$[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (8.41$[in] $+ 10.35$[in]$)*0.701 - 0.22$[in] $= \mathbf{12.93}$[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((12.93$[in] $+ 0.22$[in]$)^2 + (8.41$[in] $+ 10.35$[in]$)^2)^{1/2} = \mathbf{22.92}$[in] p. 13-5

$H_b = \alpha*P/r = 12.93$[in]$*152$[kip]$/22.92$[in] $= \mathbf{85.79}$[kip] p. 13-5

$H_c = e_c*P/r = 0.22$[in]$*152$[kip]$/22.92$[in] $= \mathbf{1.46}$[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35$[in]$*152$[kip]$/22.92$[in] $- 15$[kip] $= \mathbf{53.65}$[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 8.41$[in]$*152$[kip]$/22.92$[in] $+ 15$[kip] $= \mathbf{70.81}$[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(53.65$[kip]$*(12.93$[in] $- 12.93$[in]$)) + abs(15$[kip]$*12.93$[in]$) = \mathbf{16.17}$[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(1.46$[kip]$*(8.41$[in] $- 8.41$[in]$)) = \mathbf{0}$[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-85.79	-53.65	-16.17	0.00	0.00	0.00	Design
DL1	85.79	53.65	16.17	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	364.78	101.42	DL1	0.28	Eq. J4-1
$A_g = L_p*t_p = 24.37$[in]$*0.5$[in] $= \mathbf{12.18}$[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*12.18$[in2] $= \mathbf{364.78}$[kip]						Eq. J4-1
Shear yielding	[Kip]	243.68	85.79	DL	0.35	Eq. J4-3
$A_g = L_p*t_p = 24.37$[in]$*0.5$[in] $= \mathbf{12.18}$[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*12.18$[in2] $= \mathbf{243.68}$[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	634103.30	DL	0.15	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000$[lb/in2] $= \mathbf{29940.12}$[lb/in2]						J4-1

$f_{ua} = V_b/(t_p*l)$ = -53.65[kip]/(0.5[in]*24.37[in]) = **-4403.5**[lb/in2] 9

Gusset edge shear stress	[Lb/ft2]	2880000.00	1013945.00	DL	0.35	J4-1

$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2] J4-1

$f_{uv} = H_b/(t_p*l)$ = -85.79[kip]/(0.5[in]*24.37[in]) = **-7041.28**[lb/in2] 9

Weld capacity	[Kip]	211.59	136.77	DL	0.65	Tables 8-4 .. 8-11

$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.17[kip/in]*1*4*24.37[in]) = **211.59**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = -53.65[kip]/24.37[in] = **-2.2**[kip/in] 9

$f_{uv} = H_b/l$ = -85.79[kip]/24.37[in] = **-3.52**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -16.17[kip*ft]/(24.37[in]^2/6) = **-1.96**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((2.2[kip/in] + 1.96[kip/in])^2 + 3.52[kip/in]^2)$^{1/2}$ = **5.45**[kip/in] 9

f_{uAve} = 0.5*((((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5*(((2.2[kip/in] - 1.96[kip/in])^2 + 3.52[kip/in]^2)$^{1/2}$ + ((2.2[kip/in] + 1.96[kip/in])^2 + 3.52[kip/in]^2)$^{1/2}$) = **4.49**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 24.37[in]*max(5.45[kip/in], 1.25*4.49[kip/in]) = **136.77**[kip] 9

Beam

Weld block shear	[Kip]	232.25	85.79	DL	0.37	Eq. J4-5

$A_{gv} = l*t_w$ = 24.37[in]*0.35[in] = **8.53**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2] 8

$A_{nv} = A_{gv}$ = **8.53**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.21**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*8.53[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*8.53[in2] + 1*65000[lb/in2]*3.21[in2]) = **232.25**[kip] Eq. J4-5

Web crippling	[Kip]	228.97	53.65	DL	0.23	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **24.37**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.35[in]^2*(1 + 3*(24.37[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **228.97**[kip] Eq. J10-4

Local web yielding	[Kip]	312.00	53.65	DL	0.17	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **24.37**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w$ = 0.667*(2.5*0.95[in] + 24.37[in])*50000[lb/in2]*0.35[in] = **312**[kip] Eq. J10-3

Ratio **0.65**

Lower right gusset interface - column

Angles

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	-70.81	-1.46	Design
DL1	70.81	1.46	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle (Gusset side)						
Weld size	[1/16in]	4	3	4	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} =$ **0.0156**						table J2.4
t_p<1/4 [in] → 0.313[in]<1/4 [in] → **False**						
$w_{max} = t_p$ - 1/16 [in] = 0.313[in] - 1/16 [in] = **0.0208**						Sec. J2.2b
Angle (Column side)						
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.13	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Gusset side)						
Weld capacity	[Kip]	142.59	70.83	DL	0.50	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*C*C_1*D*L) = 2 * (0.5*2.85[kip/in]*1*4*12.5[in]) = **142.59**[kip]						Tables 8-4 .. 8-11

Shear yielding	[Kip]	112.50	70.81	DL	0.63	Eq. J4-3

$A_g = L_p*t_p$ = 12.5[in]*0.313[in] = **3.91**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * $((1/\Omega)*0.60*F_y*A_g)$ = 2 * (0.667*0.60*36000[lb/in2]*3.91[in2]) = **112.5**[kip] Eq. J4-3

Leg tensile yielding	[Kip]	168.41	1.46	DL1	0.01	Eq. J4-1

$A_g = L_p*t_p$ = 12.5[in]*0.313[in] = **3.91**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * $((1/\Omega)*F_y*A_g)$ = 2 * (0.599*36000[lb/in2]*3.91[in2]) = **168.41**[kip] Eq. J4-1

Angle (Column side)

Bolts shear	[Kip]	134.49	70.81	DL1	0.53	Tables (7-1..14)

$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0)$ = max(1 - 1.46[kip]/(0.667*1.13*64[kip]*8), 0.0) = **0.996** Eq. J3-5

$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s$ = 0.667*0.35*1.13*1*64[kip]*1*0.996 = **16.81**[kip] Eq. J3-4

$(1/\Omega)R_n$ = 2 * $(C*(1/\Omega)R_n)$ = 2 * (4*16.81[kip]) = **134.49**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	152.93	70.81	DL	0.46	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * $((1/\Omega)*(C/(n_c*n))*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c)$ = 2 * (0.5*(4/(1*4))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.313[in]*58000[lb/in2]*1) = **152.93**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	112.50	70.81	DL	0.63	Eq. J4-3

$A_g = L_p*t_p$ = 12.5[in]*0.313[in] = **3.91**[in2] Sec. D3-1

$(1/\Omega)R_n$ = 2 * $((1/\Omega)*0.60*F_y*A_g)$ = 2 * (0.667*0.60*36000[lb/in2]*3.91[in2]) = **112.5**[kip] Eq. J4-3

Shear rupture	[Kip]	87.00	70.81	DL	0.81	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 12.5[in] - 4*1.13[in] = **8**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 8[in]*0.313[in] = **2.5**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * $((1/\Omega)*0.60*F_u*A_{nv})$ = 2 * (0.5*0.60*58000[lb/in2]*2.5[in2]) = **87**[kip] Eq. J4-4

Block shear	[Kip]	100.88	70.81	DL	0.70	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2.13[in] + (1 - 1)*3[in] - (1 - 0.5)*1.13[in])*0.313[in] = **0.488**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (4 - 1)*3[in])*0.313[in] = **3.36**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.313[in] = **2.13**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000[lb/in2]*2.13[in2] + 1*58000[lb/in2]*0.488[in2], 0.6*36000[lb/in2]*3.36[in2] + 1*58000[lb/in2]*0.488[in2])) =$ **100.88**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	15.91	1.46	DL1	0.09	p. 9-13, p. 9-10

$f_v = F/(A_b*N_{bolts}) = 70.81[kip]/(0.785[in2]*8) =$ **11276.14**[lb/in2] Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*11276.14[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) =$ **1.04E+05**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*1.04E+05[lb/in2]*0.785[in2] =$ **40.81**[kip] Eq. J3-2

$f_v = F/(A_b*N_{bolts}) = 70.81[kip]/(0.785[in2]*8) =$ **11276.14**[lb/in2] Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*11276.14[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) =$ **1.04E+05**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b = 0.5*1.04E+05[lb/in2]*0.785[in2] =$ **40.81**[kip] Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(2.13[in] + 1[in]/2, 1.25*2.72[in] + 1[in]/2) =$ **2.63**[in] p. 9-12

$b' = b - d/2 = 2.72[in] - 1[in]/2 =$ **2.22**[in] p. 9-12

$\rho = b'/a' = 2.22[in]/2.63[in] =$ **0.845** p. 9-12

$\delta = 1 - d'/p = 1 - 1.06[in]/3[in] =$ **0.646** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*40.81[kip]*2.22[in])/(0.5*3[in]*58000[lb/in2]))^{0.5} =$ **1.86**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.646*(1 + 0.845)))*((1.86[in]/0.313[in])^2 - 1) =$ **28.94** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.86[in])^2*(1 + 0.646) =$ **0.0464** p. 9-13

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(2.13[in] + 1[in]/2, 1.25*2.72[in] + 1[in]/2) =$ **2.63**[in] p. 9-12

$b' = b - d/2 = 2.72[in] - 1[in]/2 =$ **2.22**[in] p. 9-12

$\rho = b'/a' = 2.22[in]/2.63[in] =$ **0.845** p. 9-12

$\delta = 1 - d'/p = 1 - 1.06[in]/3.25[in] =$ **0.673** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*40.81[kip]*2.22[in])/(0.5*3.25[in]*58000[lb/in2]))^{0.5} =$ **1.79**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.673*(1 + 0.845)))*((1.79[in]/0.313[in])^2 - 1) =$ **25.57** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.313[in]/1.79[in])^2*(1 + 0.673) =$ **0.0511** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n = (2*0.0511 + (4 - 2)*0.0464)/4 =$ **0.0487** p. 9-13

$T_{avail} = 8 * (B*Q) = 8 * (40.81[kip]*0.0487) =$ **15.91**[kip] p. 9-10

Gusset

Welds rupture	[Kip/ft]	234.00	88.51	DL	0.38	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.5[in] =$ **19.5**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 35.41[kip]/(0.5*2.85[kip/in]*1*12.5[in]) =$ **1.99** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 2 * (0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in]) = 2 * (0.6*70000[lb/in2]*(2)^{1/2}/2*1.99/16\ [in]) =$ **7.38**[kip/in] p. 9-5

Shear yielding	[Kip]	168.29	70.81	DL	0.42	Eq. J4-3

$A_g = L_p*t_p = 16.83[in]*0.5[in] =$ **8.41**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*8.41$[in2]$ =$ **168.29**[kip] Eq. J4-3

Tear out under axial load	[Kip]	266.88	1.46	DL1	0.01	Eq. J4-5

$A_{gv} = 2.0*(b - c)*t_p = 2.0*(5$[in]$ - 0.75$[in]$)*0.5$[in]$ =$ **4.25**[in2] Sec. J4-3

$A_{nv} = A_{gv} =$ **4.25**[in2] Sec. J4-3

$A_{nt} = L*t_p = 12.5$[in]$*0.5$[in]$ =$ **6.25**[in2] Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*4.25$[in2]$ + 1*65000$[lb/in2]$*6.25$[in2]$, 0.6*50000$[lb/in2]$*4.25$[in2]$ + 1*65000$[lb/in2]$*6.25$[in2]$) =$ **266.88**[kip] Eq. J4-5

Column

Bolt bearing under shear load	[Kip]	268.13	70.81	DL	0.26	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0,$ 1.20E+31[in] $- 1.06$[in]$/2) =$ **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$

$t_p*F_u*n_c) = 2 * (0.5*(\min(1.2*1.20E+31$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*$

$(4 - 1))*0.44$[in]$*65000$[lb/in2]$*1) =$ **268.13**[kip] Eq. J3-6

Ratio **0.81**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip]$ + 57.27$[kip]$ + -85.79$[kip]$ =$ **-28.51**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip]$ - 31.18$[kip]$ + -53.65$[kip]$ =$ **-49.83**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip]$ + -57.27$[kip]$ + 85.79$[kip]$ =$ **28.51**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35$[kip]$ - -31.18$[kip]$ + 53.65$[kip]$ =$ **119.83**[kip]

Right beam interface - column

Angles

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	-49.83	-28.51	Design
DL1	119.83	28.51	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References

Angle

Length	[in]	18.50	9.40	18.80	✔	p. 10-8
$L_{min} = T/2 = 18.8$[in]$/2 =$ **9.4**[in]						p. 10-8
$L_{max} = d$ - max(k, d_{cl}) - max(k, d_{cb}) = 20.7[in] - max(0.95[in], 0[in]) - max(0.95[in], 0[in]) = **18.8**[in]						p. 10-8
Angle (Beam side)						
Weld size	[1/16in]	4	3	5	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} =$ **0.0156**						table J2.4
t_p<1/4 [in] → 0.375[in]<1/4 [in] → **False**						
$w_{max} = t_p$ - 1/16 [in] = 0.375[in] - 1/16 [in] = **0.026**						Sec. J2.2b
Angle (Column side)						
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.05	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Weld capacity	[Kip]	201.11	123.18	DL1	0.61	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.72$[kip/in]$*1*4*18.5$[in]$) =$ **201.11**[kip]						Tables 8-4 .. 8-11
Shear yielding	[Kip]	199.80	119.83	DL1	0.60	Eq. J4-3
$A_g = L_p*t_p = 18.5$[in]$*0.375$[in] = **6.94**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000$[lb/in2]$*6.94$[in2]$) =$ **199.8**[kip]						Eq. J4-3
Leg tensile yielding	[Kip]	299.10	28.51	DL1	0.10	Eq. J4-1
$A_g = L_p*t_p = 18.5$[in]$*0.375$[in] = **6.94**[in2]						Sec. D3-1
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_y*A_g) = 2 * (0.599*36000$[lb/in2]$*6.94$[in2]$) =$ **299.1**[kip]						Eq. J4-1

Angle (Column side)

Bolts shear	[Kip]	192.52	119.83	DL1	0.62	Tables (7-1..14)

k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 28.51[kip]/(0.667*1.13*64[kip]*12), 0.0) = **0.951** Eq. J3-5

(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*0.951 = **16.04**[kip] Eq. J3-4

(1/Ω)R_n = 2 * (*C*(1/Ω)R_n) = 2 * (6*16.04[kip]) = **192.52**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	284.65	119.83	DL1	0.42	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = 2 * ((1/Ω)*(*C*/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(6/(1*6))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(6 - 1))*0.375[in]*58000[lb/in2]*1) = **284.65**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	199.80	119.83	DL1	0.60	Eq. J4-3

A_g = L_p*t_p = 18.5[in]*0.375[in] = **6.94**[in2] Sec. D3-1

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*6.94[in2]) = **199.8**[kip] Eq. J4-3

Shear rupture	[Kip]	153.34	119.83	DL1	0.78	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 18.5[in] - 6*1.13[in] = **11.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 11.75[in]*0.375[in] = **4.41**[in2] Sec. J4-2

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*4.41[in2]) = **153.34**[kip] Eq. J4-4

Block shear	[Kip]	168.03	119.83	DL1	0.71	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2.05[in] + (1 - 1)*3[in] - (1 - 0.5)*1.13[in])*0.375[in] = **0.558**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (6 - 1)*3[in])*0.375[in] = **6.28**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.375[in] = **3.96**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*3.96[in2] + 1*58000[lb/in2]*0.558[in2], 0.6*36000[lb/in2]*6.28[in2] + 1*58000[lb/in2]*0.558[in2])) = **168.03**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	33.15	28.51	DL1	0.86	p. 9-13, p. 9-10

f_v = F/(A_b*N_{bolts}) = 119.83[kip]/(0.785[in2]*12) = **12721.13**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*12721.13[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **98545.76**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*98545.76[lb/in2]*0.785[in2] = **38.68**[kip] Eq. J3-2

$f_v = F/(A_b*N_{bolts})$ = 119.83[kip]/(0.785[in2]*12) = **12721.13**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - $F_{nt}*f_v/((1/\Omega)*F_{nv})$, 0.0), F_{nt}) = min(max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*12721.13[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **98545.76**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*98545.76[lb/in2]*0.785[in2] = **38.68**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(2.05[in] + 1[in]/2, 1.25*2.76[in] + 1[in]/2) = **2.55**[in] p. 9-12

b' = b - d/2 = 2.76[in] - 1[in]/2 = **2.26**[in] p. 9-12

ρ = b'/a' = 2.26[in]/2.55[in] = **0.887** p. 9-12

δ = 1 - d'/p = 1 - 1.06[in]/3[in] = **0.646** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5}$ = ((3.33*38.68[kip]*2.26[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.83**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.646*(1 + 0.887)))*((1.83[in]/0.375[in])^2 - 1) = **18.72** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta)$ = (0.375[in]/1.83[in])^2*(1 + 0.646) = **0.0691** p. 9-13

a' = Min(a + d/2, 1.25*b + d/2) = Min(2.05[in] + 1[in]/2, 1.25*2.76[in] + 1[in]/2) = **2.55**[in] p. 9-12

b' = b - d/2 = 2.76[in] - 1[in]/2 = **2.26**[in] p. 9-12

ρ = b'/a' = 2.26[in]/2.55[in] = **0.887** p. 9-12

δ = 1 - d'/p = 1 - 1.06[in]/3.25[in] = **0.673** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5}$ = ((3.33*38.68[kip]*2.26[in])/(0.5*3.25[in]*58000[lb/in2]))$^{0.5}$ = **1.76**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.673*(1 + 0.887)))*((1.76[in]/0.375[in])^2 - 1) = **16.52** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta)$ = (0.375[in]/1.76[in])^2*(1 + 0.673) = **0.0761** p. 9-13

HasEqualLengths → **False**

$Q = (2*Q_{ext} + (n - 2)*Q_{int})/n$ = (2*0.0761 + (6 - 2)*0.0691)/6 = **0.0714** p. 9-13

T_{avail} = 12 * (B*Q) = 12 * (38.68[kip]*0.0714) = **33.15**[kip] p. 9-10

Beam

Welds rupture	[Kip/ft]	163.80	109.14	DL1	0.67	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.35[in] = **13.65**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 61.59[kip]/(0.5*2.72[kip/in]*1*18.5[in]) = **2.45** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 2 * (0.6*F_{EXX}*(2)$^{1/2}$/2*D_{min}/16 [in]) = 2 * (0.6*70000[lb/in2]*(2)$^{1/2}$/2*2.45/16 [in]) = **9.1**[kip/in] p. 9-5

Shear yielding	[Kip]	144.90	119.83	DL1	0.83	Eq. J4-3

$A_g = L_p*t_p$ = 20.7[in]*0.35[in] = **7.25**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_y*A_g$ = 0.667*0.60*50000[lb/in2]*7.25[in2] = **144.9**[kip] Eq. J4-3

Tear out under axial load	[Kip]	255.06	28.51	DL1	0.11	Eq. J4-5

A_{gv} = 2.0*(b - c)*t_p = 2.0*(5[in] - 0.75[in])*0.35[in] = **2.98**[in2] Sec. J4-3

$A_{nv} = A_{gv}$ = **2.98**[in2] Sec. J4-3

$A_{nt} = L*t_p$ = 18.5[in]*0.35[in] = **6.48**[in2] Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u*A_{nv} + U_{bs}*F_u*A_{nt}$, 0.6*$F_y*A_{gv} + U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*65000[lb/in2]*2.98[in2] + 1*65000[lb/in2]*6.48[in2], 0.6*50000[lb/in2]*2.98[in2] + 1*65000[lb/in2]*6.48[in2]) = **255.06**[kip] Eq. J4-5

Column

Bolt bearing under shear load	[Kip]	401.12	119.83	DL1	0.30	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 1.06[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*

t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*

(6 - 1))*0.44[in]*65000[lb/in2]*1) = **401.12**[kip] Eq. J3-6

Ratio **0.86**

Global critical strength ratio **0.86**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

a': Distance for prying action

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

α_{bar}: Centroid of the gusset to beam connection

B: Available tensile strength per bolt

b: Plate, connector or member width

B: Available strength of all bolts

b': Distance for prying action

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

c: Setback

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F: Required shear force for combined tension and shear

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

F'_{nt}: Nominal tensile stress modified to include the effects of shear stress

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasEqualLengths: Has equal tributary length for interior and exterior bolts

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

N_{bolts}: Number of bolts

n_c: Number of bolt columns

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q_{ext}: Prying action coefficient for exterior bolts

Q_{int}: Prying action coefficient for interior bolts

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

T_b: Minimum fastener pretension

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{max}: Maximum weld size required

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

Current Date: 2016-05-25 1:40 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : **VB-02-9**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	102.00	0.00	0.00	-152.00	Design
DL1	0.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	-102.00	0.00	0.00	152.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
102.00	DL	Design
-102.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	102.00	DL	0.55	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	102.00	DL	0.42	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	102.00	DL	0.52	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	102.00	DL	0.35	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.55**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	102.00	DL	0.36	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	102.00	DL	0.50	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.349$[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 9.96_{[in2]}*0.7 = \mathbf{6.97}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*6.97_{[in2]} = \mathbf{202.26}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	292.62	102.00	DL	0.35	Eq. J4-1

$A_g = L_w*t_p = 19.55_{[in]}*0.5_{[in]} = \mathbf{9.77}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*9.77_{[in2]} = \mathbf{292.62}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	261.83	102.00	DL1	0.39	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*8.66_{[in]}/0.144_{[in]})^2 = \mathbf{1.88E+05}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.88E+05_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/1.88E+05_{[lb/in2]})}*50000_{[lb/in2]} =$

$\mathbf{44738.58}_{[lb/in2]}$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*44738.58_{[lb/in2]}*9.77_{[in2]} = \mathbf{261.83}_{[kip]}$ Eq. E3-1

Ratio **0.50**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*\tan\theta - e_c = 10.35_{[in]}*0.696 - 6.05_{[in]} = \mathbf{1.15}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar}) = 9.47_{[in]}*(0.696 + 9.47_{[in]}/11.96_{[in]}) = \mathbf{14.09}_{[in]}$ p. 13-10

$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.696)^2 + (9.47_{[in]}/11.96_{[in]})^2 = \mathbf{1.11}$ p. 13-10

$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (14.09_{[in]}*0.696 + 1.15_{[in]}*(9.47_{[in]}/$
$11.96_{[in]})^2)/1.11 = \mathbf{9.47}_{[in]}$ p. 13-10

$\beta = (K' - K*\tan\theta)/D = (14.09_{[in]} - 1.15_{[in]}*0.696)/1.11 = \mathbf{11.96}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.47_{[in]} + 6.05_{[in]})^2 + (11.96_{[in]} +$
$10.35_{[in]})^2)^{1/2} = \mathbf{27.18}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 9.47_{[in]}*102_{[kip]}/27.18_{[in]} = \mathbf{35.55}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 6.05_{[in]}*102_{[kip]}/27.18_{[in]} = \mathbf{22.71}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35_{[in]}*102_{[kip]}/27.18_{[in]} - 0_{[kip]} = \mathbf{38.85}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 11.96_{[in]}*102_{[kip]}/27.18_{[in]} + 0_{[kip]} = \mathbf{44.88}_{[kip]}$ p. 13-5

$M_b = \text{abs}(V_b*(\alpha - \alpha_{bar})) + \text{abs}(\Delta V*\alpha) = \text{abs}(38.85_{[kip]}*(9.47_{[in]} - 9.47_{[in]})) +$
$\text{abs}(0_{[kip]}*9.47_{[in]}) = \mathbf{4.31E-15}_{[kip*ft]}$ p. 13-10

$M_c = \text{abs}(H_c*(\beta - \beta_{bar})) = \text{abs}(22.71_{[kip]}*(11.96_{[in]} - 11.96_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*\tan\theta - e_c = 10.35_{[in]}*0.696 - 6.05_{[in]} = \mathbf{1.15}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar}) = 9.47_{[in]}*(0.696 + 9.47_{[in]}/11.96_{[in]}) = \mathbf{14.09}_{[in]}$ p. 13-10

$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.696)^2 + (9.47_{[in]}/11.96_{[in]})^2 = \mathbf{1.11}$ p. 13-10

$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (14.09_{[in]}*0.696 + 1.15_{[in]}*(9.47_{[in]}/$
$11.96_{[in]})^2)/1.11 = \mathbf{9.47}_{[in]}$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (14.09[in] - 1.15[in]*0.696)/1.11 =$ **11.96**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.47[in] + 6.05[in])^2 + (11.96[in] +$
$10.35[in])^2)^{1/2} =$ **27.18**[in] p. 13-5

$H_b = \alpha*P/r = 9.47[in]*-102[kip]/27.18[in] =$ **-35.55**[kip] p. 13-5

$H_c = e_c*P/r = 6.05[in]*-102[kip]/27.18[in] =$ **-22.71**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35[in]*-102[kip]/27.18[in] - 0[kip] =$ **-38.85**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 11.96[in]*-102[kip]/27.18[in] + 0[kip] =$ **-44.88**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-38.85[kip]*(9.47[in] - 9.47[in])) +$
$abs(0[kip]*9.47[in]) =$ **4.31E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-22.71[kip]*(11.96[in] - 11.96[in])) =$ **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.55	38.85	0.00	0.00	0.00	0.00	Design
DL1	-35.55	-38.85	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	261.11	38.85	DL	0.15	Eq. J4-1
$A_g = L_p*t_p = 17.44[in]*0.5[in] =$ **8.72**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.72[in2] =$ **261.11**[kip]						Eq. J4-1
Shear yielding	[Kip]	174.42	35.55	DL	0.20	Eq. J4-3
$A_g = L_p*t_p = 17.44[in]*0.5[in] =$ **8.72**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*8.72[in2] =$ **174.42**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	641456.70	DL	0.15	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000[lb/in2] =$ **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l) = 38.85[kip]/(0.5[in]*17.44[in]) =$ **4454.56**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	586975.30	DL	0.20	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y = 0.667*0.6*50000[lb/in2] =$ **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l) = 35.55[kip]/(0.5[in]*17.44[in]) =$ **4076.22**[lb/in2]						9
Weld capacity	[Kip]	213.16	65.82	DL	0.31	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.44[kip/in]*1*5*17.44[in]) =$ **213.16**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l = 38.85[kip]/17.44[in] =$ **2.23**[kip/in]						9

$f_{uv} = H_b/l$ = 35.55[kip]/17.44[in] = **2.04**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = 4.31E-15[kip*ft]/(17.44[in]^2/6) = **1.02E-15**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((2.23[kip/in] + 1.02E-15[kip/in])^2 + 2.04[kip/in]^2)$^{1/2}$ = **3.02**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((2.23[kip/in] - 1.02E-15[kip/in])^2 + 2.04[kip/in]^2)$^{1/2}$ + ((2.23[kip/in] + 1.02E-15[kip/in])^2 + 2.04[kip/in]^2)$^{1/2}$) = **3.02**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 17.44[in]*max(3.02[kip/in], 1.25*3.02[kip/in]) = **65.82**[kip] 9

Beam

Weld block shear	[Kip]	195.89	35.55	DL	0.18	Eq. J4-5

$A_{gv} = l*t_w$ = 17.44[in]*0.35[in] = **6.1**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2] 8

$A_{nv} = A_{gv}$ = **6.1**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.21**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*6.1[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*6.1[in2] + 1*65000[lb/in2]*3.21[in2]) = **195.89**[kip] Eq. J4-5

Web crippling	[Kip]	106.20	38.85	DL1	0.37	Eq. J10-5b

IsBeamReaction → **False**

$N = N$ = **17.44**[in] Sec. J10-2

$N/d <= 0.2$ → 17.44[in]/20.7[in]<=0.2 → **False**

$(1/\Omega)R_n = (1/\Omega)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.40*0.35[in]^2*(1 + (4*17.44[in]/20.7[in] - 0.2)*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **106.2**[kip] Eq. J10-5b

Local web yielding	[Kip]	231.20	38.85	DL	0.17	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **17.44**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w$ = 0.667*(2.5*0.95[in] + 17.44[in])*50000[lb/in2]*0.35[in] = **231.2**[kip] Eq. J10-3

Ratio **0.37**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	44.88	22.71	0.00	0.00	0.00	Design

DL1	-44.88	-22.71	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.50	11.96	23.91	✔	p. 10-104
$L_{min} = T/2 = 23.91$[in]$/2 =$ **11.96**[in]						p. 10-104
$L_{max} = L =$ **23.91**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p,$ 12 [in]$) = \min(24*0.5$[in]$,$ 12 [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	7.46	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $=$ **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	50.30	DL	0.75	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 4*16.87[kip]*1 = **67.5**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	137.11	44.88	DL	0.33	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*65000[lb/in2]*1 = **137.11**[kip] — Eq. J3-6

Shear yielding	[Kip]	125.00	44.88	DL	0.36	Eq. J4-3

A_g = L_p*t_p = 12.5[in]*0.5[in] = **6.25**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.25[in2] = **125**[kip] — Eq. J4-3

Shear rupture	[Kip]	78.00	44.88	DL	0.58	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 12.5[in] - 4*1.13[in] = **8**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.5[in] = **4**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*4[in2] = **78**[kip] — Eq. J4-4

Block shear	[Kip]	89.78	44.88	DL	0.50	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*1.13[in])*0.5[in] = **0.719**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (4 - 1)*3[in])*0.5[in] = **5.38**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **3.41**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.41[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*5.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **89.78**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	114.56	22.71	DL	0.20	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*65000[lb/in2]*4 = **114.56**[kip] — Eq. J3-6

Tension yielding	[Kip]	187.13	22.71	DL	0.12	Eq. J4-1
$A_g = L_p*t_p$ = 12.5[in]*0.5[in] = **6.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*6.25[in2] = **187.13**[kip]						Eq. J4-1
Tension rupture	[Kip]	130.00	22.71	DL	0.17	Eq. J4-2
$A_g = L_p*t_p$ = 12.5[in]*0.5[in] = **6.25**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (12.5[in] - 4*1.13[in])*0.5[in] = **4**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*6.25[in2], 4[in2]) = **4**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4[in2] = **130**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	119.44	22.71	DL	0.19	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
n>1 → 4>1 → **True**						
A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2]						Sec. J4-3
A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2]						Sec. J4-3
A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*2.81[in2]) = **119.44**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	133.61	50.30	DL	0.38	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.28[kip/in]*1*5*12.5[in] = **133.61**[kip]						Tables 8-4 .. 8-11
Web crippling	[Kip]	150.77	22.71	DL1	0.15	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **9**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N$/$d$)*($t_w$/$t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f$/$t_w$)$^{1/2}$ = 0.5*0.80*0.345[in]^2*(1 + 3*(9[in]/12.1[in])*(0.345[in]/0.575[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.575[in]/0.345[in])$^{1/2}$ = **150.77**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	152.34	44.88	DL	0.29	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 7.46[in] - 1.06[in]/2) = **6.93**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*6.93[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*65000[lb/in2]*1 = **152.34**[kip]						Eq. J3-6
Shear yielding	[Kip]	239.14	44.88	DL	0.19	Eq. J4-3

$A_g = L_p * t_p$ = 23.91[in]*0.5[in] = **11.96**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.96[in2] = **239.14**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	134.06	22.71	DL	0.17	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **134.06**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	357.99	22.71	DL	0.06	Eq. J4-1

$A_g = L_p * t_p$ = 23.91[in]*0.5[in] = **11.96**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*11.96[in2] = **357.99**[kip] Eq. J4-1

Tension rupture	[Kip]	315.47	22.71	DL	0.07	Eq. J4-2

$A_g = L_p * t_p$ = 23.91[in]*0.5[in] = **11.96**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (23.91[in] - 4*1.13[in])*0.5[in] = **9.71**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*11.96[in2], 9.71[in2]) = **9.71**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*9.71[in2] = **315.47**[kip] Eq. J4-2

Tear out under axial load	[Kip]	124.31	22.71	DL	0.18	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/
in2]*2.81[in2]) = **124.31**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	269.10	41.93	DL	0.16	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.575[in] = **22.43**[kip/in] p. 9-5

D_{min} = P/(*(1/Ω)*C*C_1*L) = 50.3[kip]/(0.5*4.28[kip/in]*1*12.5[in]) = **1.88** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.88/16 [in] = **3.49**[kip/in] p. 9-5

Ratio **0.75**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-152.00	DL	Design
152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	185.62	152.00	DL	0.82	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.64	152.00	DL	0.47	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.465$[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.64**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	195.00	152.00	DL	0.78	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	287.50	152.00	DL1	0.53	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in]$, 10$[in]$)$ = **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **10.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2]) = **287.5**[kip]						Eq. J4-5

Ratio	0.82

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	152.00	DL1	0.41	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	262.25	152.00	DL1	0.58	Eq. J4-2
$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3[in]/10[in] = **0.7**						Table D3.1
$A_e = A_n*U$ = 12.92[in2]*0.7 = **9.04**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.04[in2] = **262.25**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	292.62	152.00	DL1	0.52	Eq. J4-1
$A_g = L_w*t_p$ = 19.55[in]*0.5[in] = **9.77**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.77[in2] = **292.62**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	262.68	152.00	DL	0.58	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*8.53[in]/0.144[in])^2 = **1.94E+05**[lb/in2]						Eq. E3-4
F_e>=0.44*Q*F_y → 1.94E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = 0.658$^{(1*50000[lb/in2]/1.94E+05[lb/in2])}$*50000[lb/in2] = **44884.25**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*44884.25[lb/in2]*9.77[in2] = **262.68**[kip]						Eq. E3-1

Ratio	0.58

Calculation of the brace interface forces

Load condition :DL

General case	DG29 p. 24-33
$K = e_b*\tan\theta - e_c$ = 10.35[in]*0.701 - 6.05[in] = **1.21**[in]	p. 13-10
$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar})$ = 9.52[in]*(0.701 + 9.52[in]/11.87[in]) = **14.32**[in]	p. 13-10
$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = (0.701)^2 + (9.52[in]/11.87[in])^2 = **1.14**	p. 13-10
$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (14.32[in]*0.701 + 1.21[in]*(9.52[in]/11.87[in])^2)/1.14 = **9.52**[in]	p. 13-10
$\beta = (K' - K*\tan\theta)/D$ = (14.32[in] - 1.21[in]*0.701)/1.14 = **11.87**[in]	p. 13-10
$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((9.52[in] + 6.05[in])^2 + (11.87[in] + 10.35[in])^2)$^{1/2}$ = **27.13**[in]	p. 13-5
$H_b = \alpha*P/r$ = 9.52[in]*-152[kip]/27.13[in] = **-53.36**[kip]	p. 13-5

$H_c = e_c*P/r$ = 6.05[in]*-152[kip]/27.13[in] = **-33.89**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.35[in]*-152[kip]/27.13[in] - 0[kip] = **-57.98**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 11.87[in]*-152[kip]/27.13[in] + 0[kip] = **-66.48**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-57.98[kip]*(9.52[in] - 9.52[in])) +$
$abs(0[kip]*9.52[in])$ = **6.44E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-33.89[kip]*(11.87[in] - 11.87[in]))$ = **3.76E-15**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c$ = 10.35[in]*0.701 - 6.05[in] = **1.21**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 9.52[in]*(0.701 + 9.52[in]/11.87[in]) = **14.32**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.701)^2 + (9.52[in]/11.87[in])^2$ = **1.14** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (14.32[in]*0.701 + 1.21[in]*(9.52[in]/$
$11.87[in])^2)/1.14$ = **9.52**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D$ = (14.32[in] - 1.21[in]*0.701)/1.14 = **11.87**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.52[in] + 6.05[in])^2 + (11.87[in] +$
$10.35[in])^2)^{1/2}$ = **27.13**[in] p. 13-5

$H_b = \alpha*P/r$ = 9.52[in]*152[kip]/27.13[in] = **53.36**[kip] p. 13-5

$H_c = e_c*P/r$ = 6.05[in]*152[kip]/27.13[in] = **33.89**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.35[in]*152[kip]/27.13[in] - 0[kip] = **57.98**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 11.87[in]*152[kip]/27.13[in] + 0[kip] = **66.48**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(57.98[kip]*(9.52[in] - 9.52[in])) +$
$abs(0[kip]*9.52[in])$ = **6.44E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(33.89[kip]*(11.87[in] - 11.87[in]))$ = **3.76E-15**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-53.36	-57.98	0.00	0.00	0.00	0.00	Design
DL1	53.36	57.98	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	262.71	57.98	DL1	0.22	Eq. J4-1
$A_g = L_p*t_p$ = 17.55[in]*0.5[in] = **8.77**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*8.77[in2] = **262.71**[kip]						Eq. J4-1
Shear yielding	[Kip]	175.49	53.36	DL	0.30	Eq. J4-3

$A_g = L_p * t_p$ = 17.55[in]*0.5[in] = **8.77**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*8.77[in2] = **175.49**[kip] Eq. J4-3

Gusset edge tension stress	[Lb/ft2]	4311377.00	951521.50	DL	0.22	J4-1

$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2] J4-1

$f_{ua} = V_b/(t_p*l)$ = -57.98[kip]/(0.5[in]*17.55[in]) = **-6607.79**[lb/in2] 9

Gusset edge shear stress	[Lb/ft2]	2880000.00	875638.20	DL	0.30	J4-1

$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2] J4-1

$f_{uv} = H_b/(t_p*l)$ = -53.36[kip]/(0.5[in]*17.55[in]) = **-6080.82**[lb/in2] 9

Weld capacity	[Kip]	214.27	98.49	DL	0.46	Tables 8-4 .. 8-11

$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*2.44[kip/in]*1*5*17.55[in]) = **214.27**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = -57.98[kip]/17.55[in] = **-3.3**[kip/in] 9

$f_{uv} = H_b/l$ = -53.36[kip]/17.55[in] = **-3.04**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -6.44E-15[kip*ft]/(17.55[in]^2/6) = **-1.50E-15**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((3.3[kip/in] + 1.50E-15[kip/in])^2 + 3.04[kip/in^2])$^{1/2}$ = **4.49**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((3.3[kip/in] - 1.50E-15[kip/in])^2 + 3.04[kip/in^2])$^{1/2}$ + ((3.3[kip/in] + 1.50E-15[kip/in])^2 + 3.04[kip/in^2])$^{1/2}$) = **4.49**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 17.55[in]*max(4.49[kip/in], 1.25*4.49[kip/in]) = **98.49**[kip] 9

Beam

Weld block shear	[Kip]	196.46	53.36	DL	0.27	Eq. J4-5

$A_{gv} = l*t_w$ = 17.55[in]*0.35[in] = **6.14**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2] 8

$A_{nv} = A_{gv}$ = **6.14**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.21**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*6.14[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*6.14[in2] + 1*65000[lb/in2]*3.21[in2]) = **196.46**[kip] Eq. J4-5

Web crippling	[Kip]	106.68	57.98	DL	0.54	Eq. J10-5b

IsBeamReaction → **False**

$N = N$ = **17.55**[in] Sec. J10-2

N/d<=0.2 → 17.55[in]/20.7[in]<=0.2 → **False**

$(1/\Omega)R_n = (1/\Omega)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.40*0.35[in]^2*(1 + (4*17.55[in]/20.7[in] - 0.2)*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **106.68**[kip] Eq. J10-5b

Local web yielding	[Kip]	232.45	57.98	DL	0.25	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **17.55**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w$ = 0.667*(2.5*0.95[in] + 17.55[in])*50000[lb/in2]*

0.35[in] = **232.45**[kip] Eq. J10-3

Ratio **0.54**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru** [Kip]	**Pu** [Kip]	**Pu** [Kip]	**Mu22** [Kip*ft]	**Mu33** [Kip*ft]	**Load type**
DL	-66.48	-33.89	0.00	0.00	0.00	Design
DL1	66.48	33.89	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.50	11.87	23.74	✔	p. 10-104
$L_{min} = T/2 = 23.74$[in]$/2 =$ **11.87**[in]						p. 10-104
$L_{max} = L =$ **23.74**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	5.87	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4,

						J3.5
Horizontal edge distance	[in]	2.25	2.00		-- ✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5		-- ✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	84.37	74.63	DL	0.88	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 5*16.87[kip]*1 = **84.37**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	174.89	66.48	DL	0.38	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(5 - 1))*0.5[in]* 65000[lb/in2]*1 = **174.89**[kip]						Eq. J3-6
Shear yielding	[Kip]	155.00	66.48	DL	0.43	Eq. J4-3
A_g = L_p*t_p = 15.5[in]*0.5[in] = **7.75**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.75[in2] = **155**[kip]						Eq. J4-3
Shear rupture	[Kip]	96.28	66.48	DL	0.69	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 15.5[in] - 5*1.13[in] = **9.88**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 9.88[in]*0.5[in] = **4.94**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*4.94[in2] = **96.28**[kip]						Eq. J4-4
Block shear	[Kip]	108.06	66.48	DL	0.62	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (5 - 1)*3[in])*0.5[in] = **6.88**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (5 - 1)*(3[in] - 1.13[in]) -						

1.13[in]/2)*0.5[in] = **4.34**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*4.34[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*6.88[in2] + 1*65000[lb/in2]*0.719[in2]) = **108.06**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	143.20	33.89	DL1	0.24	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*

F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*

65000[lb/in2]*5 = **143.2**[kip] Eq. J3-6

Tension yielding	[Kip]	232.04	33.89	DL1	0.15	Eq. J4-1

A_g = L_p*t_p = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*7.75[in2] = **232.04**[kip] Eq. J4-1

Tension rupture	[Kip]	160.47	33.89	DL1	0.21	Eq. J4-2

A_g = L_p*t_p = 15.5[in]*0.5[in] = **7.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (15.5[in] - 5*1.13[in])*0.5[in] = **4.94**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*7.75[in2], 4.94[in2]) = **4.94**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)**F_u*A_e = 0.5*65000[lb/in2]*4.94[in2] = **160.47**[kip] Eq. J4-2

Tear out under axial load	[Kip]	149.91	33.89	DL1	0.23	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.5[in] = **3.75**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*3.75[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*3.75[in2]) = **149.91**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	165.87	74.63	DL1	0.45	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*4.28[kip/in]*1*5*15.5[in] = **165.87**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	176.35	33.89	DL	0.19	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*
0.80*0.345[in]^2*(1 + 3*(12[in]/12.1[in])*(0.345[in]/0.575[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.575[in]/0.345[in])$^{1/2}$ = **176.35**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	190.13	66.48	DL	0.35	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.87\text{[in]} - 1.06\text{[in]}/2) =$ **5.34**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*5.34[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(5 - 1))*0.5[in]*
65000[lb/in2]*1 = **190.13**[kip] Eq. J3-6

Shear yielding	[Kip]	237.36	66.48	DL	0.28	Eq. J4-3

$A_g = L_p*t_p$ = 23.74[in]*0.5[in] = **11.87**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*11.87[in2] = **237.36**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	167.58	33.89	DL1	0.20	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*5 = **167.58**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	355.33	33.89	DL1	0.10	Eq. J4-1

$A_g = L_p*t_p$ = 23.74[in]*0.5[in] = **11.87**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*11.87[in2] = **355.33**[kip] Eq. J4-1

Tension rupture	[Kip]	294.31	33.89	DL1	0.12	Eq. J4-2

$A_g = L_p*t_p$ = 23.74[in]*0.5[in] = **11.87**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (23.74[in] - 5*1.13[in])*0.5[in] = **9.06**[in2] Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*11.87\text{[in2]}, 9.06\text{[in2]}) =$ **9.06**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*9.06[in2] = **294.31**[kip] Eq. J4-2

Tear out under axial load	[Kip]	154.78	33.89	DL1	0.22	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(5 - 1)*0.5[in] = **3.75**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*3.75[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*3.75[in2]) =$ **154.78**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	269.10	50.11	DL	0.19	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.575[in] =$ **22.43**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 74.63[kip]/(0.5*4.28[kip/in]*1*15.5[in]) =$ **2.25** tables 8-4..11

$HasWeldsOnBothSides \rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000[lb/in2]*(2)^{1/2}/2*2.25/16$ [in] = **4.18**[kip/in] p. 9-5

Ratio **0.88**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + 35.55[kip] + -53.36[kip] =$ **-17.81**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35[kip] - 38.85[kip] + -57.98[kip] =$ **-61.83**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -35.55[kip] + 53.36[kip] =$ **17.81**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 35[kip] - -38.85[kip] + 57.98[kip] =$ **131.83**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-61.83	-17.81	0.00	0.00	0.00	Design
DL1	131.83	17.81	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.50	9.40	18.80	✓	p. 10-104

$L_{min} = T/2 = 18.8[in]/2 =$ **9.4**[in] p. 10-104

$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 20.7[in] - \max(0.95[in], 0[in]) -$
$\max(0.95[in], 0[in]) =$ **18.8**[in] p. 10-49

Thickness	[in]	0.75	--	1.12	✓	p. 10-103

M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*54.17[in] = **265.76**[kip*ft] p. 10-103

t_{max} = (6*M_{max})/(F_y*d^2) = (6*265.76[kip*ft])/(50000[lb/in2]*18.5[in^2]) = **1.12**[in] p. 10-103

Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.40	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in] Sec. J3.5

Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	8.40	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Support

Weld size	[1/16in]	8	8	--	✔	p. 10-101

w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	141.71	133.03	DL1	0.94 ●	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s$ = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor$ = 8.4*16.87[kip]*1 = **141.71**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	299.38	131.83	DL1	0.44	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min($k_1*L_{c\text{-}end}*t_p*F_u$, $k_2*d*t_p*F_u$) = min(1.2*1.22[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **71.3**[kip] Eq. J3-6

r_{n2} = min($k_1*L_{c\text{-}spa}*t_p*F_u$, $k_2*d*t_p*F_u$) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C$*min($r_{n1}$, r_{n2}) = 0.5*8.4*min(71.3[kip], 113.34[kip]) = **299.38**[kip] p. 7-18

Shear yielding	[Kip]	277.50	131.83	DL1	0.48	Eq. J4-3

$A_g = L_p*t_p$ = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_y*A_g$ = 0.667*0.60*50000[lb/in2]*13.88[in2] = **277.5**[kip] Eq. J4-3

Shear rupture	[Kip]	171.84	131.83	DL1	0.77	Eq. J4-4

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 18.5[in] - 6*1.13[in] = **11.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 11.75[in]*0.75[in] = **8.81**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*8.81[in2] = **171.84**[kip] Eq. J4-4

Block shear	[Kip]	194.85	131.83	DL1	0.68	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (6 - 1)*3[in])*0.75[in] = **12.56**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **7.92**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u*A_{nv}$ + $U_{bs}*F_u*A_{nt}$, 0.6*F_y*A_{gv} + $U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*65000[lb/in2]*7.92[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*12.56[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **194.85**[kip] Eq. J4-5

Flexural rupture	[Kip]	461.74	131.83	DL1	0.29	p. 9-6

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.75[in]/4*(18.5[in]^2 - 3[in]^2*6*(6^2 - 1)*1.13[in]/18.5[in]) = **42.62**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*42.62[in3]/3[in] = **461.74**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	360.79	17.81	DL1	0.05	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*8.4*min(85.92[kip], 113.34[kip]) = **360.79**[kip] p. 7-18

Tension yielding	[Kip]	415.42	17.81	DL1	0.04	Eq. J4-1

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*13.88[in2] = **415.42**[kip] Eq. J4-1

Tension rupture	[Kip]	286.41	17.81	DL1	0.06	Eq. J4-2

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (18.5[in] - 6*1.13[in])*0.75[in] = **8.81**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*13.88[in2], 8.81[in2]) = **8.81**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*8.81[in2] = **286.41**[kip] Eq. J4-2

Tear out under axial load	[Kip]	325.41	17.81	DL1	0.05	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.75[in] = **7.03**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*7.03[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*7.03[in2]) = **325.41**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	281.44	133.03	DL1	0.47	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.8[kip/in]*1*8*18.5[in] = **281.44**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	133.75	32.96	DL1	0.25	p. 10-103

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

f_v = V/A_g = 131.83[kip]/13.88[in2] = **9501.16**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*9501.16[lb/in2]^2))$^{1/2}$ = **25011.89**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*18.5[in]^2/4 = **64.17**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 25011.89[lb/in2]*64.17[in3] = **133.75**[kip*ft] p. 10-103

Web crippling	[Kip]	201.94	17.81	DL	0.09	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **15**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.345[in]^2*(1 + 3*(15[in]/12.1[in])*(0.345[in]/0.575[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.575[in]/0.345[in])$^{1/2}$ = **201.94**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	222.10	131.83	DL1	0.59	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85\text{[in]} - 1.06\text{[in]}/2) =$ **2.32**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \text{min}(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*2.32\text{[in]}*0.35\text{[in]}*65000\text{[lb/in2]}, 2.4*1\text{[in]}*0.35\text{[in]}*65000\text{[lb/in2]}) =$ **54.6**[kip] Eq. J3-6

$r_{n2} = \text{min}(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*1.94\text{[in]}*0.35\text{[in]}*65000\text{[lb/in2]}, 2.4*1\text{[in]}*0.35\text{[in]}*65000\text{[lb/in2]}) =$ **52.89**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\text{min}(r_{n1}, r_{n2}) = 0.5*8.4*\text{min}(54.6\text{[kip]}, 52.89\text{[kip]}) =$ **222.1**[kip] p. 7-18

Shear yielding	[Kip]	144.90	131.83	DL1	0.91	Eq. J4-3

$A_g = L_p*t_p = 20.7\text{[in]}*0.35\text{[in]} =$ **7.25**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*7.25\text{[in2]} =$ **144.9**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	299.45	17.81	DL1	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\text{min}(1.2*1.72\text{[in]}, 2.4*1\text{[in]}) + \text{min}(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(2 - 1))*0.35\text{[in]}*65000\text{[lb/in2]}*6 =$ **299.45**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	389.22	17.81	DL1	0.05	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*13\text{[in2]} =$ **389.22**[kip] Eq. D2-1

Tension rupture	[Kip]	300.13	17.81	DL1	0.06	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 13\text{[in2]} - 6*0.35\text{[in]}*1.13\text{[in]} =$ **10.64**[in2] Sec. D3-2

$U = 1 - x/l = 1 - 0.791\text{[in]}/6\text{[in]} =$ **0.868** Table D3.1

$A_e = U*A_n = 0.868*10.64\text{[in2]} =$ **9.23**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*9.23\text{[in2]} =$ **300.13**[kip] Eq. J4-2

Tear out under axial load	[Kip]	155.27	17.81	DL1	0.11	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (2 - 1)*3\text{[in]})*0.35\text{[in]} =$ **3.68**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (2 - 1)*3\text{[in]} - 1.13\text{[in]}*(2 - 0.5))*0.35\text{[in]} =$ **2.49**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.35[in] = \mathbf{3.28}[in2]$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000[lb/in2]*2.49[in2] + 1*65000[lb/in2]*3.28[in2], 0.6*50000[lb/in2]*3.68[in2] + 1*65000[lb/in2]*3.28[in2]) = \mathbf{155.27}[kip]$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	269.10	84.22	DL1	0.31	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.575[in] = \mathbf{22.43}[kip/in]$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 133.03[kip]/(0.5*3.8[kip/in]*1*18.5[in]) = \mathbf{3.78}$ tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\ [in] = 0.6*70000[lb/in2]*(2)^{1/2}/2*3.78/16\ [in] = \mathbf{7.02}[kip/in]$ p. 9-5

Ratio **0.94**

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-02 K-Vertical Brace Connection\VB-02.cnx\

Steel connections

Results

Connection name : **CBB_DA**

Connection ID : **VB-02-10**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	112.00	0.00	0.00	-186.00	Design
DL1	0.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	-112.00	0.00	0.00	186.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
112.00	DL	Design
-112.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	112.00	DL	0.60	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	112.00	DL	0.46	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	112.00	DL	0.57	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	112.00	DL	0.39	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in]$, 10$[in]$) = **10**[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$, 0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.60**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	112.00	DL	0.39	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	112.00	DL	0.55	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.349$[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 9.96_{[in2]}*0.7 = \mathbf{6.97}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*6.97_{[in2]} = \mathbf{202.26}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	292.62	112.00	DL	0.38	Eq. J4-1

$A_g = L_w*t_p = 19.55_{[in]}*0.5_{[in]} = \mathbf{9.77}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*9.77_{[in2]} = \mathbf{292.62}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	259.76	112.00	DL1	0.43	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*8.96_{[in]}/0.144_{[in]})^2 = \mathbf{1.76E+05}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.76E+05_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/1.76E+05_{[lb/in2]})}*50000_{[lb/in2]} =$

44384.77[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*44384.77_{[lb/in2]}*9.77_{[in2]} = \mathbf{259.76}_{[kip]}$ Eq. E3-1

Ratio **0.55**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*\tan\theta - e_c = 10.35_{[in]}*0.728 - 7_{[in]} = \mathbf{0.536}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar}) = 9.33_{[in]}*(0.728 + 9.33_{[in]}/12.08_{[in]}) = \mathbf{14}_{[in]}$ p. 13-10

$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.728)^2 + (9.33_{[in]}/12.08_{[in]})^2 = \mathbf{1.13}$ p. 13-10

$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (14_{[in]}*0.728 + 0.536_{[in]}*(9.33_{[in]}/$
$12.08_{[in]})^2)/1.13 = \mathbf{9.33}_{[in]}$ p. 13-10

$\beta = (K' - K*\tan\theta)/D = (14_{[in]} - 0.536_{[in]}*0.728)/1.13 = \mathbf{12.08}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.33_{[in]} + 7_{[in]})^2 + (12.08_{[in]} + 10.35_{[in]})^2)^{1/}$
$^2 = \mathbf{27.74}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 9.33_{[in]}*112_{[kip]}/27.74_{[in]} = \mathbf{37.66}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 7_{[in]}*112_{[kip]}/27.74_{[in]} = \mathbf{28.26}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35_{[in]}*112_{[kip]}/27.74_{[in]} - 0_{[kip]} = \mathbf{41.79}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 12.08_{[in]}*112_{[kip]}/27.74_{[in]} + 0_{[kip]} = \mathbf{48.75}_{[kip]}$ p. 13-5

$M_b = \text{abs}(V_b*(\alpha - \alpha_{bar})) + \text{abs}(\Delta V*\alpha) = \text{abs}(41.79_{[kip]}*(9.33_{[in]} - 9.33_{[in]})) +$
$\text{abs}(0_{[kip]}*9.33_{[in]}) = \mathbf{4.64E-15}_{[kip*ft]}$ p. 13-10

$M_c = \text{abs}(H_c*(\beta - \beta_{bar})) = \text{abs}(28.26_{[kip]}*(12.08_{[in]} - 12.08_{[in]})) = \mathbf{6.28E-15}_{[kip*ft]}$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*\tan\theta - e_c = 10.35_{[in]}*0.728 - 7_{[in]} = \mathbf{0.536}_{[in]}$ p. 13-10

$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar}) = 9.33_{[in]}*(0.728 + 9.33_{[in]}/12.08_{[in]}) = \mathbf{14}_{[in]}$ p. 13-10

$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.728)^2 + (9.33_{[in]}/12.08_{[in]})^2 = \mathbf{1.13}$ p. 13-10

$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (14_{[in]}*0.728 + 0.536_{[in]}*(9.33_{[in]}/$
$12.08_{[in]})^2)/1.13 = \mathbf{9.33}_{[in]}$ p. 13-10

$\beta = (K' - K*\tan\theta)/D = (14_{[in]} - 0.536_{[in]}*0.728)/1.13 = \mathbf{12.08}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.33_{[in]} + 7_{[in]})^2 + (12.08_{[in]} + 10.35_{[in]})^2)^{1/2} = \mathbf{27.74}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 9.33_{[in]}*-112_{[kip]}/27.74_{[in]} = \mathbf{-37.66}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 7_{[in]}*-112_{[kip]}/27.74_{[in]} = \mathbf{-28.26}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35_{[in]}*-112_{[kip]}/27.74_{[in]} - 0_{[kip]} = \mathbf{-41.79}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 12.08_{[in]}*-112_{[kip]}/27.74_{[in]} + 0_{[kip]} = \mathbf{-48.75}_{[kip]}$ p. 13-5

$M_b = \text{abs}(V_b*(\alpha - \alpha_{bar})) + \text{abs}(\Delta V*\alpha) = \text{abs}(-41.79_{[kip]}*(9.33_{[in]} - 9.33_{[in]})) + \text{abs}(0_{[kip]}*9.33_{[in]}) = \mathbf{4.64E\text{-}15}_{[kip*ft]}$ p. 13-10

$M_c = \text{abs}(H_c*(\beta - \beta_{bar})) = \text{abs}(-28.26_{[kip]}*(12.08_{[in]} - 12.08_{[in]})) = \mathbf{6.28E\text{-}15}_{[kip*ft]}$ p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	37.66	41.79	0.00	0.00	0.00	0.00	Design
DL1	-37.66	-41.79	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	264.33	41.79	DL	0.16	Eq. J4-1
$A_g = L_p*t_p = 17.66_{[in]}*0.5_{[in]} = \mathbf{8.83}_{[in2]}$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*8.83_{[in2]} = \mathbf{264.33}_{[kip]}$						Eq. J4-1
Shear yielding	[Kip]	176.57	37.66	DL	0.21	Eq. J4-3
$A_g = L_p*t_p = 17.66_{[in]}*0.5_{[in]} = \mathbf{8.83}_{[in2]}$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*8.83_{[in2]} = \mathbf{176.57}_{[kip]}$						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	681579.20	DL	0.16	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000_{[lb/in2]} = \mathbf{29940.12}_{[lb/in2]}$						J4-1
$f_{ua} = V_b/(t_p*l) = 41.79_{[kip]}/(0.5_{[in]}*17.66_{[in]}) = \mathbf{4733.19}_{[lb/in2]}$						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	614323.60	DL	0.21	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y = 0.667*0.6*50000_{[lb/in2]} = \mathbf{20000}_{[lb/in2]}$						J4-1
$f_{uv} = H_b/(t_p*l) = 37.66_{[kip]}/(0.5_{[in]}*17.66_{[in]}) = \mathbf{4266.14}_{[lb/in2]}$						9
Weld capacity	[Kip]	216.33	70.32	DL	0.33	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.45_{[kip/in]}*1*5*17.66_{[in]}) = \mathbf{216.33}_{[kip]}$						Tables 8-4 .. 8-11
$f_{ua} = V_b/l = 41.79_{[kip]}/17.66_{[in]} = \mathbf{2.37}_{[kip/in]}$						9

$f_{uv} = H_b/l$ = 37.66[kip]/17.66[in] = **2.13**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = 4.64E-15[kip*ft]/(17.66[in]^2/6) = **1.07E-15**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((2.37[kip/in] + 1.07E-15[kip/in])^2 + 2.13[kip/in]^2)$^{1/2}$ = **3.19**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((2.37[kip/in] - 1.07E-15[kip/in])^2 + 2.13[kip/in]^2)$^{1/2}$ + ((2.37[kip/in] + 1.07E-15[kip/in])^2 + 2.13[kip/in]^2)$^{1/2}$) = **3.19**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 17.66[in]*max(3.19[kip/in], 1.25*3.19[kip/in]) = **70.32**[kip] 9

Beam

Weld block shear	[Kip]	197.03	37.66	DL	0.19	Eq. J4-5

$A_{gv} = l*t_w$ = 17.66[in]*0.35[in] = **6.18**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2] 8

$A_{nv} = A_{gv}$ = **6.18**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.21**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*6.18[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*6.18[in2] + 1*65000[lb/in2]*3.21[in2]) = **197.03**[kip] Eq. J4-5

Web crippling	[Kip]	107.16	41.79	DL1	0.39	Eq. J10-5b

IsBeamReaction → **False**

$N = N$ = **17.66**[in] Sec. J10-2

$N/d <= 0.2$ → 17.66[in]/20.7[in]<=0.2 → **False**

$(1/\Omega)R_n = (1/\Omega)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.40*0.35[in]^2*(1 + (4*17.66[in]/20.7[in] - 0.2)*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **107.16**[kip] Eq. J10-5b

Local web yielding	[Kip]	233.71	41.79	DL	0.18	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **17.66**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w$ = 0.667*(2.5*0.95[in] + 17.66[in])*50000[lb/in2]*0.35[in] = **233.71**[kip] Eq. J10-3

Ratio **0.39**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	48.75	28.26	0.00	0.00	0.00	Design

DL1	-48.75	-28.26	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Length	[in]	12.50	12.08	24.15	✔	p. 10-104
$L_{min} = T/2 = 24.15$[in]$/2 =$ **12.08**[in]						p. 10-104
$L_{max} = L =$ **24.15**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	7.58	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $=$ **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	56.35	DL	0.83	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] — Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 4*16.87[kip]*1 = **67.5**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	137.11	48.75	DL	0.36	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*
65000[lb/in2]*1 = **137.11**[kip] — Eq. J3-6

Shear yielding	[Kip]	125.00	48.75	DL	0.39	Eq. J4-3

A_g = L_p*t_p = 12.5[in]*0.5[in] = **6.25**[in2] — Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6.25[in2] = **125**[kip] — Eq. J4-3

Shear rupture	[Kip]	78.00	48.75	DL	0.63	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

L_e = L - n*L_h = 12.5[in] - 4*1.13[in] = **8**[in] — DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.5[in] = **4**[in2] — Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*4[in2] = **78**[kip] — Eq. J4-4

Block shear	[Kip]	89.78	48.75	DL	0.54	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] — Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] — Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (4 - 1)*3[in])*0.5[in] = **5.38**[in2] — Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **3.41**[in2] — Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 — Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.41[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*5.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **89.78**[kip] — Eq. J4-5

Bolt bearing under axial load	[Kip]	114.56	28.26	DL	0.25	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **114.56**[kip] — Eq. J3-6

Tension yielding	[Kip]	187.13	28.26	DL	0.15	Eq. J4-1
$A_g = L_p*t_p$ = 12.5[in]*0.5[in] = **6.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*6.25[in2] = **187.13**[kip]						Eq. J4-1
Tension rupture	[Kip]	130.00	28.26	DL	0.22	Eq. J4-2
$A_g = L_p*t_p$ = 12.5[in]*0.5[in] = **6.25**[in2]						Sec. D3-1
IsBoltedConnection → **True**						
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_n = (l - n*L_h)*t_p$ = (12.5[in] - 4*1.13[in])*0.5[in] = **4**[in2]						Sec. D3-2
A_e = min(0.85*A_g, A_n) = min(0.85*6.25[in2], 4[in2]) = **4**[in2]						Sec. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4[in2] = **130**[kip]						Eq. J4-2
Tear out under axial load	[Kip]	119.44	28.26	DL	0.24	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
n>1 → 4>1 → **True**						
A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2]						Sec. J4-3
A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2]						Sec. J4-3
A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*2.81[in2]) = **119.44**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	136.61	56.35	DL	0.41	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.37[kip/in]*1*5*12.5[in] = **136.61**[kip]						Tables 8-4 .. 8-11
Web crippling	[Kip]	229.90	28.26	DL1	0.12	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **9**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N$/$d$)*($t_w$/$t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f$/$t_w$)$^{1/2}$ = 0.5*0.80*0.44[in]^2*(1 + 3*(9[in]/14[in])*(0.44[in]/0.71[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.71[in]/0.44[in])$^{1/2}$ = **229.9**[kip]						Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	152.34	48.75	DL	0.32	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 7.58[in] - 1.06[in]/2) = **7.04**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*7.04[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*65000[lb/in2]*1 = **152.34**[kip]						Eq. J3-6
Shear yielding	[Kip]	241.50	48.75	DL	0.20	Eq. J4-3

$A_g = L_p * t_p$ = 24.15[in]*0.5[in] = **12.08**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*12.08[in2] = **241.5**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	153.56	28.26	DL	0.18	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5[in] - 1.06[in]/2) = \mathbf{1.97}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*

65000[lb/in2]*4 = **153.56**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	361.53	28.26	DL	0.08	Eq. J4-1

$A_g = L_p * t_p$ = 24.15[in]*0.5[in] = **12.08**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*12.08[in2] = **361.53**[kip] Eq. J4-1

Tension rupture	[Kip]	319.32	28.26	DL	0.09	Eq. J4-2

$A_g = L_p * t_p$ = 24.15[in]*0.5[in] = **12.08**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (24.15[in] - 4*1.13[in])*0.5[in] = **9.83**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*12.08[in2], 9.83[in2])$ = **9.83**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*9.83[in2] = **319.32**[kip] Eq. J4-2

Tear out under axial load	[Kip]	128.91	28.26	DL	0.22	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 4>1$ → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 -

0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*2.81[in2]) = **128.91**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	332.28	45.94	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 56.35[kip]/(0.5*4.37[kip/in]*1*12.5[in]) = **2.06** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.06/16 [in] = **3.83**[kip/in] p. 9-5

Ratio **0.83**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-186.00	DL	Design
186.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	186.00	DL	0.84	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	388.37	186.00	DL	0.48	Eq. J4-4
$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]						
$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	234.00	186.00	DL	0.79	Eq. J4-4
$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]						
$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	317.50	186.00	DL1	0.59	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) =$ **12**[in]						
$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **12.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip]						Eq. J4-5

Ratio **0.84**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	186.00	DL1	0.50	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	280.98	186.00	DL1	0.66	Eq. J4-2
$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3[in]/12[in] = **0.75**						Table D3.1
$A_e = A_n*U$ = 12.92[in2]*0.75 = **9.69**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.69[in2] = **280.98**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	327.19	186.00	DL1	0.57	Eq. J4-1
$A_g = L_w*t_p$ = 21.86[in]*0.5[in] = **10.93**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.93[in2] = **327.19**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	297.42	186.00	DL	0.63	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*8.02[in]/0.144[in])^2 = **2.19E+05**[lb/in2]						Eq. E3-4
F_e>=0.44*Q*F_y → 2.19E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = 0.658$^{(1*50000[lb/in2]/2.19E+05[lb/in2])}$*50000[lb/in2] = **45449.73**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*45449.73[lb/in2]*10.93[in2] = **297.42**[kip]						Eq. E3-1

Ratio **0.66**

Calculation of the brace interface forces

Load condition :DL

General case	DG29 p. 24-33
$K = e_b*\tan\theta - e_c$ = 10.35[in]*0.734 - 7[in] = **0.594**[in]	p. 13-10
$K' = \alpha_{bar}*(\tan\theta + \alpha_{bar}/\beta_{bar})$ = 9.98[in]*(0.734 + 9.98[in]/12.79[in]) = **15.11**[in]	p. 13-10
$D = (\tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = (0.734)^2 + (9.98[in]/12.79[in])^2 = **1.15**	p. 13-10
$\alpha = (K'*\tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (15.11[in]*0.734 + 0.594[in]*(9.98[in]/12.79[in])^2)/1.15 = **9.98**[in]	p. 13-10
$\beta = (K' - K*\tan\theta)/D$ = (15.11[in] - 0.594[in]*0.734)/1.15 = **12.79**[in]	p. 13-10
$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((9.98[in] + 7[in])^2 + (12.79[in] + 10.35[in])^2)$^{1/2}$ = **28.7**[in]	p. 13-5
$H_b = \alpha*P/r$ = 9.98[in]*-186[kip]/28.7[in] = **-64.67**[kip]	p. 13-5

$H_c = e_c*P/r$ = 7[in]*-186[kip]/28.7[in] = **-45.37**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.35[in]*-186[kip]/28.7[in] - 0[kip] = **-67.08**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 12.79[in]*-186[kip]/28.7[in] + 0[kip] = **-82.88**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(-67.08[kip]*(9.98[in] - 9.98[in])) +$
$abs(0[kip]*9.98[in])$ = **7.45E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(-45.37[kip]*(12.79[in] - 12.79[in]))$ = **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c$ = 10.35[in]*0.734 - 7[in] = **0.594**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 9.98[in]*(0.734 + 9.98[in]/12.79[in]) = **15.11**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.734)^2 + (9.98[in]/12.79[in])^2$ = **1.15** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (15.11[in]*0.734 + 0.594[in]*(9.98[in]/
12.79[in])^2)/1.15 = **9.98**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D$ = (15.11[in] - 0.594[in]*0.734)/1.15 = **12.79**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((9.98[in] + 7[in])^2 + (12.79[in] + 10.35[in])^2)^{1/}$
^{2} = **28.7**[in] p. 13-5

$H_b = \alpha*P/r$ = 9.98[in]*186[kip]/28.7[in] = **64.67**[kip] p. 13-5

$H_c = e_c*P/r$ = 7[in]*186[kip]/28.7[in] = **45.37**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 10.35[in]*186[kip]/28.7[in] - 0[kip] = **67.08**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 12.79[in]*186[kip]/28.7[in] + 0[kip] = **82.88**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(67.08[kip]*(9.98[in] - 9.98[in])) +$
$abs(0[kip]*9.98[in])$ = **7.45E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(45.37[kip]*(12.79[in] - 12.79[in]))$ = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-64.67	-67.08	0.00	0.00	0.00	0.00	Design
DL1	64.67	67.08	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	276.28	67.08	DL1	0.24	Eq. J4-1
$A_g = L_p*t_p$ = 18.46[in]*0.5[in] = **9.23**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.23[in2] = **276.28**[kip]						Eq. J4-1
Shear yielding	[Kip]	184.56	64.67	DL	0.35	Eq. J4-3

$A_g = L_p * t_p$ = 18.46[in]*0.5[in] = **9.23**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_y * A_g$ = 0.667*0.60*50000[lb/in2]*9.23[in2] = **184.56**[kip] Eq. J4-3

Gusset edge tension stress	[Lb/ft2]	4311377.00	1046789.00	DL	0.24	J4-1

$(1/\Omega)F_n = (1/\Omega) * F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2] J4-1

$f_{ua} = V_b/(t_p * l)$ = -67.08[kip]/(0.5[in]*18.46[in]) = **-7269.37**[lb/in2] 9

Gusset edge shear stress	[Lb/ft2]	2880000.00	1009143.00	DL	0.35	J4-1

$(1/\Omega)F_n = (1/\Omega) * 0.6 * F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2] J4-1

$f_{uv} = H_b/(t_p * l)$ = -64.67[kip]/(0.5[in]*18.46[in]) = **-7007.94**[lb/in2] 9

Weld capacity	[Kip]	223.60	116.47	DL	0.52	Tables 8-4 .. 8-11

$(1/\Omega)R_n$ = 2 * $((1/\Omega) * C * C_1 * D * L)$ = 2 * (0.5*2.42[kip/in]*1*5*18.46[in]) = **223.6**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = -67.08[kip]/18.46[in] = **-3.63**[kip/in] 9

$f_{uv} = H_b/l$ = -64.67[kip]/18.46[in] = **-3.5**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = -7.45E-15[kip*ft]/(18.46[in]^2/6) = **-1.57E-15**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((3.63[kip/in] + 1.57E-15[kip/in])^2 + 3.5[kip/in^2])$^{1/2}$ = **5.05**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((3.63[kip/in] - 1.57E-15[kip/in])^2 + 3.5[kip/in^2])$^{1/2}$ + ((3.63[kip/in] + 1.57E-15[kip/in])^2 + 3.5[kip/in^2])$^{1/2}$) = **5.05**[kip/in] 9

$f_{uWeld} = l * \max(f_{uPeak}, 1.25 * f_{uAve})$ = 18.46[in]*max(5.05[kip/in], 1.25*5.05[kip/in]) = **116.47**[kip] 9

Beam

Weld block shear	[Kip]	201.22	64.67	DL	0.32	Eq. J4-5

$A_{gv} = l * t_w$ = 18.46[in]*0.35[in] = **6.46**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w * T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2] 8

$A_{nv} = A_{gv}$ = **6.46**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.21**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*6.46[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*6.46[in2] + 1*65000[lb/in2]*3.21[in2]) = **201.22**[kip] Eq. J4-5

Web crippling	[Kip]	110.69	67.08	DL	0.61	Eq. J10-5b

IsBeamReaction → **False**

$N = N$ = **18.46**[in] Sec. J10-2

$N/d <= 0.2$ → 18.46[in]/20.7[in]<=0.2 → **False**

$(1/\Omega)R_n = (1/\Omega) * 0.40 * t_w^2 * (1 + (4 * N/d - 0.2) * (t_w/t_f)^{1.5}) * (E * F_{yw} * t_f/t_w)^{1/2}$ = 0.5*0.40*0.35[in]^2*(1 + (4*18.46[in]/20.7[in] - 0.2)*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **110.69**[kip] Eq. J10-5b

Local web yielding	[Kip]	243.02	67.08	DL	0.28	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **18.46**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w = 0.667*(2.5*0.95\text{[in]} + 18.46\text{[in]})*50000\text{[lb/in2]}*0.35\text{[in]} = \mathbf{243.02}\text{[kip]}$ Eq. J10-3

Ratio **0.61**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-82.88	-45.37	0.00	0.00	0.00	Design
DL1	82.88	45.37	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.50	12.79	25.58	✔	p. 10-104
$L_{min} = T/2 = 25.58\text{[in]}/2 = \mathbf{12.79}\text{[in]}$						p. 10-104
$L_{max} = L = \mathbf{25.58}\text{[in]}$						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ \text{[in]} = 1\text{[in]}/2 + 1/16\ \text{[in]} = \mathbf{0.563}\text{[in]}$						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25\text{[in]} + 0\text{[in]} = \mathbf{1.25}\text{[in]}$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1\text{[in]} = \mathbf{2}\text{[in]}$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1\text{[in]} = \mathbf{2.67}\text{[in]}$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ \text{[in]}) = \min(24*0.5\text{[in]}, 12\ \text{[in]}) = \mathbf{12}\text{[in]}$						Sec. J3.5
Beam						
Vertical edge distance	[in]	5.29	1.25	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	101.25	94.48	DL	0.93	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 6*16.87$[kip]$*1 =$ **101.25**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	212.67	82.88	DL	0.39	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.75$[in] $- 1.06$[in]$/2) =$ **1.22**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*1.22$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(6 - 1))*0.5$[in]$*$ 65000[lb/in2]$*1 =$ **212.67**[kip]						Eq. J3-6
Shear yielding	[Kip]	185.00	82.88	DL	0.45	Eq. J4-3
$A_g = L_p*t_p = 18.5$[in]$*0.5$[in] = **9.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*9.25$[in2] = **185**[kip]						Eq. J4-3
Shear rupture	[Kip]	114.56	82.88	DL	0.72	Eq. J4-4
$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$L_e = L - n*L_h = 18.5$[in] $- 6*1.13$[in] = **11.75**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 11.75$[in]$*0.5$[in] = **5.88**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*5.88$[in2] = **114.56**[kip]						Eq. J4-4
Block shear	[Kip]	126.34	82.88	DL	0.66	Eq. J4-5
$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] $+ (1 - 1)*3$[in] $- (1 - 0.5)*$ 1.13[in]$)*0.5$[in] = **0.719**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75$[in] $+ (6 - 1)*3$[in]$)*0.5$[in] = **8.38**[in2]						Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **5.28**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*5.28[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*8.38[in2] + 1*65000[lb/in2]*0.719[in2]) = **126.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	171.84	45.37	DL1	0.26	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*65000[lb/in2]*6 = **171.84**[kip] Eq. J3-6

Tension yielding	[Kip]	276.95	45.37	DL1	0.16	Eq. J4-1

A_g = L_p*t_p = 18.5[in]*0.5[in] = **9.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*9.25[in2] = **276.95**[kip] Eq. J4-1

Tension rupture	[Kip]	190.94	45.37	DL1	0.24	Eq. J4-2

A_g = L_p*t_p = 18.5[in]*0.5[in] = **9.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (18.5[in] - 6*1.13[in])*0.5[in] = **5.88**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*9.25[in2], 5.88[in2]) = **5.88**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*5.88[in2] = **190.94**[kip] Eq. J4-2

Tear out under axial load	[Kip]	180.38	45.37	DL1	0.25	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.5[in] = **4.69**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*4.69[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*4.69[in2]) = **180.38**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	200.26	94.48	DL	0.47	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.33[kip/in]*1*5*18.5[in] = **200.26**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	304.20	45.37	DL	0.15	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **15**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.44[in]^2*(1 + 3*(15[in]/14[in])*(0.44[in]/0.71[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.71[in]/0.44[in])$^{1/2}$ = **304.2**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	227.91	82.88	DL	0.36	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 5.29\text{[in]} - 1.06\text{[in]}/2) =$ **4.76**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*4.76[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(6 - 1))*0.5[in]*65000[lb/in2]*1 = **227.91**[kip] Eq. J3-6

Shear yielding	[Kip]	255.76	82.88	DL	0.32	Eq. J4-3

$A_g = L_p*t_p = 25.58\text{[in]}*0.5\text{[in]} =$ **12.79**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*12.79\text{[in2]} =$ **255.76**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	201.09	45.37	DL1	0.23	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) =$ **1.72**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*65000[lb/in2]*6 = **201.09**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	382.87	45.37	DL1	0.12	Eq. J4-1

$A_g = L_p*t_p = 25.58\text{[in]}*0.5\text{[in]} =$ **12.79**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*12.79\text{[in2]} =$ **382.87**[kip] Eq. J4-1

Tension rupture	[Kip]	305.92	45.37	DL1	0.15	Eq. J4-2

$A_g = L_p*t_p = 25.58\text{[in]}*0.5\text{[in]} =$ **12.79**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (25.58\text{[in]} - 6*1.13\text{[in]})*0.5\text{[in]} =$ **9.41**[in2] Sec. D3-2

$A_e = \text{min}(0.85*A_g, A_n) = \text{min}(0.85*12.79\text{[in2]}, 9.41\text{[in2]}) =$ **9.41**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*9.41\text{[in2]} =$ **305.92**[kip] Eq. J4-2

Tear out under axial load	[Kip]	185.25	45.37	DL1	0.24	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]})*0.5\text{[in]} =$ **2.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 - 0.5))*0.5\text{[in]} =$ **1.69**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(6 - 1)*0.5\text{[in]} =$ **4.69**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*4.69[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*4.69[in2]) = **185.25**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	332.28	52.55	DL	0.16	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in] p. 9-5

D_{min} = P/((1/Ω)*C*C_1*L) = 94.48[kip]/(0.5*4.33[kip/in]*1*18.5[in]) = **2.36** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.36/16 [in] = **4.38**[kip/in] p. 9-5

Ratio **0.93**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn}$ = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + 37.66[kip] + -64.67[kip] = **-27**[kip]

$V_{BeamToColumn}$ = V_{Beam} - V_{Top} + V_{Bot} = 30[kip] - 41.79[kip] + -67.08[kip] = **-78.87**[kip]

Load condition :DL1

$H_{BeamToColumn}$ = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -37.66[kip] + 64.67[kip] = **27**[kip]

$V_{BeamToColumn}$ = V_{Beam} - V_{Top} + V_{Bot} = 30[kip] - -41.79[kip] + 67.08[kip] = **138.87**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-78.87	-27.00	0.00	0.00	0.00	Design
DL1	138.87	27.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.50	9.40	18.80	✔	p. 10-104

L_{min} = T/2 = 18.8[in]/2 = **9.4**[in] p. 10-104

L_{max} = d - max(k, d_{ct}) - max(k, d_{cb}) = 20.7[in] - max(0.95[in], 0[in]) -

max(0.95[in], 0[in]) = **18.8**[in] p. 10-49

Thickness	[in]	0.75	--	1.12	✔	p. 10-103
M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*54.17[in] = **265.76**[kip*ft]						p. 10-103
t_{max} = (6*M_{max})/(F_y*d^2) = (6*265.76[kip*ft])/(50000[lb/in2]*18.5[in]^2) = **1.12**[in]						p. 10-103
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.40	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	8.40	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	141.48	141.47	DL1	1.00 ●	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102

k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*$BoltFactor$ = 8.38*16.87[kip]*1 = **141.48**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	298.89	138.87	DL1	0.46	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.22[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **71.3**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = (1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*8.38*min(71.3[kip], 113.34[kip]) = **298.89**[kip] p. 7-18

Shear yielding	[Kip]	277.50	138.87	DL1	0.50	Eq. J4-3

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*13.88[in2] = **277.5**[kip] Eq. J4-3

Shear rupture	[Kip]	171.84	138.87	DL1	0.81	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 18.5[in] - 6*1.13[in] = **11.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 11.75[in]*0.75[in] = **8.81**[in2] Sec. J4-2

(1/Ω)R_n = (1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*8.81[in2] = **171.84**[kip] Eq. J4-4

Block shear	[Kip]	194.85	138.87	DL1	0.71	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (6 - 1)*3[in])*0.75[in] = **12.56**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (6 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **7.92**[in2] Sec. J4-3

$IsStressUniform$ → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = (1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*7.92[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*12.56[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **194.85**[kip] Eq. J4-5

Flexural rupture	[Kip]	461.74	138.87	DL1	0.30	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75[in]/4*(18.5[in]^2 - 3[in]^2*6*(6^2 - 1)*1.13[in]/18.5[in]) = **42.62**[in3] 4

(1/Ω)R_n = (1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*42.62[in3]/3[in] = **461.74**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	360.20	27.00	DL1	0.07	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*8.38*min(85.92[kip], 113.34[kip]) = **360.2**[kip] p. 7-18

Tension yielding	[Kip]	415.42	27.00	DL1	0.07	Eq. J4-1

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*13.88[in2] = **415.42**[kip] Eq. J4-1

Tension rupture	[Kip]	286.41	27.00	DL1	0.09	Eq. J4-2

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (18.5[in] - 6*1.13[in])*0.75[in] = **8.81**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*13.88[in2], 8.81[in2]) = **8.81**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*8.81[in2] = **286.41**[kip] Eq. J4-2

Tear out under axial load	[Kip]	325.41	27.00	DL1	0.08	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.75[in] = **7.03**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*7.03[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*7.03[in2]) = **325.41**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	286.17	141.47	DL1	0.49	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*3.87[kip/in]*1*8*18.5[in] = **286.17**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	130.54	34.72	DL1	0.27	p. 10-103

A_g = L_p*t_p = 18.5[in]*0.75[in] = **13.88**[in2] Sec. D3-1

f_v = V/A_g = 138.87[kip]/13.88[in2] = **10008.51**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*10008.51[lb/in2]^2))$^{1/2}$ = **24411.06**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*18.5[in]^2/4 = **64.17**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 24411.06[lb/in2]*64.17[in3] = **130.54**[kip*ft] p. 10-103

Web crippling	[Kip]	304.20	27.00	DL	0.09	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{15}$[in] — Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$ $0.80*0.44$[in]$^2*(1 + 3*(15$[in]$/14$[in]$)*(0.44$[in]$/0.71$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$ 0.71[in]$/0.44$[in]$)^{1/2} = \mathbf{304.2}$[kip] — Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	221.74	138.87	DL1	0.63	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85\text{[in]} - 1.06\text{[in]}/2) = \mathbf{2.32}$[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}$[in] — Sec. J4.10

$r_{n1} = \text{min}(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*2.32$[in]$*0.35$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.35$[in]$*65000$[lb/in2]$) = \mathbf{54.6}$[kip] — Eq. J3-6

$r_{n2} = \text{min}(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \text{min}(1.2*1.94$[in]$*0.35$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.35$[in]$*65000$[lb/in2]$) = \mathbf{52.89}$[kip] — Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\text{min}(r_{n1}, r_{n2}) = 0.5*8.38*\text{min}(54.6$[kip]$, 52.89$[kip]$) = \mathbf{221.74}$[kip] — p. 7-18

Shear yielding	[Kip]	144.90	138.87	DL1	0.96	Eq. J4-3

$A_g = L_p*t_p = 20.7$[in]$*0.35$[in] $= \mathbf{7.25}$[in2] — Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*7.25$[in2] $= \mathbf{144.9}$[kip] — Eq. J4-3

Bolt bearing under axial load	[Kip]	319.92	27.00	DL1	0.08	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.97}$[in] — Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}$[in] — Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\text{min}(1.2*1.97$[in]$, 2.4*1$[in]$) + \text{min}(1.2*1.94$[in]$, 2.4*1$[in]$)*(2 - 1))*0.35$[in]$*$ 65000[lb/in2]$*6 = \mathbf{319.92}$[kip] — Eq. J3-6

Yielding strength due to axial load	[Kip]	389.22	27.00	DL1	0.07	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*13$[in2] $= \mathbf{389.22}$[kip] — Eq. D2-1

Tension rupture	[Kip]	300.13	27.00	DL1	0.09	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] — Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 13$[in2] $- 6*0.35$[in]$*1.13$[in] $= \mathbf{10.64}$[in2] — Sec. D3-2

$U = 1 - x/l = 1 - 0.791$[in]$/6$[in] $= \mathbf{0.868}$ — Table D3.1

$A_e = U*A_n = 0.868*10.64$[in2] $= \mathbf{9.23}$[in2] — Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*9.23$[in2] $= \mathbf{300.13}$[kip] — Eq. J4-2

Tear out under axial load	[Kip]	158.68	27.00	DL1	0.17	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] — Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] — Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5$[in] $+ (2 - 1)*3$[in]$)*0.35$[in] $= \mathbf{3.85}$[in2] — Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5$[in] $+ (2 - 1)*3$[in] $- 1.13$[in]$*(2 -$

0.5))*0.35[in] = **2.67**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.35[in] = **3.28**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*2.67[in2] + 1*65000[lb/in2]*3.28[in2], 0.6*50000[lb/in2]*3.85[in2] + 1*65000[lb/in2]*3.28[in2]) = **158.68**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	332.28	88.09	DL1	0.27	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in] p. 9-5

D_{min} = P/((*1/Ω*)*C*C_1*L) = 141.47[kip]/(0.5*3.87[kip/in]*1*18.5[in]) = **3.95** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*3.95/16 [in] = **7.34**[kip/in] p. 9-5

Ratio **1.00**

Global critical strength ratio **1.00**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

(1/Ω)R_n: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

VB-03 HSS Brace-Beam-Column Gusset Connection

Connection ID	Column Size	Beam Size	HSS Size	Brace Slope Angles		Beam Reaction (kips) "R"	Transfer Force (kips) "A"	Gusset Plate To HSS Brace Interface				Gusset Plate to Column Interface via Shear Tab									Gusset Plate to Beam Interface via Direct Weld			Beam to Column Connnection Via Shear Tab (Bolt Group Center Level w. WP EL.)						
				"θ"	Axial Loading (kips) ±P			Gusset Plate (A572 Gr.50 Steel) Thickness (inch) tg	Weld Size (inch) "W"	Weld length (inch) "L"	Max. Distance to face of beam/column flange (inch) Lu	Shear Tab (Gr50 Steel) Thickness (inch) tc	Bolt Quantity Row x Col. (3 inch Bolt Spa. Typ.)	Bolt Grade & Size	Distance between Weld to Bolts Line (inch)	Bolt edge distance Vertical (inch)	Bolt edge distance Horizontal (inch)	Weld Size on Column (inch) "W_c"	Centroid of the Connection to Beam Flange Face (inch) β	Weld Size (inch) "W_g"	Weld length (inch) "L_g"	Centroid of the Connection to Column Face (inch) α	Shear Tab (Gr. 50 Steel) Thickness (inch) tb	Bolt Quantity Row x Col. (3 inch Bolt Spa. Typ.)	"Bolt Grade & Size"	Distance between Weld to Bolt Line (inch)	Bolt edge distance (inch)	Bolt edge distance (inch)	Weld Size on Column (inch) Wcb
VB-03-1	W12x72 F	W18x40	HSS9x9x3/8	-27	±52	20	-	1/2"	1/4"		16.9	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	4.1	1/4"	37.9"	19.46	1/2"	4x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-2	W12x72 F	W18x55	HSS8x8x5/8	-32.5	±156	40	-	1/2"	5/16"	14	12.35	3/8"	3x1	1" A490 SC	3"	1.5"	2"	1/4"	5.8	1/4"	32.8	17.15	3/4"	5x3	1" A490 SC	3"	1.5"	2"	1/2"
VB-03-3	W12x87 F	W18x55	HSS8x8x5/8	35.0	±156	40	-	1/2"	5/16"	14	13.6	3/8"	4x1	1" A490 SC	3"	1.5"	2"	1/4"	7.05	1/4"	32	16.74	3/4"	5x3	1" A490 SC	3"	1.5"	2"	1/2"
VB-03-4	W12x72 F	W24x76	HSS8x8x5/8	-35.0	±156	65	-	1/2"	5/16"	14	14.6	3/8"	3x1	1" A490 SC	3"	1.5"	2"	1/4"	5.85	1/4"	37.05	19.27	3/4"	7x2	1" A490 SC	3"	1.5"	2"	1/2"
VB-03-5	W12x87 F	W24x76	HSS8x8x1/2	35.0	±85	65	-	1/2"	5/16"	10	12.6	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	4.1	1/4"	32.28	16.64	1/2"	7x2	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-6	W12x72 F	W24x76	HSS8x8x1/2	-34.9	±85	65	-	1/2"	5/16"	12	16.62	3/8"	3x1	1" A490 SC	3"	1.5"	2"	1/4"	5.73	1/4"	37.4	19.2	1/2"	6x2	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-7	W12x87 F	W24x76	HSS8x8x3/8	36.2	±36	65	-	1/2"	5/16"	8	14.32	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	4.38	1/4"	31.13	16.1	1/2"	6x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-8	W12x72 F	W21x50	HSS8x8x3/8	-36.2	±36	30	±15	1/2"	5/16"	8	10.32	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	3.94	1/4"	25.88	13.44	1/2"	6x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-9	W12x87 F	W27x84	HSS10x10x5/8	-28.0	±207	75	-	1/2"	5/16"	20	26.52	1/2"	4x1	1" A490 SC	3"	1.5"	2"	5/16"	7	1/4"	62.59	32.05	3/4"	8x2	1" A490 SC	3"	1.5"	2"	1/2"
VB-03-10	W12x72 F	W27x84	HSS9x9x5/8	26.0	±157	75	-	1/2"	5/16"	16	22.44	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	4.1	1/4"	58.27	29.63	3/4"	8x2	1" A490 SC	3"	1.5"	2"	1/2"
VB-03-11	W12x87 F	W27x84	HSS9x9x5/8	-26.0	±157	75	-	1/2"	5/16"	14	22.44	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	3.75	1/4"	56.12	28.8	3/4"	8x2	1" A490 SC	3"	1.5"	2"	1/2"
VB-03-12	W12x72 F	W27x84	HSS9x9x1/2	27.0	±60	75	-	1/2"	5/16"	14	22	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	3.98	1/4"	54.71	27.86	1/2"	7x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-13	W12x87 F	W24x68	HSS9x9x1/2	-27.0	±60	35	±35	1/2"	5/16"	14	20	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	4.3	1/4"	49.88	25.44	1/2"	6x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-14	W10x49 F	W21x44	HSS8x8x3/8	-27.0	±25	20	±8	1/2"	5/16"	10	21	3/8"	2x1	1" A490 SC	3"	1.5"	2"	1/4"	4	1/4"	45.3	23.15	1/2"	5x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-16	W12x53 F	W18x40	HSS8x8x5/16	-56.3	±40	20	±10	1/2"	5/16"	8	17.48	3/8"	4x1	1" A490 SC	3"	1.75"	2"	1/4"	12.34	1/4"	15.3	8.15	1/2"	4x1	1" A490 SC	3"	1.5"	2"	5/16"
VB-03-17	W14x90 F	W18x40	HSS8x8x5/16	-55.0	±36	35	±20	1/2"	5/16"	8	16.88	3/8"	4x1	1" A490 SC	3"	1.75"	2"	1/4"	12.44	1/4"	14.96	7.98	1/2"	4x1	1" A490 SC	3"	1.5"	2"	5/16"

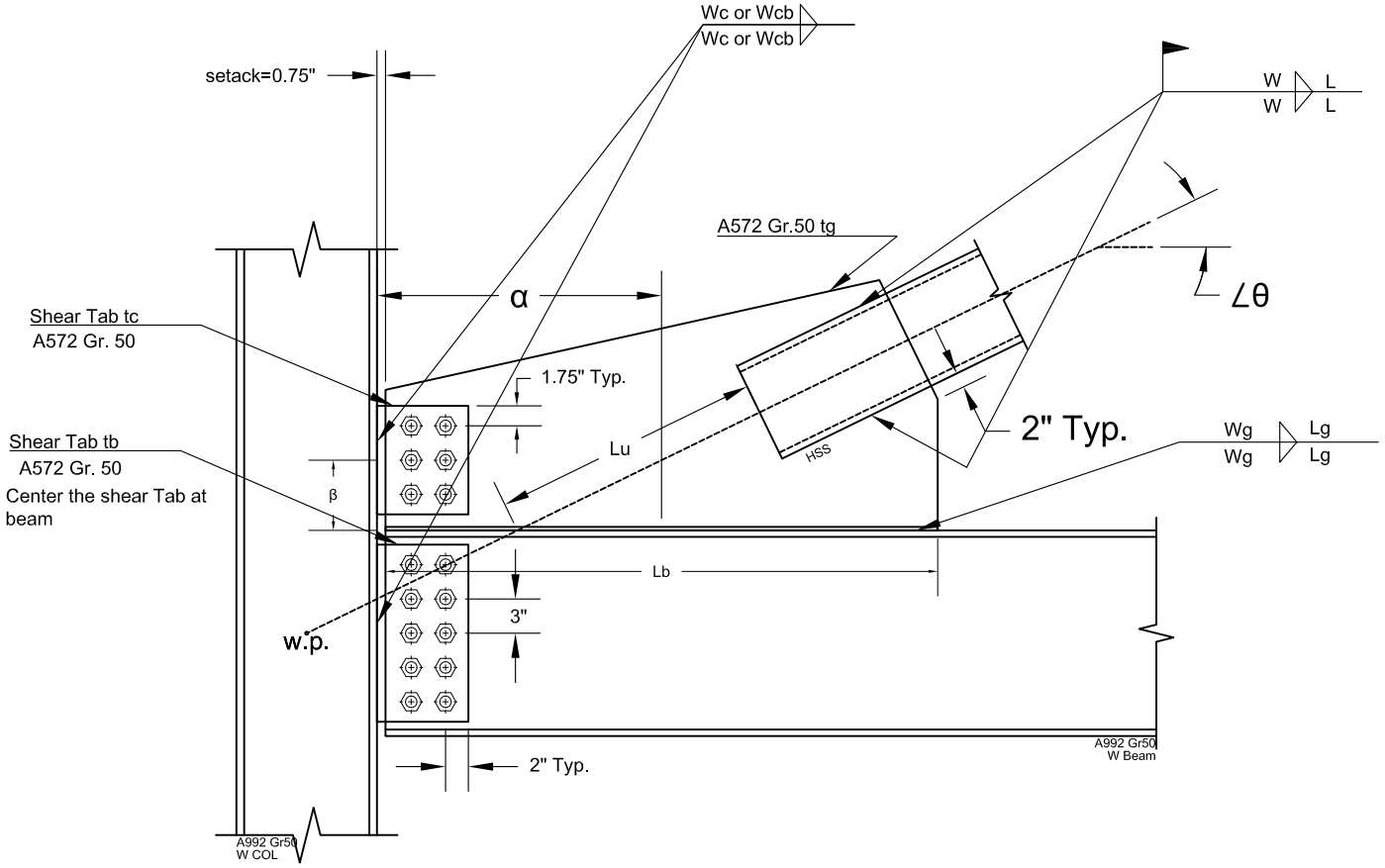
All Bolts are slip-critical Type
Beam/gusset plate setback= 3/4" from column face

VB-03a HSS Brace-Beam-Column Gusset Connection

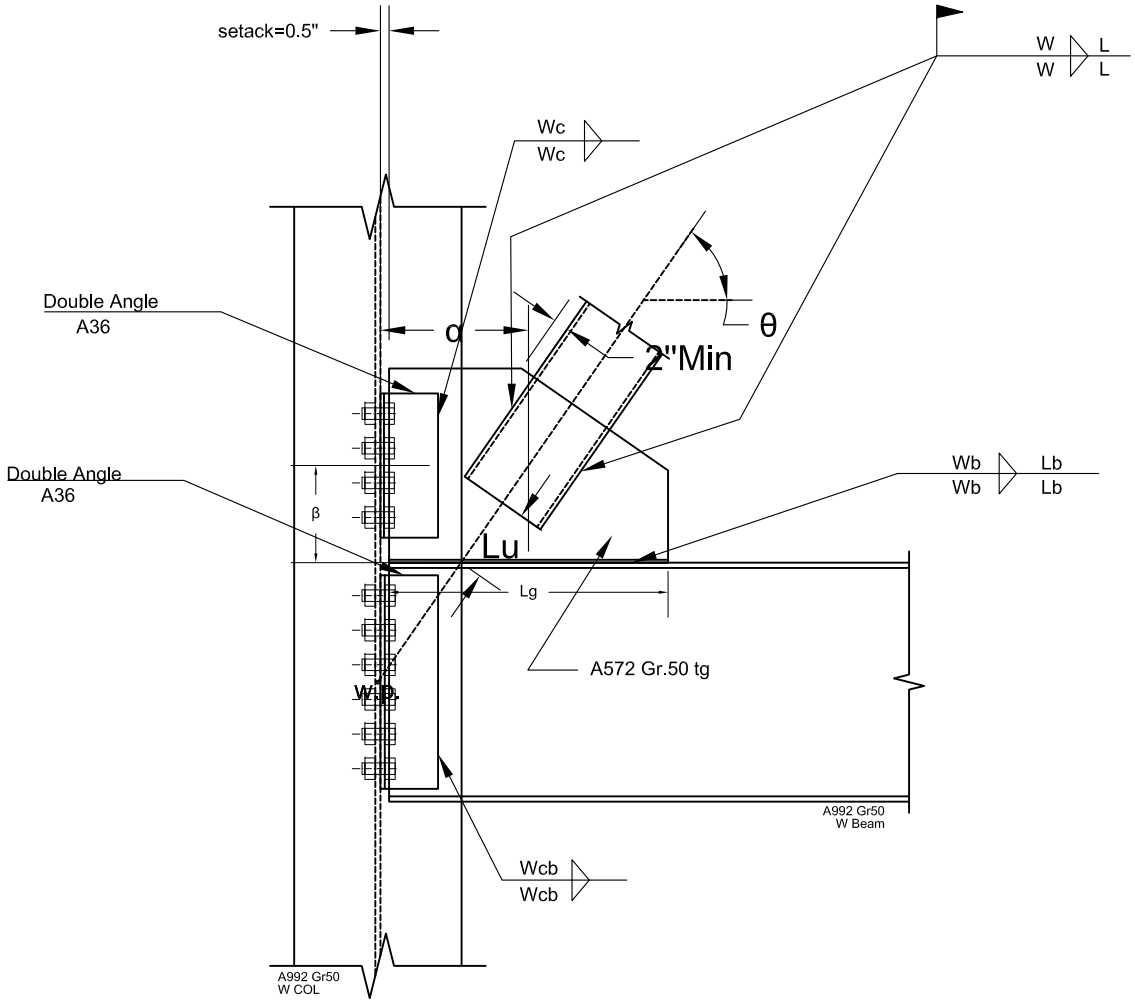
Connection ID	Column Size (Web/Flange)	Beam Size	Gusset Plate To HSS Brace Interface			Beam Reaction (kips) "R"	Transfer Force (kips) "A"	Gusset Plate To HSS Brace Interface				Gusset Plate to Column Connection via Double Angle								Gusset Plate To Beam Flange via Direct Weld			Beam to Column Connnection Double Angle Connection (Bolt Group Center at WP Elevation)						
			HSS Size	θ (Deg)	HSS Axial Loading (kips) "±P"			A572 Gr.50 Plate Thickness (inch) tg	Weld Size (inch) "W"	Weld length (inch) "L"	Max. Distance to face of beam/column flange (inch) "Lu"	Double Angle Size	Bolt Spa.	Bolt Grade & Size	Bolt Gage on Column Web (inch) "Ga."	Bolt edge distance "Vertical (inch)"	Bolt edge distance Horizontal (inch)	Weld Size on Plate (inch) W_c	Centroid of the Connection to Beam Flange Face β	Weld Size (inch) "W_b"	Weld length (inch) "L_b"	Centroid of the Connection to Column Face (inch) α	Double Angle Size**	Bolt Row 3" Type Bolt Spa.	Bolt Grade & Size	Bolt Gage on Column Web (inch) "Ga."	Bolt edge distance Vertical (inch)	Bolt edge distance Horizontal (inch)	Weld Size on Beam (inch) W_{cb}
VB-03-15	W14x90 W	W18x40	HSS8x8x5/16	-56.3	±40	25	20	1/2"	5/16"	8"	5.76	L4x4x5/16	3	1" A490 SC	5.5	1.5	Varies≥1.25"	1/4"	7.68	1/4"	20.75	10.87	L4x4x1/2	4	1" A490 SC	5.5	1.5	Varies≥1.25"	1/4"

All Bolts are slip-critical Type

VB-03 Vertical HSS Beam Column Gusset Connection



VB-03 Vertical HSS Beam Column Gusset Connection



Current Date: 2016-05-25 11:51 AM

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-1**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X40

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	Design
DL1	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-52.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
52.00	DL	Design
-52.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	52.00	DL	0.35	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	52.00	DL	0.21	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	52.00	DL	0.27	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	303.75	52.00	DL	0.17	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + 1$*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + 1$*65000$[lb/in2]$*4.5$[in2]$)$ = **303.75**[kip] — Eq. J4-5

Ratio **0.35**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	325.03	52.00	DL	0.16	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*11.8$[in2] = **325.03**[kip] — Eq. J4-1

Tension rupture	[Kip]	218.33	52.00	DL	0.24	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 11.8[in2] - 2*(0.5[in] + 1/8\ [in])*0.349[in] =$ **11.36**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3.38[in]/10[in] =$ **0.663** Table D3.1

$A_e = A_n*U = 11.36[in2]*0.663 =$ **7.53**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*7.53[in2] =$ **218.33**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	261.82	52.00	DL	0.20	Eq. J4-1

$A_g = L_w*t_p = 17.49[in]*0.5[in] =$ **8.74**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.74[in2] =$ **261.82**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	208.88	52.00	DL1	0.25	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*13.26[in]/0.144[in])^2 =$ **80263.87**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 80263.87[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/80263.87[lb/in2])}*50000[lb/in2] =$

38524.29[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*38524.29[lb/in2]*9.06[in2] =$ **208.88**[kip] Eq. E3-1

Ratio **0.25**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} =$ **4.16**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.16[in] + 8.95[in])*1.96 - 6.15[in] =$ **19.58**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((19.58[in] + 6.15[in])^2 + (4.16[in] +$

$8.95[in])^2)^{1/2} =$ **28.88**[in] p. 13-5

$H_b = \alpha*P/r = 19.58[in]*52[kip]/28.88[in] =$ **35.26**[kip] p. 13-5

$H_c = e_c*P/r = 6.15[in]*52[kip]/28.88[in] =$ **11.07**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*52[kip]/28.88[in] - 0[kip] =$ **16.11**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 4.16[in]*52[kip]/28.88[in] + 0[kip] =$ **7.49**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(16.11[kip]*(19.58[in] - 19.58[in])) +$

$abs(0[kip]*19.58[in]) =$ **3.58E-15**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(11.07[kip]*(4.16[in] - 4.16[in])) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} =$ **4.16**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.16[in] + 8.95[in])*1.96 - 6.15[in] =$ **19.58**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((19.58[in] + 6.15[in])^2 + (4.16[in] +$

$8.95[in])^2)^{1/2} =$ **28.88**[in] p. 13-5

$H_b = \alpha*P/r = 19.58[in]*-52[kip]/28.88[in] =$ **-35.26**[kip] p. 13-5

$H_c = e_c*P/r = 6.15[in]*-52[kip]/28.88[in] =$ **-11.07**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*-52[kip]/28.88[in] - 0[kip] =$ **-16.11**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 4.16[in]*-52[kip]/28.88[in] + 0[kip] =$ **-7.49**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-16.11[kip]*(19.58[in] - 19.58[in])) +
abs(0[kip]*19.58[in]) = **3.58E-15**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-11.07[kip]*(4.16[in] - 4.16[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	35.26	16.11	0.00	0.00	0.00	0.00	Design
DL1	-35.26	-16.11	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	563.85	16.11	DL	0.03	Eq. J4-1
A_g = L_p*t_p = 37.67[in]*0.5[in] = **18.83**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*18.83[in2] = **563.85**[kip]						Eq. J4-1
Shear yielding	[Kip]	376.65	35.26	DL	0.09	Eq. J4-3
A_g = L_p*t_p = 37.67[in]*0.5[in] = **18.83**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*18.83[in2] = **376.65**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	123217.40	DL	0.03	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 16.11[kip]/(0.5[in]*37.67[in]) = **855.68**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	269600.90	DL	0.09	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 35.26[kip]/(0.5[in]*37.67[in]) = **1872.23**[lb/in2]						9
Weld capacity	[Kip]	317.12	48.46	DL	0.15	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.1[kip/in]*1*4*37.67[in]) = **317.12**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 16.11[kip]/37.67[in] = **0.428**[kip/in]						9
f_{uv} = H_b/l = 35.26[kip]/37.67[in] = **0.936**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 3.58E-15[kip*ft]/(37.67[in]^2/6) = **1.82E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.428[kip/in] + 1.82E-16[kip/in])^2 + 0.936[kip/in]^2)$^{1/2}$ = **1.03**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.428[kip/in] - 1.82E-16[kip/in])^2 + 0.936[kip/in]^2)$^{1/2}$ + ((0.428[kip/in] + 1.82E-16[kip/in])^2 + 0.936[kip/in]^2)$^{1/2}$) = **1.03**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 37.67[in]*max(1.03[kip/in], 1.25*1.03[kip/in]) = **48.46**[kip] 9

Beam

Weld block shear	[Kip]	287.58	35.26	DL	0.12	Eq. J4-5

$A_{gv} = l$*t_w = 37.67[in]*0.315[in] = **11.86**[in2] Sec. J4.3

A_{gt} = (A_g - t_w*T)/2 = (11.8[in2] - 0.315[in]*16.05[in])/2 = **3.37**[in2] 8

$A_{nv} = A_{gv}$ = **11.86**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.37**[in2] Sec. J4.3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*11.86[in2] + 1*65000[lb/in2]*3.37[in2], 0.6*50000[lb/in2]*11.86[in2] + 1*
65000[lb/in2]*3.37[in2]) = **287.58**[kip] Eq. J4-5

Web crippling	[Kip]	242.72	16.11	DL1	0.07	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **37.67**[in] Sec. J10-2

(1/Ω)R_n = *(1/Ω)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ = 0.5*
0.80*0.315[in]^2*(1 + 3*(37.67[in]/17.9[in])*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.525[in]/0.315[in])$^{1/2}$ = **242.72**[kip] Eq. J10-4

Local web yielding	[Kip]	444.15	16.11	DL	0.04	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **37.67**[in] Sec. J10-2

IsMemberEnd → **False**

(1/Ω)R_n = *(1/Ω)*(5*k + N)*F_{yw}*t_w = 0.667*(5*0.927[in] + 37.67[in])*50000[lb/in2]*
0.315[in] = **444.15**[kip] Eq. J10-2

Ratio **0.15**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	7.49	11.07	0.00	0.00	0.00	Design
DL1	-7.49	-11.07	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.00	4.16	8.32	✔	p. 10-104

L_{min} = T/2 = 8.32[in]/2 = **4.16**[in] p. 10-104

L_{max} = L = **8.32**[in]

Thickness	[in]	0.38	--	0.56	✔	p. 10-102

t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in] p. 10-102

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.66	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101

w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	13.37	DL	0.40	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*$BoltFactor$ = 2*16.87[kip]*1 = **33.75**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	7.49	DL	0.18	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	7.49	DL	0.17	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	7.49	DL	0.27	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	7.49	DL	0.20	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	11.07	DL	0.26	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	11.07	DL	0.16	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	11.07	DL	0.24	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6\text{[in]} - 2*1.13\text{[in]})*0.375\text{[in]} = \mathbf{1.41}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25\text{[in2]}, 1.41\text{[in2]}) = \mathbf{1.41}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*1.41\text{[in2]} = \mathbf{45.7}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	43.88	11.07	DL	0.25	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2\text{[in]} + (1 - 1)*3\text{[in]})*0.375\text{[in]} = \mathbf{1.5}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 - 0.5))*0.375\text{[in]} = \mathbf{1.08}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(2 - 1)*0.375\text{[in]} = \mathbf{0.703}\text{[in2]}$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000\text{[lb/in2]}*1.08\text{[in2]} + 1*65000\text{[lb/in2]}*0.703\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.5\text{[in2]} + 1*65000\text{[lb/in2]}*0.703\text{[in2]}) = \mathbf{43.88}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	61.34	13.37	DL	0.22	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*5.11\text{[kip/in]}*1*4*6\text{[in]} = \mathbf{61.34}\text{[kip]}$ Tables 8-4 .. 8-11

Web crippling	[Kip]	152.99	11.07	DL1	0.07	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{3}\text{[in]}$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.43\text{[in]}^2*(1 + 3*(3\text{[in]}/12.3\text{[in]})*(0.43\text{[in]}/0.67\text{[in]})^{1.5})*(2.90E+07\text{[lb/in2]}*50000\text{[lb/in2]}*0.67\text{[in]}/0.43\text{[in]})^{1/2} = \mathbf{152.99}\text{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	7.49	DL	0.10	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.66\text{[in]} - 1.06\text{[in]}/2) = \mathbf{2.13}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*2.13\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(2 - 1))*0.5\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{76.78}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	83.23	7.49	DL	0.09	Eq. J4-3

$A_g = L_p*t_p = 8.32\text{[in]}*0.5\text{[in]} = \mathbf{4.16}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*4.16\text{[in2]} = \mathbf{83.23}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	11.07	DL	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.97}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*1.97\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(1 - 1))*0.5\text{[in]}*$

65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	124.59	11.07	DL	0.09	Eq. J4-1

$A_g = L_p*t_p$ = 8.32[in]*0.5[in] = **4.16**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.16[in2] = **124.59**[kip] Eq. J4-1

Tension rupture	[Kip]	98.69	11.07	DL	0.11	Eq. J4-2

$A_g = L_p*t_p$ = 8.32[in]*0.5[in] = **4.16**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.32[in] - 2*1.13[in])*0.5[in] = **3.04**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.16[in2], 3.04[in2]) = **3.04**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.04[in2] = **98.69**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	11.07	DL	0.16	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	19.42	DL	0.06	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 13.37[kip]/(0.5*5.11[kip/in]*1*6[in]) = **0.872** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.872/16 [in] = **1.62**[kip/in] p. 9-5

Ratio **0.40**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + 35.26[kip] = **35.26**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 20[kip] - 0[kip] + 16.11[kip] = **36.11**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + -35.26[kip] = **-35.26**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 20[kip] - 0[kip] + -16.11[kip] = \mathbf{3.89}[kip]$

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	36.11	35.26	0.00	0.00	0.00	Design
DL1	3.89	-35.26	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	12.00	8.02	16.05	✔	p. 10-104
$L_{min} = T/2 = 16.05[in]/2 = \mathbf{8.02}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 17.9[in] - \max(0.927[in], 0[in]) - \max(0.927[in], 0[in]) = \mathbf{16.05}[in]$						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 1[in]/2 + 1/16\ [in] = \mathbf{0.563}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.315[in], 12\ [in]) = \mathbf{7.56}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	50.47	DL	0.75	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 4*16.87[kip]*1 = **67.5**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	132.23	36.11	DL	0.27	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p* F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]* 65000[lb/in2]*1 = **132.23**[kip]						Eq. J3-6
Shear yielding	[Kip]	120.00	36.11	DL	0.30	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6[in2] = **120**[kip]						Eq. J4-3
Shear rupture	[Kip]	73.13	36.11	DL	0.49	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 12[in] - 4*1.13[in] = **7.5**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 7.5[in]*0.5[in] = **3.75**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.75[in2] = **73.13**[kip]						Eq. J4-4
Block shear	[Kip]	87.34	36.11	DL	0.41	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.5[in] = **5.25**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **3.28**[in2]						Sec. J4-3
IsStressUniform → **True**						

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*0.719[in2]) = **87.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	114.56	35.26	DL	0.31	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2\text{[in]} - 1.06\text{[in]}/2) =$ **1.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **114.56**[kip] Eq. J3-6

Tension yielding	[Kip]	179.64	35.26	DL	0.20	Eq. J4-1

$A_g = L_p*t_p$ = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*6[in2] = **179.64**[kip] Eq. J4-1

Tension rupture	[Kip]	121.88	35.26	DL	0.29	Eq. J4-2

$A_g = L_p*t_p$ = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (12[in] - 4*1.13[in])*0.5[in] = **3.75**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*6\text{[in2]}, 3.75\text{[in2]})$ = **3.75**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.75[in2] = **121.88**[kip] Eq. J4-2

Tear out under axial load	[Kip]	119.44	35.26	DL	0.30	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*2.81[in2]) = **119.44**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	143.88	50.47	DL	0.35	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.8[kip/in]*1*5*12[in] = **143.88**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	236.64	35.26	DL1	0.15	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **9**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*

$0.80*0.43_{[in]}^{2}*(1 + 3*(9_{[in]}/12.3_{[in]})*(0.43_{[in]}/0.67_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*0.67_{[in]}/0.43_{[in]})^{1/2}$ = **236.64**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	95.98	36.11	DL	0.38	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.45[in] - 1.06[in]/2) = **3.92**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*3.92[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.315[in]*65000[lb/in2]*1 = **95.98**[kip] Eq. J3-6

Shear yielding	[Kip]	112.77	36.11	DL	0.32	Eq. J4-3

$A_g = L_p*t_p$ = 17.9[in]*0.315[in] = **5.64**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*5.64[in2] = **112.77**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	84.46	35.26	DL	0.42	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.315[in]*65000[lb/in2]*4 = **84.46**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	353.29	35.26	DL	0.10	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*11.8[in2] = **353.29**[kip] Eq. D2-1

Tension rupture	[Kip]	241.37	35.26	DL	0.15	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h$ = 11.8[in2] - 4*0.315[in]*1.13[in] = **10.38**[in2] Sec. D3-2

$U = 1 - x/l$ = 1 - 0.854[in]/3[in] = **0.715** Table D3.1

$A_e = U*A_n$ = 0.715*10.38[in2] = **7.43**[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*7.43[in2] = **241.37**[kip] Eq. J4-2

Tear out under axial load	[Kip]	78.32	35.26	DL	0.45	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.315[in] = **1.42**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.315[in] = **1.06**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(4 - 1)*0.315[in] = **1.77**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*1.06[in2] + 1*65000[lb/in2]*1.77[in2], 0.6*50000[lb/in2]*1.42[in2] + 1*65000[lb/in2]*1.77[in2]) = **78.32**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	39.07	DL	0.12	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 50.47$[kip]$/(0.5*4.8$[kip/in]$*1*12$[in]$) =$ **1.75** tables 8-4..11

$HasWeldsOnBothSides \rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.75/16$ [in] = **3.26**[kip/in] p. 9-5

Ratio **0.75**

Global critical strength ratio **0.75**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

Current Date: 2016-05-25 11:40 AM

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-2**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X55

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	156.00	Design
DL1	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-156.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
156.00	DL	Design
-156.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	156.00	DL	0.60	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	156.00	DL	0.28	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.581$[in] = **16.27**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*16.27$[in2]$)$ = **566.13**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	156.00	DL	0.57	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	347.50	156.00	DL	0.45	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$) =$ **347.5**[kip] Eq. J4-5

Ratio **0.60**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	451.74	156.00	DL	0.35	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*16.4$[in2] = **451.74**[kip] Eq. J4-1

Tension rupture	[Kip]	357.14	156.00	DL	0.44	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 16.4[in2] - 2*(0.5[in] + 1/8\ [in])*0.581[in] = \mathbf{15.67}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/14[in] = \mathbf{0.786}$ Table D3.1

$A_e = A_n*U = 15.67[in2]*0.786 = \mathbf{12.32}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*12.32[in2] = \mathbf{357.14}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	314.05	156.00	DL	0.50	Eq. J4-1

$A_g = L_w*t_p = 20.98[in]*0.5[in] = \mathbf{10.49}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*10.49[in2] = \mathbf{314.05}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	301.26	156.00	DL1	0.52	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*7.6[in]/0.144[in])^2 = \mathbf{2.45E+05}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 2.45E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/2.45E+05[lb/in2])}*50000[lb/in2] =$

45898.8[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*45898.8[lb/in2]*10.96[in2] = \mathbf{301.26}[kip]$ Eq. E3-1

Ratio **0.52**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.76}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.76[in] + 9.05[in])*1.57 - 6.15[in] = \mathbf{17.1}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((17.1[in] + 6.15[in])^2 + (5.76[in] + 9.05[in])^2)^{1/2} = \mathbf{27.57}[in]$ p. 13-5

$H_b = \alpha*P/r = 17.1[in]*156[kip]/27.57[in] = \mathbf{96.77}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*156[kip]/27.57[in] = \mathbf{34.8}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9.05[in]*156[kip]/27.57[in] - 0[kip] = \mathbf{51.2}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.76[in]*156[kip]/27.57[in] + 0[kip] = \mathbf{32.61}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(51.2[kip]*(17.1[in] - 17.1[in])) + abs(0[kip]*17.1[in]) = \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(34.8[kip]*(5.76[in] - 5.76[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.76}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.76[in] + 9.05[in])*1.57 - 6.15[in] = \mathbf{17.1}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((17.1[in] + 6.15[in])^2 + (5.76[in] + 9.05[in])^2)^{1/2} = \mathbf{27.57}[in]$ p. 13-5

$H_b = \alpha*P/r = 17.1[in]*-156[kip]/27.57[in] = \mathbf{-96.77}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*-156[kip]/27.57[in] = \mathbf{-34.8}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9.05[in]*-156[kip]/27.57[in] - 0[kip] = \mathbf{-51.2}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.76[in]*-156[kip]/27.57[in] + 0[kip] = \mathbf{-32.61}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-51.2[kip]*(17.1[in] - 17.1[in])) +
abs(0[kip]*17.1[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-34.8[kip]*(5.76[in] - 5.76[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	96.77	51.20	0.00	0.00	0.00	0.00	Design
DL1	-96.77	-51.20	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	489.64	51.20	DL	0.10	Eq. J4-1
A_g = L_p*t_p = 32.71[in]*0.5[in] = **16.35**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*16.35[in2] = **489.64**[kip]						Eq. J4-1
Shear yielding	[Kip]	327.08	96.77	DL	0.30	Eq. J4-3
A_g = L_p*t_p = 32.71[in]*0.5[in] = **16.35**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*16.35[in2] = **327.08**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	450867.30	DL	0.10	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 51.2[kip]/(0.5[in]*32.71[in]) = **3131.02**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	852108.20	DL	0.30	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 96.77[kip]/(0.5[in]*32.71[in]) = **5917.42**[lb/in2]						9
Weld capacity	[Kip]	281.68	136.86	DL1	0.49	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.15[kip/in]*1*4*32.71[in]) = **281.68**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = -51.2[kip]/32.71[in] = **-1.57**[kip/in]						9
f_{uv} = H_b/l = -96.77[kip]/32.71[in] = **-2.96**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 0[kip*ft]/(32.71[in]^2/6) = **0**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((1.57[kip/in] + 0[kip/in])^2 + 2.96[kip/in]^2)$^{1/2}$ = **3.35**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((1.57[kip/in] - 0[kip/in])^2 + 2.96[kip/in]^2)$^{1/2}$ + ((1.57[kip/in] + 0[kip/in])^2 + 2.96[kip/in]^2)$^{1/2}$) = **3.35**[kip/in]						9

$f_{uWeld} = l^*\max(f_{uPeak}, 1.25^*f_{uAve}) = 32.71[in]^*\max(3.35[kip/in], 1.25^*3.35[kip/in]) =$
136.86[kip] 9

Beam

Weld block shear	[Kip]	352.94	96.77	DL	0.27	Eq. J4-5
$A_{gv} = l^*t_w = 32.71[in]^*0.39[in] =$ **12.76**[in2]						Sec. J4.3
$A_{gt} = (A_g - t_w^*T)/2 = (16.2[in2] - 0.39[in]^*16.04[in])/2 =$ **4.97**[in2]						8
$A_{nv} = A_{gv} =$ **12.76**[in2]						Sec. J4.3
$A_{nt} = A_{gt} =$ **4.97**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)^*\min(0.6^*F_u^*A_{nv} + U_{bs}^*F_u^*A_{nt}, 0.6^*F_y^*A_{gv} + U_{bs}^*F_u^*A_{nt}) =$ $0.5^*\min(0.6^*65000[lb/in2]^*12.76[in2] + 1^*65000[lb/in2]^*4.97[in2], 0.6^*50000[lb/in2]^*12.76[in2] + 1^*$ $65000[lb/in2]^*4.97[in2]) =$ **352.94**[kip]						Eq. J4-5
Web crippling	[Kip]	338.97	51.20	DL1	0.15	Eq. J10-4
IsBeamReaction → **False**						
$N = N =$ **32.71**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)^*0.80^*t_w^2*(1 + 3^*(N/d)^*(t_w/t_f)^{1.5})^*(E^*F_{yw}^*t_f/t_w)^{1/2} = 0.5^*$ $0.80^*0.39[in]^2*(1 + 3^*(32.71[in]/18.1[in])^*(0.39[in]/0.63[in])^{1.5})^*(2.90E+07[lb/in2]^*50000[lb/in2]^*$ $0.63[in]/0.39[in])^{1/2} =$ **338.97**[kip]						Eq. J10-4
Local web yielding	[Kip]	458.68	51.20	DL	0.11	Eq. J10-3
IsBeamReaction → **False**						
$N = N =$ **32.71**[in]						Sec. J10-2
IsMemberEnd → **True**						
$(1/\Omega)R_n = (1/\Omega)^*(2.5^*k + N)^*F_{yw}^*t_w = 0.667^*(2.5^*1.03[in] + 32.71[in])^*50000[lb/in2]^*$ $0.39[in] =$ **458.68**[kip]						Eq. J10-3
Ratio	**0.49**					

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	32.61	34.80	0.00	0.00	0.00	Design
DL1	-32.61	-34.80	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	9.00	5.76	11.53	✔	p. 10-104
$L_{min} = T/2 = 11.53$[in]$/2 =$ **5.76**[in]						p. 10-104
$L_{max} = L =$ **11.53**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.76	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	50.62	47.69	DL	0.94 ●	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*16.87$[kip]$*1 =$ **50.62**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	70.84	32.61	DL	0.46	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.375[in]*
65000[lb/in2]*1 = **70.84**[kip] Eq. J3-6

Shear yielding	[Kip]	67.50	32.61	DL	0.48	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.38[in2] = **67.5**[kip] Eq. J4-3

Shear rupture	[Kip]	41.13	32.61	DL	0.79	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.375[in] = **2.11**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.11[in2] = **41.13**[kip] Eq. J4-4

Block shear	[Kip]	51.80	32.61	DL	0.63	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.76**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.76[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*2.81[in2] + 1*65000[lb/
in2]*0.539[in2]) = **51.8**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	64.44	34.80	DL	0.54	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*3 = **64.44**[kip] Eq. J3-6

Tension yielding	[Kip]	101.05	34.80	DL	0.34	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*3.38[in2] = **101.05**[kip] Eq. J4-1

Tension rupture	[Kip]	68.55	34.80	DL	0.51	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (9[in] - 3*1.13[in])*0.375[in] = \mathbf{2.11}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*3.38[in2], 2.11[in2]) = \mathbf{2.11}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*2.11[in2] = \mathbf{68.55}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	66.73	34.80	DL	0.52	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.375[in] = \mathbf{1.41}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*1.41[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*1.41[in2]) = \mathbf{66.73}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	87.64	47.69	DL1	0.54	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.87[kip/in]*1*4*9[in] = \mathbf{87.64}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	105.63	34.80	DL1	0.33	Eq. J10-5b

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{6}$[in] Sec. J10-2

$N/d <= 0.2 \rightarrow 6[in]/12.3[in] <= 0.2 \rightarrow$ **False**

$(1/\Omega)R_n = (1/\Omega)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} =$
$0.5*0.40*0.43[in]^2*(1 + (4*6[in]/12.3[in] - 0.2)*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.67[in]/0.43[in])^{1/2} = \mathbf{105.63}$[kip] Eq. J10-5b

Beam

Bolt bearing under shear load	[Kip]	114.56	32.61	DL	0.28	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.76[in] - 1.06[in]/2) = \mathbf{2.23}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.23[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.5[in]*$
$65000[lb/in2]*1 = \mathbf{114.56}$[kip] Eq. J3-6

Shear yielding	[Kip]	115.29	32.61	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 11.53[in]*0.5[in] = \mathbf{5.76}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.76[in2] = \mathbf{115.29}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	100.55	34.80	DL	0.35	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(1 - 1))*0.5\text{[in]}*$
$65000\text{[lb/in2]}*3 = \mathbf{100.55}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	172.59	34.80	DL	0.20	Eq. J4-1

$A_g = L_p*t_p = 11.53\text{[in]}*0.5\text{[in]} = \mathbf{5.76}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*5.76\text{[in2]} = \mathbf{172.59}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	132.50	34.80	DL	0.26	Eq. J4-2

$A_g = L_p*t_p = 11.53\text{[in]}*0.5\text{[in]} = \mathbf{5.76}\text{[in2]}$ Sec. D3-1

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$A_n = (l - n*L_h)*t_p = (11.53\text{[in]} - 3*1.13\text{[in]})*0.5\text{[in]} = \mathbf{4.08}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*5.76\text{[in2]}, 4.08\text{[in2]}) = \mathbf{4.08}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*4.08\text{[in2]} = \mathbf{132.5}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	93.84	34.80	DL	0.37	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]})*0.5\text{[in]} = \mathbf{2.25}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 - 0.5))*0.5\text{[in]} = \mathbf{1.69}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(3 - 1)*0.5\text{[in]} = \mathbf{1.88}\text{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000\text{[lb/in2]}*1.69\text{[in2]} + 1*65000\text{[lb/in2]}*1.88\text{[in2]}, 0.6*50000\text{[lb/in2]}*2.25\text{[in2]} + 1*65000\text{[lb/in2]}*1.88\text{[in2]}) = \mathbf{93.84}\text{[kip]}$ Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	48.48	DL1	0.15	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000\text{[lb/in2]}*0.67\text{[in]} = \mathbf{26.13}\text{[kip/in]}$ p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 47.69\text{[kip]}/(0.5*4.87\text{[kip/in]}*1*9\text{[in]}) = \mathbf{2.18}$ tables 8-4..11

$HasWeldsOnBothSides \rightarrow \mathbf{False}$

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16\text{ [in]} = 0.6*70000\text{[lb/in2]}*(2)^{1/2}/2*2.18/16\text{ [in]} = \mathbf{4.04}\text{[kip/in]}$ p. 9-5

Ratio **0.94**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0\text{[kip]} + 0\text{[kip]} + 96.77\text{[kip]} = \mathbf{96.77}\text{[kip]}$

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 40\text{[kip]} - 0\text{[kip]} + 51.2\text{[kip]} = \mathbf{91.2}\text{[kip]}$

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + 0[kip] + -96.77[kip] = **-96.77**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 40$[kip] - 0[kip] + -51.2[kip] = **-11.2**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	91.20	96.77	0.00	0.00	0.00	Design
DL1	-11.20	-96.77	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	8.02	16.04	✔	p. 10-104
$L_{min} = T/2 = 16.04$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18.1$[in] - max(1.03[in], 0[in]) - max(1.03[in], 0[in]) = **16.04**[in]						p. 10-49
Thickness	[in]	0.75	--	2.02	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*64.35$[in] = **315.71**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*315.71$[kip*ft]$)/(50000$[lb/in2]$*15$[in]^2) = **2.02**[in]						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.36	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.39$[in], 12 [in]$) =$ **9.36**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	9.36	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.39[in], 12 [in]) = **9.36**[in] — Sec. J3.5

Beam

Vertical edge distance	[in]	3.05	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	160.54	132.98	DL	0.83	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 9.51*16.87[kip]*1 = **160.54**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	269.58	91.20	DL	0.34	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip]						Eq. J3-6
r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip]						Eq. J3-6
(1/Ω)R_n = (1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*9.51*min(56.67[kip], 113.34[kip]) = **269.58**[kip]						p. 7-18
Shear yielding	[Kip]	225.00	91.20	DL	0.41	Eq. J4-3
A_g = L_p*t_p = 15[in]*0.75[in] = **11.25**[in2]						Sec. D3-1
(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.25[in2] = **225**[kip]						Eq. J4-3
Shear rupture	[Kip]	137.11	91.20	DL	0.67	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 15[in] - 5*1.13[in] = **9.38**[in]						DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 9.38[in]*0.75[in] = **7.03**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*7.03[in2] = **137.11**[kip] Eq. J4-4

Block shear	[Kip]	186.62	91.20	DL	0.49	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (3 - 1)*3[in] - (3 - 0.5)*1.13[in])*0.75[in] = **3.89**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (5 - 1)*3[in])*0.75[in] = **10.13**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (5 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **6.33**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*6.33[in2] + 0.5*65000[lb/in2]*3.89[in2], 0.6*50000[lb/in2]*10.13[in2] + 0.5*65000[lb/in2]*3.89[in2]) = **186.62**[kip] Eq. J4-5

Flexural rupture	[Kip]	292.50	91.20	DL	0.31	p. 9-6

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.75[in]/4*(15[in]^2 - 3[in]^2*5*(5^2 - 1)*1.13[in]/15[in]) = **27**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*27[in3]/3[in] = **292.5**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	408.71	96.77	DL	0.24	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, $L_e - d_h/2$) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, $s - d_h$) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*9.51*min(85.92[kip], 113.34[kip]) = **408.71**[kip] p. 7-18

Tension yielding	[Kip]	336.83	96.77	DL	0.29	Eq. J4-1

$A_g = L_p*t_p$ = 15[in]*0.75[in] = **11.25**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*11.25[in2] = **336.83**[kip] Eq. J4-1

Tension rupture	[Kip]	228.52	96.77	DL	0.42	Eq. J4-2

$A_g = L_p*t_p$ = 15[in]*0.75[in] = **11.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (15[in] - 5*1.13[in])*0.75[in] = **7.03**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*11.25[in2], 7.03[in2]) = **7.03**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*7.03[in2] = **228.52**[kip] Eq. J4-2

Tear out under axial load	[Kip]	334.55	96.77	DL	0.29	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (3 - 1)*3[in])*0.75[in] = **12**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (3 - 1)*3[in] - 1.13[in]*(3 - 0.5))*0.75[in] = **7.78**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(5 - 1)*0.75[in] = **5.63**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
0.5*min(0.6*65000[lb/in2]*7.78[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*12[in2] + 1*65000[lb/in2]*5.63[in2]) = **334.55**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	291.88	132.98	DL	0.46	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.86$[kip/in]*1*8*15[in] = **291.88**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	92.96	22.80	DL	0.25	p. 10-103

$A_g = L_p*t_p = 15$[in]*0.75[in] = **11.25**[in2] Sec. D3-1

$f_v = V/A_g = 91.2$[kip]/11.25[in2] = **8107.05**[lb/in2] p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000$[lb/in2])$^2 - 3*8107.05$[lb/in2]$^2))^{1/2}$ = **26443.1**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.75$[in]*15[in]$^2/4$ = **42.19**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 26443.1$[lb/in2]*42.19[in3] = **92.96**[kip*ft] p. 10-103

Web crippling	[Kip]	161.40	96.77	DL1	0.60	Eq. J10-5b

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **12**[in] Sec. J10-2

$N/d<=0.2 \rightarrow 12$[in]/12.3[in]$<=0.2 \rightarrow$ **False**

$(1/\Omega)R_n = (1/\Omega)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} =$
0.5*0.40*0.43[in]^2*(1 + (4*12[in]/12.3[in] - 0.2)*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.67[in]/0.43[in])$^{1/2}$ = **161.4**[kip] Eq. J10-5b

Beam

Bolt bearing under shear load	[Kip]	280.36	91.20	DL	0.33	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.05$[in] - 1.06[in]$/2) =$ **2.52**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 1.06[in]$) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.52$[in]*0.39[in]*65000[lb/in2], 2.4*1[in]*0.39[in]*65000[lb/in2]) = **60.84**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]*0.39[in]*65000[lb/in2], 2.4*1[in]*0.39[in]*65000[lb/in2]) = **58.94**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*9.51*\min(60.84$[kip], 58.94[kip]$) =$ **280.36**[kip] p. 7-18

Shear yielding	[Kip]	141.18	91.20	DL	0.65	Eq. J4-3

$A_g = L_p*t_p = 18.1$[in]*0.39[in] = **7.06**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*7.06$[in2] $= \mathbf{141.18}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	425.40	96.77	DL	0.23	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25$[in] $- 1.06$[in]$/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(3 - 1))*0.39$[in]$*$
65000[lb/in2]$*5 = \mathbf{425.4}$[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	485.03	96.77	DL	0.20	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*16.2$[in2] $= \mathbf{485.03}$[kip] Eq. D2-1

Tension rupture	[Kip]	396.92	96.77	DL	0.24	Eq. J4-2

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 16.2$[in2] $- 5*0.39$[in]$*1.13$[in] $= \mathbf{14.01}$[in2] Sec. D3-2

$U = 1 - x/l = 1 - 1.15$[in]$/9$[in] $= \mathbf{0.872}$ Table D3.1

$A_e = U*A_n = 0.872*14.01$[in2] $= \mathbf{12.21}$[in2] Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*12.21$[in2] $= \mathbf{396.92}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	177.77	96.77	DL	0.54	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25$[in] $+ (3 - 1)*3$[in]$)*0.39$[in] $= \mathbf{6.44}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25$[in] $+ (3 - 1)*3$[in] $- 1.13$[in]$*(3 -$
$0.5))*0.39$[in] $= \mathbf{4.24}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] $- 1.13$[in]$)*(5 - 1)*0.39$[in] $= \mathbf{2.93}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*4.24$[in2] $+ 1*65000$[lb/in2]$*2.93$[in2]$, 0.6*50000$[lb/in2]$*6.44$[in2] $+ 1*65000$[lb/in2]$*2.93$[in2]$) = \mathbf{177.77}$[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	81.18	DL	0.26	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] $= \mathbf{26.13}$[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 132.98$[kip]$/(0.5*4.86$[kip/in]$*1*15$[in]$) = \mathbf{3.64}$ tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*3.64/16$ [in] $= \mathbf{6.77}$[kip/in] p. 9-5

Ratio **0.83**

Global critical strength ratio **0.94**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-3**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X55

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	156.00	0.00	0.00	0.00	Design
DL1	0.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	-156.00	0.00	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
156.00	DL	Design
-156.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	156.00	DL	0.60	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	156.00	DL	0.28	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.581$[in] = **16.27**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*16.27$[in2]$)$ = **566.13**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	156.00	DL	0.57	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	347.50	156.00	DL	0.45	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$) =$ **347.5**[kip] Eq. J4-5

Ratio **0.60**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	451.74	156.00	DL	0.35	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*16.4$[in2] = **451.74**[kip] Eq. J4-1

Tension rupture	[Kip]	357.14	156.00	DL	0.44	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 16.4[in2] - 2*(0.5[in] + 1/8\ [in])*0.581[in] = \mathbf{15.67}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/14[in] = \mathbf{0.786}$ Table D3.1

$A_e = A_n*U = 15.67[in2]*0.786 = \mathbf{12.32}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*12.32[in2] = \mathbf{357.14}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	336.10	156.00	DL	0.46	Eq. J4-1

$A_g = L_w*t_p = 22.45[in]*0.5[in] = \mathbf{11.23}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*11.23[in2] = \mathbf{336.1}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	311.16	156.00	DL1	0.50	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*8.29[in]/0.144[in])^2 = \mathbf{2.05E+05}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 2.05E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/2.05E+05[lb/in2])}*50000[lb/in2] =$

$\mathbf{45155.55}[lb/in2]$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*45155.55[lb/in2]*11.51[in2] = \mathbf{311.16}[kip]$ Eq. E3-1

Ratio **0.50**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{7.05}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (7.05[in] + 9.05[in])*1.43 - 6.25[in] = \mathbf{16.74}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((16.74[in] + 6.25[in])^2 + (7.05[in] +$
$9.05[in])^2)^{1/2} = \mathbf{28.07}[in]$ p. 13-5

$H_b = \alpha*P/r = 16.74[in]*156[kip]/28.07[in] = \mathbf{93.05}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*156[kip]/28.07[in] = \mathbf{34.74}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9.05[in]*156[kip]/28.07[in] - 0[kip] = \mathbf{50.3}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 7.05[in]*156[kip]/28.07[in] + 0[kip] = \mathbf{39.18}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(50.3[kip]*(16.74[in] - 16.74[in])) +$
$abs(0[kip]*16.74[in]) = \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(34.74[kip]*(7.05[in] - 7.05[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{7.05}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (7.05[in] + 9.05[in])*1.43 - 6.25[in] = \mathbf{16.74}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((16.74[in] + 6.25[in])^2 + (7.05[in] +$
$9.05[in])^2)^{1/2} = \mathbf{28.07}[in]$ p. 13-5

$H_b = \alpha*P/r = 16.74[in]*-156[kip]/28.07[in] = \mathbf{-93.05}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*-156[kip]/28.07[in] = \mathbf{-34.74}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 9.05[in]*-156[kip]/28.07[in] - 0[kip] = \mathbf{-50.3}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 7.05[in]*-156[kip]/28.07[in] + 0[kip] = \mathbf{-39.18}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-50.3[kip]*(16.74[in] - 16.74[in])) +
abs(0[kip]*16.74[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-34.74[kip]*(7.05[in] - 7.05[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	93.05	50.30	0.00	0.00	0.00	0.00	Design
DL1	-93.05	-50.30	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	478.83	50.30	DL	0.11	Eq. J4-1
A_g = L_p*t_p = 31.99[in]*0.5[in] = **15.99**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*15.99[in2] = **478.83**[kip]						Eq. J4-1
Shear yielding	[Kip]	319.86	93.05	DL	0.29	Eq. J4-3
A_g = L_p*t_p = 31.99[in]*0.5[in] = **15.99**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*15.99[in2] = **319.86**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	452877.40	DL	0.11	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 50.3[kip]/(0.5[in]*31.99[in]) = **3144.98**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	837841.70	DL	0.29	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 93.05[kip]/(0.5[in]*31.99[in]) = **5818.35**[lb/in2]						9
Weld capacity	[Kip]	276.42	132.22	DL	0.48	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.16[kip/in]*1*4*31.99[in]) = **276.42**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 50.3[kip]/31.99[in] = **1.57**[kip/in]						9
f_{uv} = H_b/l = 93.05[kip]/31.99[in] = **2.91**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 0[kip*ft]/(31.99[in]^2/6) = **0**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((1.57[kip/in] + 0[kip/in])^2 + 2.91[kip/in]^2)$^{1/2}$ = **3.31**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((1.57[kip/in] - 0[kip/in])^2 + 2.91[kip/in]^2)$^{1/2}$ + ((1.57[kip/in] + 0[kip/in])^2 + 2.91[kip/in]^2)$^{1/2}$) = **3.31**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 31.99[in]*max(3.31[kip/in], 1.25*3.31[kip/in]) =
132.22[kip] 9

Beam

Weld block shear	[Kip]	348.71	93.05	DL	0.27	Eq. J4-5

$A_{gv} = l$*t_w = 31.99[in]*0.39[in] = **12.47**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (16.2[in2] - 0.39[in]*16.04[in])/2 = **4.97**[in2] 8

$A_{nv} = A_{gv}$ = **12.47**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **4.97**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*12.47[in2] + 1*65000[lb/in2]*4.97[in2], 0.6*50000[lb/in2]*12.47[in2] + 1*
65000[lb/in2]*4.97[in2]) = **348.71**[kip] Eq. J4-5

Web crippling	[Kip]	333.55	50.30	DL1	0.15	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **31.99**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.39[in]^2*(1 + 3*(31.99[in]/18.1[in])*(0.39[in]/0.63[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.63[in]/0.39[in])$^{1/2}$ = **333.55**[kip] Eq. J10-4

Local web yielding	[Kip]	449.29	50.30	DL	0.11	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **31.99**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)$*(2.5*$k$ + N)*F_{yw}*t_w = 0.667*(2.5*1.03[in] + 31.99[in])*50000[lb/in2]*
0.39[in] = **449.29**[kip] Eq. J10-3

Ratio **0.48**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	39.18	34.74	0.00	0.00	0.00	Design
DL1	-39.18	-34.74	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	12.00	7.05	14.10	✔	p. 10-104
L_{min} = T/2 = 14.1[in]/2 = **7.05**[in]						p. 10-104
L_{max} = L = **14.1**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.55	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	52.36	DL	0.78	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 4*16.87[kip]*1 = **67.5**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	99.18	39.18	DL	0.40	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.375[in]*
65000[lb/in2]*1 = **99.18**[kip] Eq. J3-6

Shear yielding	[Kip]	90.00	39.18	DL	0.44	Eq. J4-3

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.5[in2] = **90**[kip] Eq. J4-3

Shear rupture	[Kip]	54.84	39.18	DL	0.71	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 12[in] - 4*1.13[in] = **7.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 7.5[in]*0.375[in] = **2.81**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.81[in2] = **54.84**[kip] Eq. J4-4

Block shear	[Kip]	65.51	39.18	DL	0.60	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.375[in] = **3.94**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **2.46**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*2.46[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*3.94[in2] + 1*65000[lb/
in2]*0.539[in2]) = **65.51**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	85.92	34.74	DL	0.40	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*4 = **85.92**[kip] Eq. J3-6

Tension yielding	[Kip]	134.73	34.74	DL	0.26	Eq. J4-1

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*4.5[in2] = **134.73**[kip] Eq. J4-1

Tension rupture	[Kip]	91.41	34.74	DL	0.38	Eq. J4-2

A_g = L_p*t_p = 12[in]*0.375[in] = **4.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (12[in] - 4*1.13[in])*0.375[in] = \mathbf{2.81}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*4.5[in2], 2.81[in2]) = \mathbf{2.81}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*2.81[in2] = \mathbf{91.41}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	89.58	34.74	DL	0.39	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.375[in] = \mathbf{2.11}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*2.11[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*2.11[in2]) = \mathbf{89.58}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	113.17	52.36	DL	0.46	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.72[kip/in]*1*4*12[in] = \mathbf{113.17}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	335.66	34.74	DL1	0.10	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{9}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515[in]^2*(1 + 3*(9[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.81[in]/0.515[in])^{1/2} = \mathbf{335.66}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	152.34	39.18	DL	0.26	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.55[in] - 1.06[in]/2) = \mathbf{2.02}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.02[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*$
$65000[lb/in2]*1 = \mathbf{152.34}$[kip] Eq. J3-6

Shear yielding	[Kip]	141.00	39.18	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 14.1[in]*0.5[in] = \mathbf{7.05}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.05[in2] = \mathbf{141}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	134.06	34.74	DL	0.26	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*4 = **134.06**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	211.07	34.74	DL	0.16	Eq. J4-1

$A_g = L_p*t_p$ = 14.1[in]*0.5[in] = **7.05**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*7.05[in2] = **211.07**[kip] Eq. J4-1

Tension rupture	[Kip]	155.99	34.74	DL	0.22	Eq. J4-2

$A_g = L_p*t_p$ = 14.1[in]*0.5[in] = **7.05**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (14.1[in] - 4*1.13[in])*0.5[in] = **4.8**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*7.05[in2], 4.8[in2]) = **4.8**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4.8[in2] = **155.99**[kip] Eq. J4-2

Tear out under axial load	[Kip]	124.31	34.74	DL	0.28	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*2.81[in2]) = **124.31**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	41.22	DL	0.11	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 52.36[kip]/(0.5*4.72[kip/in]*1*12[in]) = **1.85** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.85/16 [in] = **3.44**[kip/in] p. 9-5

Ratio **0.78**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 93.05[kip] + 0[kip] = **93.05**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 40[kip] - 50.3[kip] + 0[kip] = **-10.3**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + -93.05[kip] + 0[kip] = **-93.05**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 40$[kip] - -50.3[kip] + 0[kip] = **90.3**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-10.30	93.05	0.00	0.00	0.00	Design
DL1	90.30	-93.05	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	8.02	16.04	✔	p. 10-104
$L_{min} = T/2 = 16.04$[in]$/2 =$ **8.02**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 18.1$[in] - max(1.03[in], 0[in]) - max(1.03[in], 0[in]) = **16.04**[in]						p. 10-49
Thickness	[in]	0.75	--	2.02	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*64.35$[in] = **315.71**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*315.71$[kip*ft]$)/(50000$[lb/in2]$*15$[in]$^2) =$ **2.02**[in]						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.36	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.39$[in]$, 12$ [in]$) =$ **9.36**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	9.36	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.39[in], 12 [in]) = **9.36**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	3.05	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	159.60	129.66	DL1	0.81	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 9.46*16.87[kip]*1 = **159.6**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	268.00	90.30	DL1	0.34	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip]						Eq. J3-6
r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip]						Eq. J3-6
(1/Ω)R_n = (1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*9.46*min(56.67[kip], 113.34[kip]) = **268**[kip]						p. 7-18
Shear yielding	[Kip]	225.00	90.30	DL1	0.40	Eq. J4-3
A_g = L_p*t_p = 15[in]*0.75[in] = **11.25**[in2]						Sec. D3-1
(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*11.25[in2] = **225**[kip]						Eq. J4-3
Shear rupture	[Kip]	137.11	90.30	DL1	0.66	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 15[in] - 5*1.13[in] = **9.38**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 9.38[in]*0.75[in] = **7.03**[in2]						Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*7.03$[in2] $= \mathbf{137.11}$[kip] Eq. J4-4

Block shear	[Kip]	186.62	90.30	DL1	0.48	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] $+ (3 - 1)*3$[in] $- (3 - 0.5)*1.13$[in]$)*0.75$[in] $= \mathbf{3.89}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] $+ (5 - 1)*3$[in]$)*0.75$[in] $= \mathbf{10.13}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] $+ (5 - 1)*(3$[in] $- 1.13$[in]$) - 1.13$[in]$/2)*0.75$[in] $= \mathbf{6.33}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **False**

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000$[lb/in2]$*6.33$[in2] $+ 0.5*65000$[lb/in2]$*3.89$[in2]$, 0.6*50000$[lb/in2]$*10.13$[in2] $+ 0.5*65000$[lb/in2]$*3.89$[in2]$) = \mathbf{186.62}$[kip] Eq. J4-5

Flexural rupture	[Kip]	292.50	90.30	DL1	0.31	p. 9-6

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75$[in]$/4*(15$[in]$^2 - 3$[in]$^2*5*(5^2 - 1)*1.13$[in]$/15$[in]$) = \mathbf{27}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*27$[in3]$/3$[in] $= \mathbf{292.5}$[kip] p. 9-6

Bolt bearing under axial load	[Kip]	593.31	93.05	DL	0.16	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in] $- 1.06$[in]$/2) = \mathbf{1.47}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.47$[in]$*0.75$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.75$[in]$*65000$[lb/in2]$) = \mathbf{85.92}$[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.75$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.75$[in]$*65000$[lb/in2]$) = \mathbf{113.34}$[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*13.81*\min(85.92$[kip]$, 113.34$[kip]$) = \mathbf{593.31}$[kip] p. 7-18

Tension yielding	[Kip]	336.83	93.05	DL	0.28	Eq. J4-1

$A_g = L_p*t_p = 15$[in]$*0.75$[in] $= \mathbf{11.25}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*11.25$[in2] $= \mathbf{336.83}$[kip] Eq. J4-1

Tension rupture	[Kip]	228.52	93.05	DL	0.41	Eq. J4-2

$A_g = L_p*t_p = 15$[in]$*0.75$[in] $= \mathbf{11.25}$[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (15$[in]$ - 5*1.13$[in]$)*0.75$[in] $= \mathbf{7.03}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*11.25$[in2]$, 7.03$[in2]$) = \mathbf{7.03}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*7.03$[in2] $= \mathbf{228.52}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	334.55	93.05	DL	0.28	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (3 - 1)*3[in])*0.75[in] = **12**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (3 - 1)*3[in] - 1.13[in]*(3 - 0.5))*0.75[in] = **7.78**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(5 - 1)*0.75[in] = **5.63**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*7.78$[in2] $+ 1*65000$[lb/in2]$*5.63$[in2], $0.6*50000$[lb/in2]$*12$[in2] $+ 1*65000$[lb/in2]$*5.63$[in2]$) =$ **334.55**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	290.45	129.66	DL1	0.45	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.84$[kip/in]$*1*8*15$[in] = **290.45**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	93.22	22.57	DL1	0.24	p. 10-103

$A_g = L_p*t_p = 15$[in]$*0.75$[in] = **11.25**[in2] Sec. D3-1

$f_v = V/A_g = 90.3$[kip]$/11.25$[in2] = **8026.43**[lb/in2] p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000$[lb/in2]$)^2 - 3*8026.43$[lb/in2]$^2))^{1/2}$ = **26516.79**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.75$[in]$*15$[in]$^2/4$ = **42.19**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 26516.79$[lb/in2]$*42.19$[in3] = **93.22**[kip*ft] p. 10-103

Web crippling	[Kip]	394.14	93.05	DL1	0.24	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515$[in]$^2*(1 + 3*(12$[in]$/12.5$[in]$)*(0.515$[in]$/0.81$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.81[in]$/0.515$[in]$)^{1/2}$ = **394.14**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	278.72	90.30	DL1	0.32	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 3.05$[in] $- 1.06$[in]$/2)$ = **2.52**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$)$ = **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.52$[in]$*0.39$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.39$[in]$*65000$[lb/in2]$)$ = **60.84**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.39$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.39$[in]$*65000$[lb/in2]$)$ = **58.94**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*9.46*\min(60.84$[kip], 58.94[kip]$)$ = **278.72**[kip] p. 7-18

Shear yielding	[Kip]	141.18	90.30	DL1	0.64	Eq. J4-3

$A_g = L_p*t_p = 18.1$[in]$*0.39$[in] = **7.06**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*7.06$[in2] = **141.18**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	425.40	93.05	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.39[in]*
65000[lb/in2]*5 = **425.4**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	485.03	93.05	DL	0.19	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*16.2[in2] = **485.03**[kip] Eq. D2-1

Tension rupture	[Kip]	396.92	93.05	DL	0.23	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 16.2[in2] - 5*0.39[in]*1.13[in] = **14.01**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.15[in]/9[in] = **0.872** Table D3.1

A_e = U*A_n = 0.872*14.01[in2] = **12.21**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*12.21[in2] = **396.92**[kip] Eq. J4-2

Tear out under axial load	[Kip]	177.77	93.05	DL	0.52	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (3 - 1)*3[in])*0.39[in] = **6.44**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (3 - 1)*3[in] - 1.13[in]*(3 -
0.5))*0.39[in] = **4.24**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.39[in] = **2.93**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*4.24[in2] + 1*65000[lb/in2]*2.93[in2], 0.6*50000[lb/in2]*6.44[in2] + 1*65000[lb/
in2]*2.93[in2]) = **177.77**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	79.55	DL1	0.21	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

D_{min} = P/(($1/\Omega$)*C*C_1*L) = 129.66[kip]/(0.5*4.84[kip/in]*1*15[in]) = **3.57** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*3.57/16 [in] = **6.63**[kip/in] p. 9-5

Ratio **0.81**

Global critical strength ratio **0.81**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-4**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W24x76

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	156.00	Design
DL1	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-156.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
156.00	DL	Design
-156.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	156.00	DL	0.60	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	156.00	DL	0.28	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.581$[in] = **16.27**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*16.27$[in2]$)$ = **566.13**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	156.00	DL	0.57	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	347.50	156.00	DL	0.45	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$) =$ **347.5**[kip] Eq. J4-5

Ratio **0.60**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	451.74	156.00	DL	0.35	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*16.4$[in2] = **451.74**[kip] Eq. J4-1

Tension rupture	[Kip]	357.14	156.00	DL	0.44	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 16.4[in2] - 2*(0.5[in] + 1/8\ [in])*0.581[in] =$ **15.67**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/14[in] =$ **0.786** Table D3.1

$A_e = A_n*U = 15.67[in2]*0.786 =$ **12.32**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*12.32[in2] =$ **357.14**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	328.49	156.00	DL	0.47	Eq. J4-1

$A_g = L_w*t_p = 21.94[in]*0.5[in] =$ **10.97**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*10.97[in2] =$ **328.49**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	278.55	156.00	DL1	0.56	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*10.87[in]/0.144[in])^2 =$ **1.20E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.20E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/1.20E+05[lb/in2])}*50000[lb/in2] =$

41970.23[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*41970.23[lb/in2]*11.08[in2] =$ **278.55**[kip] Eq. E3-1

Ratio **0.56**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} =$ **5.85**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.85[in] + 11.95[in])*1.43 - 6.15[in] =$ **19.27**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((19.27[in] + 6.15[in])^2 + (5.85[in] +$
$11.95[in])^2)^{1/2} =$ **31.04**[in] p. 13-5

$H_b = \alpha*P/r = 19.27[in]*156[kip]/31.04[in] =$ **96.88**[kip] p. 13-5

$H_c = e_c*P/r = 6.15[in]*156[kip]/31.04[in] =$ **30.91**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*156[kip]/31.04[in] - 0[kip] =$ **60.07**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 5.85[in]*156[kip]/31.04[in] + 0[kip] =$ **29.41**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(60.07[kip]*(19.27[in] - 19.27[in])) +$
$abs(0[kip]*19.27[in]) =$ **1.33E-14**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(30.91[kip]*(5.85[in] - 5.85[in])) =$ **0**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} =$ **5.85**[in] p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.85[in] + 11.95[in])*1.43 - 6.15[in] =$ **19.27**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((19.27[in] + 6.15[in])^2 + (5.85[in] +$
$11.95[in])^2)^{1/2} =$ **31.04**[in] p. 13-5

$H_b = \alpha*P/r = 19.27[in]*-156[kip]/31.04[in] =$ **-96.88**[kip] p. 13-5

$H_c = e_c*P/r = 6.15[in]*-156[kip]/31.04[in] =$ **-30.91**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*-156[kip]/31.04[in] - 0[kip] =$ **-60.07**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V = 5.85[in]*-156[kip]/31.04[in] + 0[kip] =$ **-29.41**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-60.07[kip]*(19.27[in] - 19.27[in])) +
abs(0[kip]*19.27[in]) = **1.33E-14**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-30.91[kip]*(5.85[in] - 5.85[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	96.88	60.07	0.00	0.00	0.00	0.00	Design
DL1	-96.88	-60.07	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	554.59	60.07	DL	0.11	Eq. J4-1
A_g = L_p*t_p = 37.05[in]*0.5[in] = **18.52**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*18.52[in2] = **554.59**[kip]						Eq. J4-1
Shear yielding	[Kip]	370.47	96.88	DL	0.26	Eq. J4-3
A_g = L_p*t_p = 37.05[in]*0.5[in] = **18.52**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*18.52[in2] = **370.47**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	466950.60	DL	0.11	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 60.07[kip]/(0.5[in]*37.05[in]) = **3242.71**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	753109.50	DL	0.26	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 96.88[kip]/(0.5[in]*37.05[in]) = **5229.93**[lb/in2]						9
Weld capacity	[Kip]	327.66	142.48	DL	0.43	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.21[kip/in]*1*4*37.05[in]) = **327.66**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 60.07[kip]/37.05[in] = **1.62**[kip/in]						9
f_{uv} = H_b/l = 96.88[kip]/37.05[in] = **2.61**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 1.33E-14[kip*ft]/(37.05[in]^2/6) = **7.00E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((1.62[kip/in] + 7.00E-16[kip/in])^2 + 2.61[kip/in^2])$^{1/2}$ = **3.08**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((1.62[kip/in] - 7.00E-16[kip/in])^2 + 2.61[kip/in^2])$^{1/2}$ + ((1.62[kip/in] + 7.00E-16[kip/in])^2 + 2.61[kip/in^2])$^{1/2}$) = **3.08**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 37.05[in]*max(3.08[kip/in], 1.25*3.08[kip/in]) =
142.48[kip] 9

Beam

Weld block shear	[Kip]	454.50	96.88	DL	0.21	Eq. J4-5

$A_{gv} = l$*t_w = 37.05[in]*0.44[in] = **16.3**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (22.4[in2] - 0.44[in]*21.54[in])/2 = **6.46**[in2] 8

$A_{nv} = A_{gv}$ = **16.3**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **6.46**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*16.3[in2] + 1*65000[lb/in2]*6.46[in2], 0.6*50000[lb/in2]*16.3[in2] + 1*65000[lb/in2]*6.46[in2]) = **454.5**[kip] Eq. J4-5

Web crippling	[Kip]	396.51	60.07	DL1	0.15	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **37.05**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.44[in]^2*(1 + 3*(37.05[in]/23.9[in])*(0.44[in]/0.68[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.68[in]/0.44[in])$^{1/2}$ = **396.51**[kip] Eq. J10-4

Local web yielding	[Kip]	586.62	60.07	DL	0.10	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **37.05**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)$*(2.5*$k$ + N)*F_{yw}*t_w = 0.667*(2.5*1.18[in] + 37.05[in])*50000[lb/in2]*
0.44[in] = **586.62**[kip] Eq. J10-3

Ratio **0.43**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	29.41	30.91	0.00	0.00	0.00	Design
DL1	-29.41	-30.91	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	9.00	5.85	11.70	✔	p. 10-104
$L_{min} = T/2 = 11.7$[in]$/2 =$ **5.85**[in]						p. 10-104
$L_{max} = L =$ **11.7**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	50.62	42.67	DL	0.84	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 3*16.87$[kip]$*1 =$ **50.62**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	70.84	29.41	DL	0.42	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.375[in]*
65000[lb/in2]*1 = **70.84**[kip] Eq. J3-6

Shear yielding	[Kip]	67.50	29.41	DL	0.44	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.38[in2] = **67.5**[kip] Eq. J4-3

Shear rupture	[Kip]	41.13	29.41	DL	0.72	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.375[in] = **2.11**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.11[in2] = **41.13**[kip] Eq. J4-4

Block shear	[Kip]	51.80	29.41	DL	0.57	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.76**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.76[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*2.81[in2] + 1*65000[lb/
in2]*0.539[in2]) = **51.8**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	64.44	30.91	DL	0.48	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*3 = **64.44**[kip] Eq. J3-6

Tension yielding	[Kip]	101.05	30.91	DL	0.31	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*3.38[in2] = **101.05**[kip] Eq. J4-1

Tension rupture	[Kip]	68.55	30.91	DL	0.45	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (9[in] - 3*1.13[in])*0.375[in] = \mathbf{2.11}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*3.38[in2], 2.11[in2]) = \mathbf{2.11}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*2.11[in2] = \mathbf{68.55}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	66.73	30.91	DL	0.46	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.375[in] = \mathbf{1.41}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*1.41[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*1.41[in2]) = \mathbf{66.73}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	87.42	42.67	DL	0.49	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.86[kip/in]*1*4*9[in] = \mathbf{87.42}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	194.81	30.91	DL1	0.16	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{6}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43[in]^2*(1 + 3*(6[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.67[in]/0.43[in])^{1/2} = \mathbf{194.81}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	114.56	29.41	DL	0.26	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85[in] - 1.06[in]/2) = \mathbf{2.32}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.32[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.5[in]*$
$65000[lb/in2]*1 = \mathbf{114.56}$[kip] Eq. J3-6

Shear yielding	[Kip]	117.03	29.41	DL	0.25	Eq. J4-3

$A_g = L_p*t_p = 11.7[in]*0.5[in] = \mathbf{5.85}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.85[in2] = \mathbf{117.03}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	100.55	30.91	DL	0.31	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*3 = **100.55**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	175.20	30.91	DL	0.18	Eq. J4-1

$A_g = L_p*t_p$ = 11.7[in]*0.5[in] = **5.85**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*5.85[in2] = **175.2**[kip] Eq. J4-1

Tension rupture	[Kip]	135.33	30.91	DL	0.23	Eq. J4-2

$A_g = L_p*t_p$ = 11.7[in]*0.5[in] = **5.85**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (11.7[in] - 3*1.13[in])*0.5[in] = **4.16**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.85[in2], 4.16[in2]) = **4.16**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4.16[in2] = **135.33**[kip] Eq. J4-2

Tear out under axial load	[Kip]	93.84	30.91	DL	0.33	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u*A_{nv}$ + $U_{bs}*F_u*A_{nt}$, 0.6*F_y*A_{gv} + $U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*1.88[in2]) = **93.84**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	43.49	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 42.67[kip]/(0.5*4.86[kip/in]*1*9[in]) = **1.95** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.95/16 [in] = **3.62**[kip/in] p. 9-5

Ratio **0.84**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + 96.88[kip] = **96.88**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 65[kip] - 0[kip] + 60.07[kip] = **125.07**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + 0[kip] + -96.88[kip] = **-96.88**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 65$[kip] - 0[kip] + -60.07[kip] = **4.93**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	125.07	96.88	0.00	0.00	0.00	Design
DL1	4.93	-96.88	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	21.00	10.77	21.54	✔	p. 10-104
$L_{min} = T/2 = 21.54$[in]$/2 =$ **10.77**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.9$[in] - max(1.18[in], 0[in]) - max(1.18[in], 0[in]) = **21.54**[in]						p. 10-49
Thickness	[in]	0.75	--	1.16	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*72.19$[in] = **354.2**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*354.2$[kip*ft]$)/(50000$[lb/in2]$*21$[in]$^2) =$ **1.16**[in]						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.44$[in]$, 12$ [in]$) =$ **10.56**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.44[in], 12 [in]) = **10.56**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.95	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	178.02	158.20	DL	0.89	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*$BoltFactor$ = 10.55*16.87[kip]*1 = **178.02**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	298.92	125.07	DL	0.42	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip]						Eq. J3-6
r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip]						Eq. J3-6
(1/Ω)R_n = (1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*10.55*min(56.67[kip], 113.34[kip]) = **298.92**[kip]						p. 7-18
Shear yielding	[Kip]	315.00	125.07	DL	0.40	Eq. J4-3
A_g = L_p*t_p = 21[in]*0.75[in] = **15.75**[in2]						Sec. D3-1
(1/Ω)R_n = (1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*15.75[in2] = **315**[kip]						Eq. J4-3
Shear rupture	[Kip]	191.95	125.07	DL	0.65	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 21[in] - 7*1.13[in] = **13.13**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 13.13[in]*0.75[in] = **9.84**[in2]						Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*9.84$[in2] = **191.95**[kip] Eq. J4-4

Block shear	[Kip]	218.61	125.07	DL	0.57	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] + (7 - 1)*3[in])*0.75[in] = **14.63**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] + (7 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **9.14**[in2] Sec. J4-3

IsStressUniform → **False**

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000$[lb/in2]$*9.14$[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*14.63[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **218.61**[kip] Eq. J4-5

Flexural rupture	[Kip]	566.72	125.07	DL	0.22	p. 9-6

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75$[in]$/4*(21$[in]$^2 - 3$[in]$^2*7*(7^2 - 1)*1.13$[in]$/21$[in]$) = **52.31**$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*52.31$[in3]$/3$[in] = **566.72**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	453.21	96.88	DL	0.21	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in] - 1.06[in]$/2) =$ **1.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 1.06[in]$) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.47$[in]$*0.75$[in]$*65000$[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.75$[in]$*65000$[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*10.55*\min(85.92$[kip], 113.34[kip]$) =$ **453.21**[kip] p. 7-18

Tension yielding	[Kip]	471.56	96.88	DL	0.21	Eq. J4-1

$A_g = L_p*t_p = 21$[in]$*0.75$[in] = **15.75**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*15.75$[in2] = **471.56**[kip] Eq. J4-1

Tension rupture	[Kip]	319.92	96.88	DL	0.30	Eq. J4-2

$A_g = L_p*t_p = 21$[in]$*0.75$[in] = **15.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (21$[in] - 7*1.13[in]$)*0.75$[in] = **9.84**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*15.75$[in2], 9.84[in2]$) =$ **9.84**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*9.84$[in2] = **319.92**[kip] Eq. J4-2

Tear out under axial load	[Kip]	371.11	96.88	DL	0.26	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 7>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(7 - 1)*0.75[in] = **8.44**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*4.97$[in2] + 1*65000[lb/in2]*8.44[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*8.44[in2]) = **371.11**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	386.55	158.20	DL	0.41	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.6$[kip/in]*1*8*21[in] = **386.55**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	183.25	31.27	DL	0.17	p. 10-103

$A_g = L_p*t_p = 21$[in]*0.75[in] = **15.75**[in2] Sec. D3-1

$f_v = V/A_g = 125.07$[kip]/15.75[in2] = **7940.67**[lb/in2] p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000$[lb/in2])$^2 - 3*7940.67$[lb/in2]$^2))^{1/2}$ = **26594.13**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.75$[in]*21[in]$^2/4$ = **82.69**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 26594.13$[lb/in2]*82.69[in3] = **183.25**[kip*ft] p. 10-103

Web crippling	[Kip]	362.11	96.88	DL1	0.27	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **18**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43$[in]$^2*(1 + 3*(18$[in]$/12.3$[in])$*(0.43$[in]$/0.67$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.67[in]$/0.43$[in]$)^{1/2}$ = **362.11**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	350.74	125.07	DL	0.36	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \max(0.0, L_e - d_h/2) = \max(0.0, 2.95$[in] - 1.06[in]/2) = **2.42**[in] Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - d_h) = \max(0.0, 3$[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.42$[in]*0.44[in]*65000[lb/in2], 2.4*1[in]*0.44[in]*65000[lb/in2]) = **68.64**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]*0.44[in]*65000[lb/in2], 2.4*1[in]*0.44[in]*65000[lb/in2]) = **66.5**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*10.55*\min(68.64$[kip], 66.5[kip]) = **350.74**[kip] p. 7-18

Shear yielding	[Kip]	210.32	125.07	DL	0.59	Eq. J4-3

$A_g = L_p*t_p = 23.9$[in]*0.44[in] = **10.52**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]*10.52[in2] = **210.32**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	439.19	96.88	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.44[in]*
65000[lb/in2]*7 = **439.19**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	670.66	96.88	DL	0.14	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*22.4[in2] = **670.66**[kip] Eq. D2-1

Tension rupture	[Kip]	483.06	96.88	DL	0.20	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 22.4[in2] - 7*0.44[in]*1.13[in] = **18.94**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.29[in]/6[in] = **0.785** Table D3.1

A_e = U*A_n = 0.785*18.94[in2] = **14.86**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*14.86[in2] = **483.06**[kip] Eq. J4-2

Tear out under axial load	[Kip]	222.01	96.88	DL	0.44	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 7>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.44[in] = **4.62**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.44[in] = **3.14**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(7 - 1)*0.44[in] = **4.95**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.14[in2] + 1*65000[lb/in2]*4.95[in2], 0.6*50000[lb/in2]*4.62[in2] + 1*65000[lb/in2]*4.95[in2]) = **222.01**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	72.93	DL	0.23	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

D_{min} = P/(($1/\Omega$)*C*C_1*L) = 158.2[kip]/(0.5*4.6[kip/in]*1*21[in]) = **3.27** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*3.27/16 [in] = **6.08**[kip/in] p. 9-5

Ratio **0.89**

Global critical strength ratio **0.89**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-5**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W24x76

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	85.00	0.00	0.00	0.00	Design
DL1	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	-85.00	0.00	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
85.00	DL	Design
-85.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	85.00	DL	0.46	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.64	85.00	DL	0.26	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.465$[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.64**[kip]						Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	85.00	DL	0.44	Eq. J4-4
$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]						
$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	287.50	85.00	DL	0.30	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$)$ = **10**[in]						
$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv}$ = **10.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = $0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip]						Eq. J4-5

Ratio	**0.46**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	85.00	DL	0.23	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	262.25	85.00	DL	0.32	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 13.5[in2] - 2*(0.5[in] + 1/8\ [in])*0.465[in] = \mathbf{12.92}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/10[in] = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 12.92[in2]*0.7 = \mathbf{9.04}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*9.04[in2] = \mathbf{262.25}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	267.75	85.00	DL	0.32	Eq. J4-1

$A_g = L_w*t_p = 17.89[in]*0.5[in] = \mathbf{8.94}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.94[in2] = \mathbf{267.75}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	230.47	85.00	DL1	0.37	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*10.27[in]/0.144[in])^2 = \mathbf{1.34E+05}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.34E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/1.34E+05[lb/in2])}*50000[lb/in2] =$

42763.93[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*42763.93[lb/in2]*9[in2] = \mathbf{230.47}[kip]$ Eq. E3-1

Ratio **0.37**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.17}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.17[in] + 11.95[in])*1.43 - 6.25[in] = \mathbf{16.77}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((16.77[in] + 6.25[in])^2 + (4.17[in] +$
$11.95[in])^2)^{1/2} = \mathbf{28.1}[in]$ p. 13-5

$H_b = \alpha*P/r = 16.77[in]*85[kip]/28.1[in] = \mathbf{50.72}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*85[kip]/28.1[in] = \mathbf{18.91}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*85[kip]/28.1[in] - 0[kip] = \mathbf{36.15}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.17[in]*85[kip]/28.1[in] + 0[kip] = \mathbf{12.6}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(36.15[kip]*(16.77[in] - 16.77[in])) +$
$abs(0[kip]*16.77[in]) = \mathbf{8.03E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(18.91[kip]*(4.17[in] - 4.17[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.17}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.17[in] + 11.95[in])*1.43 - 6.25[in] = \mathbf{16.77}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((16.77[in] + 6.25[in])^2 + (4.17[in] +$
$11.95[in])^2)^{1/2} = \mathbf{28.1}[in]$ p. 13-5

$H_b = \alpha*P/r = 16.77[in]*-85[kip]/28.1[in] = \mathbf{-50.72}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*-85[kip]/28.1[in] = \mathbf{-18.91}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*-85[kip]/28.1[in] - 0[kip] = \mathbf{-36.15}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.17[in]*-85[kip]/28.1[in] + 0[kip] = \mathbf{-12.6}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-36.15[kip]*(16.77[in] - 16.77[in])) +
abs(0[kip]*16.77[in]) = **8.03E-15**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-18.91[kip]*(4.17[in] - 4.17[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	50.72	36.15	0.00	0.00	0.00	0.00	Design
DL1	-50.72	-36.15	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	479.52	36.15	DL	0.08	Eq. J4-1
A_g = L_p*t_p = 32.03[in]*0.5[in] = **16.02**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*16.02[in2] = **479.52**[kip]						Eq. J4-1
Shear yielding	[Kip]	320.32	50.72	DL	0.16	Eq. J4-3
A_g = L_p*t_p = 32.03[in]*0.5[in] = **16.02**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*16.02[in2] = **320.32**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	325041.60	DL	0.08	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 36.15[kip]/(0.5[in]*32.03[in]) = **2257.23**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	456032.10	DL	0.16	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 50.72[kip]/(0.5[in]*32.03[in]) = **3166.89**[lb/in2]						9
Weld capacity	[Kip]	290.40	77.86	DL	0.27	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.27[kip/in]*1*4*32.03[in]) = **290.4**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 36.15[kip]/32.03[in] = **1.13**[kip/in]						9
f_{uv} = H_b/l = 50.72[kip]/32.03[in] = **1.58**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 8.03E-15[kip*ft]/(32.03[in]^2/6) = **5.63E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((1.13[kip/in] + 5.63E-16[kip/in])^2 + 1.58[kip/in]^2)$^{1/2}$ = **1.94**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((1.13[kip/in] - 5.63E-16[kip/in])^2 + 1.58[kip/in]^2)$^{1/2}$ + ((1.13[kip/in] + 5.63E-16[kip/in])^2 + 1.58[kip/in]^2)$^{1/2}$) = **1.94**[kip/in]						9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve}) = 32.03\text{[in]}*\max(1.94\text{[kip/in]}, 1.25*1.94\text{[kip/in]}) = \mathbf{77.86}\text{[kip]}$ 9

Beam

Weld block shear	[Kip]	421.40	50.72	DL	0.12	Eq. J4-5

$A_{gv} = l*t_w = 32.03\text{[in]}*0.44\text{[in]} = \mathbf{14.09}\text{[in2]}$ Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2 = (22.4\text{[in2]} - 0.44\text{[in]}*21.54\text{[in]})/2 = \mathbf{6.46}\text{[in2]}$ 8

$A_{nv} = A_{gv} = \mathbf{14.09}\text{[in2]}$ Sec. J4.3

$A_{nt} = A_{gt} = \mathbf{6.46}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000\text{[lb/in2]}*14.09\text{[in2]} + 1*65000\text{[lb/in2]}*6.46\text{[in2]}, 0.6*50000\text{[lb/in2]}*14.09\text{[in2]} + 1*$
$65000\text{[lb/in2]}*6.46\text{[in2]}) = \mathbf{421.4}\text{[kip]}$ Eq. J4-5

Web crippling	[Kip]	358.53	36.15	DL1	0.10	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{32.03}\text{[in]}$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.44\text{[in]}^2*(1 + 3*(32.03\text{[in]}/23.9\text{[in]})*(0.44\text{[in]}/0.68\text{[in]})^{1.5})*(2.90E+07\text{[lb/in2]}*50000\text{[lb/in2]}*$
$0.68\text{[in]}/0.44\text{[in]})^{1/2} = \mathbf{358.53}\text{[kip]}$ Eq. J10-4

Local web yielding	[Kip]	513.06	36.15	DL	0.07	Eq. J10-3

IsBeamReaction → **False**

$N = N = \mathbf{32.03}\text{[in]}$ Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w = 0.667*(2.5*1.18\text{[in]} + 32.03\text{[in]})*50000\text{[lb/in2]}*$
$0.44\text{[in]} = \mathbf{513.06}\text{[kip]}$ Eq. J10-3

Ratio **0.27**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	12.60	18.91	0.00	0.00	0.00	Design
DL1	-12.60	-18.91	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.00	4.17	8.33	✔	p. 10-104

L_{min} = T/2 = 8.33[in]/2 = **4.17**[in] p. 10-104

L_{max} = L = **8.33**[in]

Thickness	[in]	0.38	--	0.56	✔	p. 10-102

t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in] p. 10-102

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.67	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101

w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	22.72	DL	0.67	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*$BoltFactor$ = 2*16.87[kip]*1 = **33.75**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	12.60	DL	0.30	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	12.60	DL	0.28	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	12.60	DL	0.46	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	12.60	DL	0.33	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	18.91	DL	0.44	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	18.91	DL	0.28	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	18.91	DL	0.41	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6\text{[in]} - 2*1.13\text{[in]})*0.375\text{[in]} = \mathbf{1.41}\text{[in2]}$ Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25\text{[in2]}, 1.41\text{[in2]}) = \mathbf{1.41}\text{[in2]}$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*1.41\text{[in2]} = \mathbf{45.7}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	43.88	18.91	DL	0.43	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2\text{[in]} + (1 - 1)*3\text{[in]})*0.375\text{[in]} = \mathbf{1.5}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 - 0.5))*0.375\text{[in]} = \mathbf{1.08}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(2 - 1)*0.375\text{[in]} = \mathbf{0.703}\text{[in2]}$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000\text{[lb/in2]}*1.08\text{[in2]} + 1*65000\text{[lb/in2]}*0.703\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.5\text{[in2]} + 1*65000\text{[lb/in2]}*0.703\text{[in2]}) = \mathbf{43.88}\text{[kip]}$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	61.45	22.72	DL	0.37	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*5.12\text{[kip/in]}*1*4*6\text{[in]} = \mathbf{61.45}\text{[kip]}$ Tables 8-4 .. 8-11

Web crippling	[Kip]	218.69	18.91	DL1	0.09	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{3}\text{[in]}$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.515\text{[in]}^2*(1 + 3*(3\text{[in]}/12.5\text{[in]})*(0.515\text{[in]}/0.81\text{[in]})^{1.5})*(2.90E+07\text{[lb/in2]}*50000\text{[lb/in2]}*0.81\text{[in]}/0.515\text{[in]})^{1/2} = \mathbf{218.69}\text{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	12.60	DL	0.16	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.67\text{[in]} - 1.06\text{[in]}/2) = \mathbf{2.13}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*2.13\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(2 - 1))*0.5\text{[in]}*65000\text{[lb/in2]}*1 = \mathbf{76.78}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	83.32	12.60	DL	0.15	Eq. J4-3

$A_g = L_p*t_p = 8.33\text{[in]}*0.5\text{[in]} = \mathbf{4.17}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*4.17\text{[in2]} = \mathbf{83.32}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	18.91	DL	0.25	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.97}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*1.97\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(1 - 1))*0.5\text{[in]}*$

65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	124.73	18.91	DL	0.15	Eq. J4-1

$A_g = L_p*t_p$ = 8.33[in]*0.5[in] = **4.17**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.17[in2] = **124.73**[kip] Eq. J4-1

Tension rupture	[Kip]	98.83	18.91	DL	0.19	Eq. J4-2

$A_g = L_p*t_p$ = 8.33[in]*0.5[in] = **4.17**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.33[in] - 2*1.13[in])*0.5[in] = **3.04**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.17[in2], 3.04[in2]) = **3.04**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.04[in2] = **98.83**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	18.91	DL	0.28	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =

0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	32.94	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 22.72[kip]/(0.5*5.12[kip/in]*1*6[in]) = **1.48** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.48/16 [in] = **2.75**[kip/in] p. 9-5

Ratio **0.67**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 50.72[kip] + 0[kip] = **50.72**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 65[kip] - 36.15[kip] + 0[kip] = **28.85**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + -50.72[kip] + 0[kip] = **-50.72**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 65[kip] - -36.15[kip] + 0[kip] = \mathbf{101.15}[kip]$

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	28.85	50.72	0.00	0.00	0.00	Design
DL1	101.15	-50.72	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	21.00	10.77	21.54	✔	p. 10-104
$L_{min} = T/2 = 21.54[in]/2 = \mathbf{10.77}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.9[in] - \max(1.18[in], 0[in]) - \max(1.18[in], 0[in]) = \mathbf{21.54}[in]$						p. 10-49
Thickness	[in]	0.50	--	1.16	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*72.19[in] = \mathbf{354.2}[kip*ft]$						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*354.2[kip*ft])/(50000[lb/in2]*21[in]^2) = \mathbf{1.16}[in]$						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.44[in], 12\ [in]) = \mathbf{10.56}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.44[in], 12\ [in]) = \mathbf{10.56}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	2.95	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	176.32	113.16	DL1	0.64	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 10.45*16.87$[kip]$*1 =$ **176.32**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	197.39	101.15	DL1	0.51	Eq. J3-6, p. 7-18
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in] $- 1.06$[in]$/2) =$ **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*0.969$[in]$*0.5$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **37.78**[kip]						Eq. J3-6
$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.5$[in]$*65000$[lb/in2], $2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **75.56**[kip]						Eq. J3-6
$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*10.45*\min(37.78$[kip], 75.56[kip]$) =$ **197.39**[kip]						p. 7-18
Shear yielding	[Kip]	210.00	101.15	DL1	0.48	Eq. J4-3
$A_g = L_p*t_p = 21$[in]$*0.5$[in] = **10.5**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*10.5$[in2] = **210**[kip]						Eq. J4-3
Shear rupture	[Kip]	127.97	101.15	DL1	0.79	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] = **1.13**[in]						Sec. D3-2
$L_e = L - n*L_h = 21$[in] $- 7*1.13$[in] = **13.13**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 13.13$[in]$*0.5$[in] = **6.56**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*6.56$[in2] = **127.97**[kip]						Eq. J4-4

Block shear	[Kip]	145.74	101.15	DL1	0.69	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (2 - 1)*3[in] - (2 - 0.5)* 1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (7 - 1)*3[in])*0.5[in] = **9.75**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (7 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **6.09**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*6.09[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*9.75[in2] + 0.5* 65000[lb/in2]*1.66[in2]) = **145.74**[kip] Eq. J4-5

Flexural rupture	[Kip]	377.81	101.15	DL1	0.27	p. 9-6

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.5[in]/4*(21[in]^2 - 3[in]^2*7*(7^2 - 1)* 1.13[in]/21[in]) = **34.88**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*34.88[in3]/3[in] = **377.81**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	320.10	50.72	DL	0.16	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u)$ = min(1.2*1.47[in]*0.5[in]*65000[lb/ in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u)$ = min(1.2*1.94[in]*0.5[in]*65000[lb/ in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2})$ = 0.5*11.18*min(57.28[kip], 75.56[kip]) = **320.1**[kip] p. 7-18

Tension yielding	[Kip]	314.37	50.72	DL	0.16	Eq. J4-1

$A_g = L_p*t_p$ = 21[in]*0.5[in] = **10.5**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.5[in2] = **314.37**[kip] Eq. J4-1

Tension rupture	[Kip]	213.28	50.72	DL	0.24	Eq. J4-2

$A_g = L_p*t_p$ = 21[in]*0.5[in] = **10.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (21[in] - 7*1.13[in])*0.5[in] = **6.56**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n)$ = min(0.85*10.5[in2], 6.56[in2]) = **6.56**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*6.56[in2] = **213.28**[kip] Eq. J4-2

Tear out under axial load	[Kip]	247.41	50.72	DL	0.21	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 7>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = \mathbf{5}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = \mathbf{3.31}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(7 - 1)*0.5[in] = \mathbf{5.63}[in2]$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*5.63[in2]) = \mathbf{247.41}[kip]$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	224.14	113.16	DL1	0.50	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.27[kip/in]*1*5*21[in] = \mathbf{224.14}[kip]$ Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	114.20	25.29	DL1	0.22	p. 10-103

$A_g = L_p*t_p = 21[in]*0.5[in] = \mathbf{10.5}[in2]$ Sec. D3-1

$f_v = V/A_g = 101.15[kip]/10.5[in2] = \mathbf{9633.47}[lb/in2]$ p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000[lb/in2])^2 - 3*9633.47[lb/in2]^2))^{1/2} = \mathbf{24859.6}[lb/in2]$ p. 10-103

$Z_x = t_p*L^2/4 = 0.5[in]*21[in]^2/4 = \mathbf{55.13}[in3]$ T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 24859.6[lb/in2]*55.13[in3] = \mathbf{114.2}[kip*ft]$ p. 10-103

Web crippling	[Kip]	511.10	50.72	DL1	0.10	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{18}[in]$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.515[in]^2*(1 + 3*(18[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])^{1/2} = \mathbf{511.1}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	347.40	101.15	DL1	0.29	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - dh/2) = \text{Max}(0.0, 2.95[in] - 1.06[in]/2) = \mathbf{2.42}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - dh) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.42[in]*0.44[in]*65000[lb/in2], 2.4*1[in]*0.44[in]*65000[lb/in2]) = \mathbf{68.64}[kip]$ Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94[in]*0.44[in]*65000[lb/in2], 2.4*1[in]*0.44[in]*65000[lb/in2]) = \mathbf{66.5}[kip]$ Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*10.45*\min(68.64[kip], 66.5[kip]) = \mathbf{347.4}[kip]$ p. 7-18

Shear yielding	[Kip]	210.32	101.15	DL1	0.48	Eq. J4-3

$A_g = L_p*t_p = 23.9[in]*0.44[in] = \mathbf{10.52}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*10.52[in2] = \mathbf{210.32}[kip]$ Eq. J4-3

Bolt bearing under axial load	[Kip]	439.19	50.72	DL	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.44[in]*
65000[lb/in2]*7 = **439.19**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	670.66	50.72	DL	0.08	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*22.4[in2] = **670.66**[kip] Eq. D2-1

Tension rupture	[Kip]	483.06	50.72	DL	0.10	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 22.4[in2] - 7*0.44[in]*1.13[in] = **18.94**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.29[in]/6[in] = **0.785** Table D3.1

A_e = U*A_n = 0.785*18.94[in2] = **14.86**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*14.86[in2] = **483.06**[kip] Eq. J4-2

Tear out under axial load	[Kip]	222.01	50.72	DL	0.23	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 7>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.44[in] = **4.62**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.44[in] = **3.14**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(7 - 1)*0.44[in] = **4.95**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.14[in2] + 1*65000[lb/in2]*4.95[in2], 0.6*50000[lb/in2]*4.62[in2] + 1*65000[lb/in2]*4.95[in2]) = **222.01**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	56.22	DL1	0.15	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

D_{min} = P/($(1/\Omega)$*C*C_1*L) = 113.16[kip]/(0.5*4.27[kip/in]*1*21[in]) = **2.52** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.52/16 [in] = **4.69**[kip/in] p. 9-5

Ratio **0.79**

Global critical strength ratio **0.79**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-6**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W24X76

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.00	Design
DL1	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-85.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
85.00	DL	Design
-85.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	222.74	85.00	DL	0.38	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	85.00	DL	0.22	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	85.00	DL	0.36	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	85.00	DL	0.27	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) =$ **12**[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.38**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	85.00	DL	0.23	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	85.00	DL	0.30	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 13.5[in2] - 2*(0.5[in] + 1/8\ [in])*0.465[in] = \mathbf{12.92}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/12[in] = \mathbf{0.75}$ Table D3.1

$A_e = A_n*U = 12.92[in2]*0.75 = \mathbf{9.69}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*9.69[in2] = \mathbf{280.98}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	304.79	85.00	DL	0.28	Eq. J4-1

$A_g = L_w*t_p = 20.36[in]*0.5[in] = \mathbf{10.18}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*10.18[in2] = \mathbf{304.79}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	234.30	85.00	DL1	0.36	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*13.32[in]/0.144[in])^2 = \mathbf{79565.8}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 79565.8[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/79565.8[lb/in2])}*50000[lb/in2] =$

38436.27[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*38436.27[lb/in2]*10.18[in2] = \mathbf{234.3}[kip]$ Eq. E3-1

Ratio **0.36**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.82}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.82[in] + 11.95[in])*1.43 - 6.15[in] = \mathbf{19.33}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((19.33[in] + 6.15[in])^2 + (5.82[in] +$
$11.95[in])^2)^{1/2} = \mathbf{31.06}[in]$ p. 13-5

$H_b = \alpha*P/r = 19.33[in]*85[kip]/31.06[in] = \mathbf{52.88}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*85[kip]/31.06[in] = \mathbf{16.83}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*85[kip]/31.06[in] - 0[kip] = \mathbf{32.7}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.82[in]*85[kip]/31.06[in] + 0[kip] = \mathbf{15.93}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(32.7[kip]*(19.33[in] - 19.33[in])) +$
$abs(0[kip]*19.33[in]) = \mathbf{7.26E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(16.83[kip]*(5.82[in] - 5.82[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{5.82}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (5.82[in] + 11.95[in])*1.43 - 6.15[in] = \mathbf{19.33}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((19.33[in] + 6.15[in])^2 + (5.82[in] +$
$11.95[in])^2)^{1/2} = \mathbf{31.06}[in]$ p. 13-5

$H_b = \alpha*P/r = 19.33[in]*-85[kip]/31.06[in] = \mathbf{-52.88}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*-85[kip]/31.06[in] = \mathbf{-16.83}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*-85[kip]/31.06[in] - 0[kip] = \mathbf{-32.7}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 5.82[in]*-85[kip]/31.06[in] + 0[kip] = \mathbf{-15.93}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-32.7[kip]*(19.33[in] - 19.33[in])) + abs(0[kip]*19.33[in]) = **7.26E-15**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-16.83[kip]*(5.82[in] - 5.82[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	52.88	32.70	0.00	0.00	0.00	0.00	Design
DL1	-52.88	-32.70	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	556.16	32.70	DL	0.06	Eq. J4-1
A_g = L_p*t_p = 37.15[in]*0.5[in] = **18.58**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*18.58[in2] = **556.16**[kip]						Eq. J4-1
Shear yielding	[Kip]	371.51	52.88	DL	0.14	Eq. J4-3
A_g = L_p*t_p = 37.15[in]*0.5[in] = **18.58**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*18.58[in2] = **371.51**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	253498.30	DL	0.06	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 32.7[kip]/(0.5[in]*37.15[in]) = **1760.4**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	409959.40	DL	0.14	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 52.88[kip]/(0.5[in]*37.15[in]) = **2846.94**[lb/in2]						9
Weld capacity	[Kip]	328.44	77.72	DL	0.24	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.21[kip/in]*1*4*37.15[in]) = **328.44**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 32.7[kip]/37.15[in] = **0.88**[kip/in]						9
f_{uv} = H_b/l = 52.88[kip]/37.15[in] = **1.42**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 7.26E-15[kip*ft]/(37.15[in]^2/6) = **3.79E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.88[kip/in] + 3.79E-16[kip/in])^2 + 1.42[kip/in]^2)$^{1/2}$ = **1.67**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.88[kip/in] - 3.79E-16[kip/in])^2 + 1.42[kip/in]^2)$^{1/2}$ + ((0.88[kip/in] + 3.79E-16[kip/in])^2 + 1.42[kip/in]^2)$^{1/2}$) = **1.67**[kip/in]						9

$f_{uWeld} = l^*\max(f_{uPeak}, 1.25^*f_{uAve}) = 37.15\text{[in]}^*\max(1.67\text{[kip/in]}, 1.25^*1.67\text{[kip/in]}) = \mathbf{77.72}\text{[kip]}$ 9

Beam

Weld block shear	[Kip]	455.19	52.88	DL	0.12	Eq. J4-5

$A_{gv} = l^*t_w = 37.15\text{[in]}^*0.44\text{[in]} = \mathbf{16.35}\text{[in2]}$ Sec. J4.3

$A_{gt} = (A_g - t_w^*T)/2 = (22.4\text{[in2]} - 0.44\text{[in]}^*21.54\text{[in]})/2 = \mathbf{6.46}\text{[in2]}$ 8

$A_{nv} = A_{gv} = \mathbf{16.35}\text{[in2]}$ Sec. J4.3

$A_{nt} = A_{gt} = \mathbf{6.46}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)^*\min(0.6^*F_u^*A_{nv} + U_{bs}^*F_u^*A_{nt}, 0.6^*F_y^*A_{gv} + U_{bs}^*F_u^*A_{nt}) =$
$0.5^*\min(0.6^*65000\text{[lb/in2]}^*16.35\text{[in2]} + 1^*65000\text{[lb/in2]}^*6.46\text{[in2]}, 0.6^*50000\text{[lb/in2]}^*16.35\text{[in2]} + 1^*$
$65000\text{[lb/in2]}^*6.46\text{[in2]}) = \mathbf{455.19}\text{[kip]}$ Eq. J4-5

Web crippling	[Kip]	397.30	32.70	DL1	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{37.15}\text{[in]}$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)^*0.80^*t_w^{2*}(1 + 3^*(N/d)^*(t_w/t_f)^{1.5})^*(E^*F_{yw}^*t_f/t_w)^{1/2} = 0.5^*$
$0.80^*0.44\text{[in]}^{2*}(1 + 3^*(37.15\text{[in]}/23.9\text{[in]})^*(0.44\text{[in]}/0.68\text{[in]})^{1.5})^*(2.90E+07\text{[lb/in2]}^*50000\text{[lb/in2]}^*$
$0.68\text{[in]}/0.44\text{[in]})^{1/2} = \mathbf{397.3}\text{[kip]}$ Eq. J10-4

Local web yielding	[Kip]	588.15	32.70	DL	0.06	Eq. J10-3

IsBeamReaction → **False**

$N = N = \mathbf{37.15}\text{[in]}$ Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)^*(2.5^*k + N)^*F_{yw}^*t_w = 0.667^*(2.5^*1.18\text{[in]} + 37.15\text{[in]})^*50000\text{[lb/in2]}^*$
$0.44\text{[in]} = \mathbf{588.15}\text{[kip]}$ Eq. J10-3

Ratio **0.24**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.93	16.83	0.00	0.00	0.00	Design
DL1	-15.93	-16.83	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	9.00	5.82	11.64	✔	p. 10-104

L_{min} = T/2 = 11.64[in]/2 = **5.82**[in] p. 10-104

L_{max} = L = **11.64**[in]

Thickness	[in]	0.38	--	0.56	✔	p. 10-102

t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in] p. 10-102

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5

s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in] Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.82	1.25	--	✔	Tables J3.4, J3.5

L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in] Tables J3.4, J3.5

Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102

L_{emin} = 2*d = 2*1[in] = **2**[in] p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101

w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195** p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	50.62	23.17	DL	0.46	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (3>=10) and (3<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*$BoltFactor$ = 3*16.87[kip]*1 = **50.62**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	70.84	15.93	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.375[in]*
65000[lb/in2]*1 = **70.84**[kip] Eq. J3-6

Shear yielding	[Kip]	67.50	15.93	DL	0.24	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.38[in2] = **67.5**[kip] Eq. J4-3

Shear rupture	[Kip]	41.13	15.93	DL	0.39	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.375[in] = **2.11**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*2.11[in2] = **41.13**[kip] Eq. J4-4

Block shear	[Kip]	51.80	15.93	DL	0.31	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.375[in] = **2.81**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.76**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.76[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*2.81[in2] + 1*65000[lb/in2]*0.539[in2]) = **51.8**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	64.44	16.83	DL	0.26	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*3 = **64.44**[kip] Eq. J3-6

Tension yielding	[Kip]	101.05	16.83	DL	0.17	Eq. J4-1

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*3.38[in2] = **101.05**[kip] Eq. J4-1

Tension rupture	[Kip]	68.55	16.83	DL	0.25	Eq. J4-2

A_g = L_p*t_p = 9[in]*0.375[in] = **3.38**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (9[in] - 3*1.13[in])*0.375[in] = \mathbf{2.11}[in2]$ Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*3.38[in2], 2.11[in2]) = \mathbf{2.11}[in2]$ Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*2.11[in2] = \mathbf{68.55}[kip]$ Eq. J4-2

Tear out under axial load	[Kip]	66.73	16.83	DL	0.25	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$n>1 \rightarrow 3>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(3 - 1)*0.375[in] = \mathbf{1.41}[in2]$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*1.41[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*1.41[in2]) = \mathbf{66.73}[kip]$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	87.50	23.17	DL	0.26	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.86[kip/in]*1*4*9[in] = \mathbf{87.5}[kip]$ Tables 8-4 .. 8-11

Web crippling	[Kip]	194.81	16.83	DL1	0.09	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{6}[in]$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.43[in]^2*(1 + 3*(6[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.67[in]/0.43[in])^{1/2} = \mathbf{194.81}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	114.56	15.93	DL	0.14	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.82[in] - 1.06[in]/2) = \mathbf{2.29}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*2.29[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.5[in]*65000[lb/in2]*1 = \mathbf{114.56}[kip]$ Eq. J3-6

Shear yielding	[Kip]	116.44	15.93	DL	0.14	Eq. J4-3

$A_g = L_p*t_p = 11.64[in]*0.5[in] = \mathbf{5.82}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*5.82[in2] = \mathbf{116.44}[kip]$ Eq. J4-3

Bolt bearing under axial load	[Kip]	115.17	16.83	DL	0.15	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5[in] - 1.06[in]/2) = \mathbf{1.97}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*1.97[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*$

65000[lb/in2]*3 = **115.17**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	174.31	16.83	DL	0.10	Eq. J4-1

$A_g = L_p*t_p$ = 11.64[in]*0.5[in] = **5.82**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*5.82[in2] = **174.31**[kip] Eq. J4-1

Tension rupture	[Kip]	134.37	16.83	DL	0.13	Eq. J4-2

$A_g = L_p*t_p$ = 11.64[in]*0.5[in] = **5.82**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (11.64[in] - 3*1.13[in])*0.5[in] = **4.13**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*5.82[in2], 4.13[in2]) = **4.13**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4.13[in2] = **134.37**[kip] Eq. J4-2

Tear out under axial load	[Kip]	98.44	16.83	DL	0.17	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 3>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(3 - 1)*0.5[in] = **1.88**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*1.88[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*1.88[in2]) = **98.44**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	23.60	DL	0.08	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 23.17[kip]/(0.5*4.86[kip/in]*1*9[in]) = **1.06** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.06/16 [in] = **1.97**[kip/in] p. 9-5

Ratio **0.46**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + 52.88[kip] = **52.88**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 65[kip] - 0[kip] + 32.7[kip] = **97.7**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + -52.88[kip] = **-52.88**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 65[kip] - 0[kip] + -32.7[kip] = \mathbf{32.3}[kip]$

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	97.70	52.88	0.00	0.00	0.00	Design
DL1	32.30	-52.88	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.00	10.77	21.54	✔	p. 10-104
$L_{min} = T/2 = 21.54[in]/2 = \mathbf{10.77}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.9[in] - \max(1.18[in], 0[in]) - \max(1.18[in], 0[in]) = \mathbf{21.54}[in]$						p. 10-49
Thickness	[in]	0.50	--	1.18	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*54.17[in] = \mathbf{265.76}[kip*ft]$						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*265.76[kip*ft])/(50000[lb/in2]*18[in]^2) = \mathbf{1.18}[in]$						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.44[in], 12\ [in]) = \mathbf{10.56}[in]$						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.44[in], 12\ [in]) = \mathbf{10.56}[in]$						Sec. J3.5

Beam

Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	142.39	111.10	DL	0.78	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 8.44*16.87$[kip]$*1 =$ **142.39**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	159.40	97.70	DL	0.61	Eq. J3-6, p. 7-18
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in] $- 1.06$[in]$/2) =$ **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*0.969$[in]$*0.5$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **37.78**[kip]						Eq. J3-6
$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.5$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.5$[in]$*65000$[lb/in2]$) =$ **75.56**[kip]						Eq. J3-6
$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*8.44*\min(37.78$[kip]$, 75.56$[kip]$) =$ **159.4**[kip]						p. 7-18
Shear yielding	[Kip]	180.00	97.70	DL	0.54	Eq. J4-3
$A_g = L_p*t_p = 18$[in]$*0.5$[in] = **9**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*9$[in2] = **180**[kip]						Eq. J4-3
Shear rupture	[Kip]	109.69	97.70	DL	0.89	Eq. J4-4
$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $=$ **1.13**[in]						Sec. D3-2
$L_e = L - n*L_h = 18$[in] $- 6*1.13$[in] $=$ **11.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p = 11.25$[in]$*0.5$[in] = **5.63**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*5.63$[in2] = **109.69**[kip]						Eq. J4-4

Block shear	[Kip]	127.46	97.70	DL	0.77	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (2 - 1)*3[in] - (2 - 0.5)* 1.13[in])*0.5[in] = **1.66**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (6 - 1)*3[in])*0.5[in] = **8.25**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (6 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **5.16**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*5.16[in2] + 0.5*65000[lb/in2]*1.66[in2], 0.6*50000[lb/in2]*8.25[in2] + 0.5* 65000[lb/in2]*1.66[in2]) = **127.46**[kip] Eq. J4-5

Flexural rupture	[Kip]	278.79	97.70	DL	0.35	p. 9-6

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L)$ = 0.5[in]/4*(18[in]^2 - 3[in]^2*6*(6^2 - 1)* 1.13[in]/18[in]) = **25.73**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e$ = 0.5*65000[lb/in2]*25.73[in3]/3[in] = **278.79**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	241.67	52.88	DL	0.22	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u)$ = min(1.2*1.47[in]*0.5[in]*65000[lb/ in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **57.28**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u)$ = min(1.2*1.94[in]*0.5[in]*65000[lb/ in2], 2.4*1[in]*0.5[in]*65000[lb/in2]) = **75.56**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2})$ = 0.5*8.44*min(57.28[kip], 75.56[kip]) = **241.67**[kip] p. 7-18

Tension yielding	[Kip]	269.46	52.88	DL	0.20	Eq. J4-1

$A_g = L_p*t_p$ = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9[in2] = **269.46**[kip] Eq. J4-1

Tension rupture	[Kip]	182.81	52.88	DL	0.29	Eq. J4-2

$A_g = L_p*t_p$ = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (18[in] - 6*1.13[in])*0.5[in] = **5.63**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n)$ = min(0.85*9[in2], 5.63[in2]) = **5.63**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*5.63[in2] = **182.81**[kip] Eq. J4-2

Tear out under axial load	[Kip]	216.94	52.88	DL	0.24	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.5[in] = \mathbf{5}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.5[in] = \mathbf{3.31}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.5[in] = \mathbf{4.69}[in2]$ Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*3.31[in2] + 1*65000[lb/in2]*4.69[in2], 0.6*50000[lb/in2]*5[in2] + 1*65000[lb/in2]*4.69[in2]) = \mathbf{216.94}[kip]$ Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	194.49	111.10	DL	0.57	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.32[kip/in]*1*5*18[in] = \mathbf{194.49}[kip]$ Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	78.64	24.43	DL	0.31	p. 10-103

$A_g = L_p*t_p = 18[in]*0.5[in] = \mathbf{9}[in2]$ Sec. D3-1

$f_v = V/A_g = 97.7[kip]/9[in2] = \mathbf{10855.63}[lb/in2]$ p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000[lb/in2])^2 - 3*10855.63[lb/in2]^2))^{1/2} = \mathbf{23299.72}[lb/in2]$ p. 10-103

$Z_x = t_p*L^2/4 = 0.5[in]*18[in]^2/4 = \mathbf{40.5}[in3]$ T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 23299.72[lb/in2]*40.5[in3] = \mathbf{78.64}[kip*ft]$ p. 10-103

Web crippling	[Kip]	320.28	52.88	DL1	0.17	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{15}[in]$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.43[in]^2*(1 + 3*(15[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.67[in]/0.43[in])^{1/2} = \mathbf{320.28}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	280.55	97.70	DL	0.35	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \max(0.0, L_e - dh/2) = \max(0.0, 4.45[in] - 1.06[in]/2) = \mathbf{3.92}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - dh) = \max(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*3.92[in]*0.44[in]*65000[lb/in2], 2.4*1[in]*0.44[in]*65000[lb/in2]) = \mathbf{68.64}[kip]$ Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94[in]*0.44[in]*65000[lb/in2], 2.4*1[in]*0.44[in]*65000[lb/in2]) = \mathbf{66.5}[kip]$ Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*8.44*\min(68.64[kip], 66.5[kip]) = \mathbf{280.55}[kip]$ p. 7-18

Shear yielding	[Kip]	210.32	97.70	DL	0.46	Eq. J4-3

$A_g = L_p*t_p = 23.9[in]*0.44[in] = \mathbf{10.52}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*10.52[in2] = \mathbf{210.32}[kip]$ Eq. J4-3

Bolt bearing under axial load	[Kip]	376.45	52.88	DL	0.14	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.44[in]*
65000[lb/in2]*6 = **376.45**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	670.66	52.88	DL	0.08	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*22.4[in2] = **670.66**[kip] Eq. D2-1

Tension rupture	[Kip]	495.69	52.88	DL	0.11	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 22.4[in2] - 6*0.44[in]*1.13[in] = **19.43**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.29[in]/6[in] = **0.785** Table D3.1

A_e = U*A_n = 0.785*19.43[in2] = **15.25**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*15.25[in2] = **495.69**[kip] Eq. J4-2

Tear out under axial load	[Kip]	195.20	52.88	DL	0.27	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.44[in] = **4.62**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.44[in] = **3.14**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.44[in] = **4.13**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.14[in2] + 1*65000[lb/in2]*4.13[in2], 0.6*50000[lb/in2]*4.62[in2] + 1*65000[lb/in2]*4.13[in2]) = **195.2**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	63.62	DL	0.20	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

D_{min} = P/($(1/\Omega)$*C*C_1*L) = 111.1[kip]/(0.5*4.32[kip/in]*1*18[in]) = **2.86** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*(2)$^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*(2)$^{1/2}$/2*2.86/16 [in] = **5.3**[kip/in] p. 9-5

Ratio **0.89**

Global critical strength ratio **0.89**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-7**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W24x76

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	0.00	0.00	0.00	Design
DL1	0.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	-36.00	0.00	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
36.00	DL	Design
-36.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	36.00	DL	0.24	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	194.32	36.00	DL	0.19	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.349$[in] = **5.58**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.58$[in2]$)$ = **194.32**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	36.00	DL	0.23	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	257.50	36.00	DL	0.14	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2], 0.6$*50000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2]$) =$ **257.5**[kip] — Eq. J4-5

Ratio	**0.24**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	286.47	36.00	DL	0.13	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip]						Eq. J4-1
Tension rupture	[Kip]	180.59	36.00	DL	0.20	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 10.4[in2] - 2*(0.5[in] + 1/8\ [in])*0.349[in] = \mathbf{9.96}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/8[in] = \mathbf{0.625}$ Table D3.1

$A_e = A_n*U = 9.96[in2]*0.625 = \mathbf{6.23}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*6.23[in2] = \mathbf{180.59}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	246.64	36.00	DL	0.15	Eq. J4-1

$A_g = L_w*t_p = 16.48[in]*0.5[in] = \mathbf{8.24}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.24[in2] = \mathbf{246.64}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	196.00	36.00	DL1	0.18	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*12.45[in]/0.144[in])^2 = \mathbf{91047.57}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 91047.57[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/91047.57[lb/in2])}*50000[lb/in2] =$

39732.54[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*39732.54[lb/in2]*8.24[in2] = \mathbf{196}[kip]$ Eq. E3-1

Ratio **0.20**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.47}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.47[in] + 11.95[in])*1.37 - 6.25[in] = \mathbf{16.19}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((16.19[in] + 6.25[in])^2 + (4.47[in] +$

$11.95[in])^2)^{1/2} = \mathbf{27.81}[in]$ p. 13-5

$H_b = \alpha*P/r = 16.19[in]*36[kip]/27.81[in] = \mathbf{20.96}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*36[kip]/27.81[in] = \mathbf{8.09}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*36[kip]/27.81[in] - 0[kip] = \mathbf{15.47}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.47[in]*36[kip]/27.81[in] + 0[kip] = \mathbf{5.79}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(15.47[kip]*(16.19[in] - 16.19[in])) +$

$abs(0[kip]*16.19[in]) = \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(8.09[kip]*(4.47[in] - 4.47[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.47}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.47[in] + 11.95[in])*1.37 - 6.25[in] = \mathbf{16.19}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((16.19[in] + 6.25[in])^2 + (4.47[in] +$

$11.95[in])^2)^{1/2} = \mathbf{27.81}[in]$ p. 13-5

$H_b = \alpha*P/r = 16.19[in]*-36[kip]/27.81[in] = \mathbf{-20.96}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*-36[kip]/27.81[in] = \mathbf{-8.09}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.95[in]*-36[kip]/27.81[in] - 0[kip] = \mathbf{-15.47}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.47[in]*-36[kip]/27.81[in] + 0[kip] = \mathbf{-5.79}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-15.47[kip]*(16.19[in] - 16.19[in])) + abs(0[kip]*16.19[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-8.09[kip]*(4.47[in] - 4.47[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	20.96	15.47	0.00	0.00	0.00	0.00	Design
DL1	-20.96	-15.47	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	462.22	15.47	DL	0.03	Eq. J4-1
A_g = L_p*t_p = 30.88[in]*0.5[in] = **15.44**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*15.44[in2] = **462.22**[kip]						Eq. J4-1
Shear yielding	[Kip]	308.76	20.96	DL	0.07	Eq. J4-3
A_g = L_p*t_p = 30.88[in]*0.5[in] = **15.44**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*15.44[in2] = **308.76**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	144310.80	DL	0.03	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 15.47[kip]/(0.5[in]*30.88[in]) = **1002.16**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	195492.60	DL	0.07	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 20.96[kip]/(0.5[in]*30.88[in]) = **1357.59**[lb/in2]						9
Weld capacity	[Kip]	281.71	32.56	DL	0.12	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.28[kip/in]*1*4*30.88[in]) = **281.71**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 15.47[kip]/30.88[in] = **0.501**[kip/in]						9
f_{uv} = H_b/l = 20.96[kip]/30.88[in] = **0.679**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 0[kip*ft]/(30.88[in]^2/6) = **0**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.501[kip/in] + 0[kip/in])^2 + 0.679[kip/in]^2)$^{1/2}$ = **0.844**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5*(((0.501[kip/in] - 0[kip/in])^2 + 0.679[kip/in]^2)$^{1/2}$ + ((0.501[kip/in] + 0[kip/in])^2 + 0.679[kip/in]^2)$^{1/2}$) = **0.844**[kip/in]						9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve}) = 30.88[in]*\max(0.844[kip/in], 1.25*0.844[kip/in]) =$
32.56[kip] 9

Beam

Weld block shear	[Kip]	413.77	20.96	DL	0.05	Eq. J4-5

$A_{gv} = l*t_w = 30.88[in]*0.44[in] =$ **13.59**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2 = (22.4[in2] - 0.44[in]*21.54[in])/2 =$ **6.46**[in2] 8

$A_{nv} = A_{gv} =$ **13.59**[in2] Sec. J4.3

$A_{nt} = A_{gt} =$ **6.46**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*13.59[in2] + 1*65000[lb/in2]*6.46[in2], 0.6*50000[lb/in2]*13.59[in2] + 1*$
$65000[lb/in2]*6.46[in2]) =$ **413.77**[kip] Eq. J4-5

Web crippling	[Kip]	349.78	15.47	DL1	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **30.88**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.44[in]^2*(1 + 3*(30.88[in]/23.9[in])*(0.44[in]/0.68[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.68[in]/0.44[in])^{1/2} =$ **349.78**[kip] Eq. J10-4

Local web yielding	[Kip]	496.12	15.47	DL	0.03	Eq. J10-3

IsBeamReaction → **False**

$N = N =$ **30.88**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w = 0.667*(2.5*1.18[in] + 30.88[in])*50000[lb/in2]*$
$0.44[in] =$ **496.12**[kip] Eq. J10-3

Ratio **0.12**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	5.79	8.09	0.00	0.00	0.00	Design
DL1	-5.79	-8.09	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	6.00	4.47	8.94	✔	p. 10-104
$L_{min} = T/2 = 8.94$[in]$/2 =$ **4.47**[in]						p. 10-104
$L_{max} = L =$ **8.94**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.97	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	33.75	9.95	DL	0.29	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*16.87$[kip]$*1 =$ **33.75**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	5.79	DL	0.14	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	5.79	DL	0.13	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	5.79	DL	0.21	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	5.79	DL	0.15	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	8.09	DL	0.19	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	8.09	DL	0.12	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	8.09	DL	0.18	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6[in] - 2*1.13[in])*0.375[in] =$ **1.41**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25[in2], 1.41[in2]) =$ **1.41**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*1.41[in2] =$ **45.7**[kip] Eq. J4-2

Tear out under axial load	[Kip]	43.88	8.09	DL	0.18	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] =$ **1.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] =$ **1.08**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.375[in] =$ **0.703**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*0.703[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*0.703[in2]) =$ **43.88**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	60.88	9.95	DL	0.16	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*5.07[kip/in]*1*4*6[in] =$ **60.88**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	218.69	8.09	DL1	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **3**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515[in]^2*(1 + 3*(3[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.81[in]/0.515[in])^{1/2} =$ **218.69**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	5.79	DL	0.08	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.97[in] - 1.06[in]/2) =$ **2.44**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.44[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*$
$65000[lb/in2]*1 =$ **76.78**[kip] Eq. J3-6

Shear yielding	[Kip]	89.45	5.79	DL	0.06	Eq. J4-3

$A_g = L_p*t_p = 8.94[in]*0.5[in] =$ **4.47**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.47[in2] =$ **89.45**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	8.09	DL	0.11	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5[in] - 1.06[in]/2) =$ **1.97**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	133.90	8.09	DL	0.06	Eq. J4-1

$A_g = L_p*t_p$ = 8.94[in]*0.5[in] = **4.47**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.47[in2] = **133.9**[kip] Eq. J4-1

Tension rupture	[Kip]	108.79	8.09	DL	0.07	Eq. J4-2

$A_g = L_p*t_p$ = 8.94[in]*0.5[in] = **4.47**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.94[in] - 2*1.13[in])*0.5[in] = **3.35**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.47[in2], 3.35[in2]) = **3.35**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.35[in2] = **108.79**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	8.09	DL	0.12	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	14.56	DL	0.04	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 9.95[kip]/(0.5*5.07[kip/in]*1*6[in]) = **0.654** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.654/16 [in] = **1.21**[kip/in] p. 9-5

Ratio **0.29**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 20.96[kip] + 0[kip] = **20.96**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 65[kip] - 15.47[kip] + 0[kip] = **49.53**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -20.96[kip] + 0[kip] = \mathbf{-20.96}[kip]$

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 65[kip] - -15.47[kip] + 0[kip] = \mathbf{80.47}[kip]$

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	49.53	20.96	0.00	0.00	0.00	Design
DL1	80.47	-20.96	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.00	10.77	21.54	✔	p. 10-104
$L_{min} = T/2 = 21.54[in]/2 = \mathbf{10.77}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 23.9[in] - \max(1.18[in], 0[in]) - \max(1.18[in], 0[in]) = \mathbf{21.54}[in]$						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 1[in]/2 + 1/16\ [in] = \mathbf{0.563}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	10.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.44[in], 12\ [in]) = \mathbf{10.56}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	101.25	83.16	DL1	0.82	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 6*16.87[kip]*1 = **101.25**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	207.80	80.47	DL1	0.39	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(6 - 1))*0.5[in]*						
65000[lb/in2]*1 = **207.8**[kip]						Eq. J3-6
Shear yielding	[Kip]	180.00	80.47	DL1	0.45	Eq. J4-3
A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9[in2] = **180**[kip]						Eq. J4-3
Shear rupture	[Kip]	109.69	80.47	DL1	0.73	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 18[in] - 6*1.13[in] = **11.25**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 11.25[in]*0.5[in] = **5.63**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*5.63[in2] = **109.69**[kip]						Eq. J4-4
Block shear	[Kip]	123.91	80.47	DL1	0.65	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.5[in] = **8.25**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **5.16**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*5.16[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*8.25[in2] + 1*65000[lb/in2]*0.719[in2]) = **123.91**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	171.84	20.96	DL	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*6 = **171.84**[kip] Eq. J3-6

Tension yielding	[Kip]	269.46	20.96	DL	0.08	Eq. J4-1

A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*9[in2] = **269.46**[kip] Eq. J4-1

Tension rupture	[Kip]	182.81	20.96	DL	0.11	Eq. J4-2

A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (18[in] - 6*1.13[in])*0.5[in] = **5.63**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*9[in2], 5.63[in2]) = **5.63**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*5.63[in2] = **182.81**[kip] Eq. J4-2

Tear out under axial load	[Kip]	180.38	20.96	DL	0.12	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.5[in] = **4.69**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*4.69[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*4.69[in2]) = **180.38**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	177.62	83.16	DL1	0.47	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*3.95[kip/in]*1*5*18[in] = **177.62**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	452.62	20.96	DL1	0.05	Eq. J10-4

IsBeamReaction → **False**

N = N = **15**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515_{[in]}{}^2*(1 + 3*(15_{[in]}/12.5_{[in]})*(0.515_{[in]}/0.81_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*$
$0.81_{[in]}/0.515_{[in]})^{1/2} = \mathbf{452.62}_{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	200.56	80.47	DL1	0.40	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45_{[in]} - 1.06_{[in]}/2) = \mathbf{3.92}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 1.06_{[in]}) = \mathbf{1.94}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.92_{[in]}, 2.4*1_{[in]}) + \min(1.2*1.94_{[in]}, 2.4*1_{[in]})*(6 - 1))*0.44_{[in]}*$
$65000_{[lb/in2]}*1 = \mathbf{200.56}_{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	210.32	80.47	DL1	0.38	Eq. J4-3

$A_g = L_p*t_p = 23.9_{[in]}*0.44_{[in]} = \mathbf{10.52}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*10.52_{[in2]} = \mathbf{210.32}_{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	176.96	20.96	DL	0.12	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25_{[in]} - 1.06_{[in]}/2) = \mathbf{1.72}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 1.06_{[in]}) = \mathbf{1.94}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72_{[in]}, 2.4*1_{[in]}) + \min(1.2*1.94_{[in]}, 2.4*1_{[in]})*(1 - 1))*0.44_{[in]}*$
$65000_{[lb/in2]}*6 = \mathbf{176.96}_{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	670.66	20.96	DL	0.03	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*22.4_{[in2]} = \mathbf{670.66}_{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	359.90	20.96	DL	0.06	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16_{[in]} = 1.06_{[in]} + 1/16_{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 22.4_{[in2]} - 6*0.44_{[in]}*1.13_{[in]} = \mathbf{19.43}_{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 1.29_{[in]}/3_{[in]} = \mathbf{0.57}$ Table D3.1

$A_e = U*A_n = 0.57*19.43_{[in2]} = \mathbf{11.07}_{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000_{[lb/in2]}*11.07_{[in2]} = \mathbf{359.9}_{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	163.02	20.96	DL	0.13	Eq. J4-5

$dh_h = d_h + 1/16_{[in]} = 1.06_{[in]} + 1/16_{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16_{[in]} = 1.06_{[in]} + 1/16_{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25_{[in]} + (1 - 1)*3_{[in]})*0.44_{[in]} = \mathbf{1.98}_{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25_{[in]} + (1 - 1)*3_{[in]} - 1.13_{[in]}*(1 -$
$0.5))*0.44_{[in]} = \mathbf{1.49}_{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3_{[in]} - 1.13_{[in]})*(6 - 1)*0.44_{[in]} = \mathbf{4.13}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000_{[lb/in2]}*1.49_{[in2]} + 1*65000_{[lb/in2]}*4.13_{[in2]}, 0.6*50000_{[lb/in2]}*1.98_{[in2]} + 1*65000_{[lb/}$

in2]*4.13[in2]) = **163.02**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	52.14	DL1	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.81$[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 83.16$[kip]$/(0.5*3.95$[kip/in]$*1*18$[in]$) =$ **2.34** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.34/16$ [in] = **4.34**[kip/in] p. 9-5

Ratio **0.82**

Global critical strength ratio **0.82**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-8**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21X50

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	15.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	Design
DL1	-15.00	65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-36.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
36.00	DL	Design
-36.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	36.00	DL	0.24	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	194.32	36.00	DL	0.19	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.349$[in] = **5.58**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.58$[in2]$)$ = **194.32**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	36.00	DL	0.23	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	257.50	36.00	DL	0.14	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2], 0.6$*50000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2]$) =$ **257.5**[kip] — Eq. J4-5

Ratio	**0.24**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	286.47	36.00	DL	0.13	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip]						Eq. J4-1
Tension rupture	[Kip]	180.59	36.00	DL	0.20	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 10.4[in2] - 2*(0.5[in] + 1/8\ [in])*0.349[in] = \mathbf{9.96}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/8[in] = \mathbf{0.625}$ Table D3.1

$A_e = A_n*U = 9.96[in2]*0.625 = \mathbf{6.23}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*6.23[in2] = \mathbf{180.59}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	240.42	36.00	DL	0.15	Eq. J4-1

$A_g = L_w*t_p = 16.06[in]*0.5[in] = \mathbf{8.03}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.03[in2] = \mathbf{240.42}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	223.02	36.00	DL1	0.16	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*7.83[in]/0.144[in])^2 = \mathbf{2.30E+05}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 2.30E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/2.30E+05[lb/in2])}*50000[lb/in2] =$

45653.39[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*45653.39[lb/in2]*8.16[in2] = \mathbf{223.02}[kip]$ Eq. E3-1

Ratio **0.20**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.03}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.03[in] + 10.4[in])*1.37 - 6.15[in] = \mathbf{13.57}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((13.57[in] + 6.15[in])^2 + (4.03[in] +$

$10.4[in])^2)^{1/2} = \mathbf{24.43}[in]$ p. 13-5

$H_b = \alpha*P/r = 13.57[in]*36[kip]/24.43[in] = \mathbf{19.99}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*36[kip]/24.43[in] = \mathbf{9.06}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*36[kip]/24.43[in] - 0[kip] = \mathbf{15.32}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.03[in]*36[kip]/24.43[in] + 0[kip] = \mathbf{5.94}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(15.32[kip]*(13.57[in] - 13.57[in])) +$

$abs(0[kip]*13.57[in]) = \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.06[kip]*(4.03[in] - 4.03[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.03}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.03[in] + 10.4[in])*1.37 - 6.15[in] = \mathbf{13.57}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((13.57[in] + 6.15[in])^2 + (4.03[in] +$

$10.4[in])^2)^{1/2} = \mathbf{24.43}[in]$ p. 13-5

$H_b = \alpha*P/r = 13.57[in]*-36[kip]/24.43[in] = \mathbf{-19.99}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*-36[kip]/24.43[in] = \mathbf{-9.06}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.4[in]*-36[kip]/24.43[in] - 0[kip] = \mathbf{-15.32}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.03[in]*-36[kip]/24.43[in] + 0[kip] = \mathbf{-5.94}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-15.32[kip]*(13.57[in] - 13.57[in])) +
abs(0[kip]*13.57[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-9.06[kip]*(4.03[in] - 4.03[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	19.99	15.32	0.00	0.00	0.00	0.00	Design
DL1	-19.99	-15.32	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	383.69	15.32	DL	0.04	Eq. J4-1
A_g = L_p*t_p = 25.63[in]*0.5[in] = **12.82**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*12.82[in2] = **383.69**[kip]						Eq. J4-1
Shear yielding	[Kip]	256.31	19.99	DL	0.08	Eq. J4-3
A_g = L_p*t_p = 25.63[in]*0.5[in] = **12.82**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*12.82[in2] = **256.31**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	172191.70	DL	0.04	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 15.32[kip]/(0.5[in]*25.63[in]) = **1195.78**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	224601.10	DL	0.08	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 19.99[kip]/(0.5[in]*25.63[in]) = **1559.73**[lb/in2]						9
Weld capacity	[Kip]	235.46	31.48	DL	0.13	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.3[kip/in]*1*4*25.63[in]) = **235.46**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 15.32[kip]/25.63[in] = **0.598**[kip/in]						9
f_{uv} = H_b/l = 19.99[kip]/25.63[in] = **0.78**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 0[kip*ft]/(25.63[in]^2/6) = **0**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.598[kip/in] + 0[kip/in])^2 + 0.78[kip/in]^2)$^{1/2}$ = **0.983**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.598[kip/in] - 0[kip/in])^2 + 0.78[kip/in]^2)$^{1/2}$ + ((0.598[kip/in] + 0[kip/in])^2 + 0.78[kip/in]^2)$^{1/2}$) = **0.983**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 25.63[in]*max(0.983[kip/in], 1.25*0.983[kip/in]) =
31.48[kip] 9

Beam

Weld block shear	[Kip]	269.37	19.99	DL	0.07	Eq. J4-5

$A_{gv} = l$*t_w = 25.63[in]*0.38[in] = **9.74**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (14.7[in2] - 0.38[in]*18.72[in])/2 = **3.79**[in2] 8

$A_{nv} = A_{gv}$ = **9.74**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.79**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*9.74[in2] + 1*65000[lb/in2]*3.79[in2], 0.6*50000[lb/in2]*9.74[in2] + 1*65000[lb/in2]*3.79[in2]) = **269.37**[kip] Eq. J4-5

Web crippling	[Kip]	265.15	15.32	DL1	0.06	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **25.63**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.38[in]^2*(1 + 3*(25.63[in]/20.8[in])*(0.38[in]/0.535[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.535[in]/0.38[in])$^{1/2}$ = **265.15**[kip] Eq. J10-4

Local web yielding	[Kip]	357.59	15.32	DL	0.04	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **25.63**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)$*(2.5*$k$ + N)*F_{yw}*t_w = 0.667*(2.5*1.04[in] + 25.63[in])*50000[lb/in2]*
0.38[in] = **357.59**[kip] Eq. J10-3

Ratio **0.13**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	5.94	9.06	0.00	0.00	0.00	Design
DL1	-5.94	-9.06	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	6.00	4.03	8.06	✔	p. 10-104
L_{min} = T/2 = 8.06[in]/2 = **4.03**[in]						p. 10-104
L_{max} = L = **8.06**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.53	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	10.83	DL	0.32	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 2*16.87[kip]*1 = **33.75**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	5.94	DL	0.14	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	5.94	DL	0.13	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	5.94	DL	0.22	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	5.94	DL	0.16	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	9.06	DL	0.21	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	9.06	DL	0.13	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	9.06	DL	0.20	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (6[in] - 2*1.13[in])*0.375[in] = **1.41**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*2.25[in2], 1.41[in2]) = **1.41**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*1.41[in2] = **45.7**[kip] Eq. J4-2

Tear out under axial load	[Kip]	43.88	9.06	DL	0.21	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = **1.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = **1.08**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.375[in] = **0.703**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*0.703[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*0.703[in2]) = **43.88**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	61.59	10.83	DL	0.18	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*5.13[kip/in]*1*4*6[in] = **61.59**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	152.99	9.06	DL1	0.06	Eq. J10-4

IsBeamReaction → **False**

N = N = **3**[in] Sec. J10-2

(1/Ω)R_n = *(1/Ω)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ = 0.5*
0.80*0.43[in]^2*(1 + 3*(3[in]/12.3[in])*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.67[in]/0.43[in])$^{1/2}$ = **152.99**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.75	5.94	DL	0.08	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.53[in] - 1.06[in]/2) = **2**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*2[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*
65000[lb/in2]*1 = **76.75**[kip] Eq. J3-6

Shear yielding	[Kip]	80.59	5.94	DL	0.07	Eq. J4-3

A_g = L_p*t_p = 8.06[in]*0.5[in] = **4.03**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.03[in2] = **80.59**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	9.06	DL	0.12	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.5[in] - 1.06[in]/2) = **1.97**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	120.64	9.06	DL	0.08	Eq. J4-1

$A_g = L_p*t_p$ = 8.06[in]*0.5[in] = **4.03**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.03[in2] = **120.64**[kip] Eq. J4-1

Tension rupture	[Kip]	94.40	9.06	DL	0.10	Eq. J4-2

$A_g = L_p*t_p$ = 8.06[in]*0.5[in] = **4.03**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.06[in] - 2*1.13[in])*0.5[in] = **2.9**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.03[in2], 2.9[in2]) = **2.9**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.9[in2] = **94.4**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	9.06	DL	0.13	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	15.67	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 10.83[kip]/(0.5*5.13[kip/in]*1*6[in]) = **0.704** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.704/16 [in] = **1.31**[kip/in] p. 9-5

Ratio **0.32**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 15[kip] + 0[kip] + 19.99[kip] = **34.99**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 65[kip] - 0[kip] + 15.32[kip] = **80.32**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = -15[kip] + 0[kip] + -19.99[kip] = **-34.99**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 65[kip] - 0[kip] + -15.32[kip] = **49.68**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	80.32	34.99	0.00	0.00	0.00	Design
DL1	49.68	-34.99	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.00	9.36	18.72	✔	p. 10-104
$L_{min} = T/2$ = 18.72[in]/2 = **9.36**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.8[in] - max(1.04[in], 0[in]) - max(1.04[in], 0[in]) = **18.72**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2$ + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d$ = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.12	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d$ = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.38[in], 12 [in]) = **9.12**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.90	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	101.25	87.61	DL	0.87	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 6*16.87[kip]*1 = **101.25**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	207.80	80.32	DL	0.39	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(6 - 1))*0.5[in]*						
65000[lb/in2]*1 = **207.8**[kip]						Eq. J3-6
Shear yielding	[Kip]	180.00	80.32	DL	0.45	Eq. J4-3
A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9[in2] = **180**[kip]						Eq. J4-3
Shear rupture	[Kip]	109.69	80.32	DL	0.73	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 18[in] - 6*1.13[in] = **11.25**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 11.25[in]*0.5[in] = **5.63**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*5.63[in2] = **109.69**[kip]						Eq. J4-4
Block shear	[Kip]	123.91	80.32	DL	0.65	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.5[in] = **8.25**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **5.16**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*5.16[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*8.25[in2] + 1*65000[lb/in2]*0.719[in2]) = **123.91**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	171.84	34.99	DL	0.20	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*6 = **171.84**[kip] Eq. J3-6

Tension yielding	[Kip]	269.46	34.99	DL	0.13	Eq. J4-1

A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*9[in2] = **269.46**[kip] Eq. J4-1

Tension rupture	[Kip]	182.81	34.99	DL	0.19	Eq. J4-2

A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (18[in] - 6*1.13[in])*0.5[in] = **5.63**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*9[in2], 5.63[in2]) = **5.63**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)**F_u*A_e = 0.5*65000[lb/in2]*5.63[in2] = **182.81**[kip] Eq. J4-2

Tear out under axial load	[Kip]	180.38	34.99	DL	0.19	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.5[in] = **4.69**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*4.69[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*4.69[in2]) = **180.38**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	188.13	87.61	DL	0.47	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*4.18[kip/in]*1*5*18[in] = **188.13**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	320.28	34.99	DL1	0.11	Eq. J10-4

IsBeamReaction → **False**

N = N = **15**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43[in]^2*(1 + 3*(15[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.67[in]/0.43[in])^{1/2} = \mathbf{320.28}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	173.21	80.32	DL	0.46	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.9[in] - 1.06[in]/2) = \mathbf{2.37}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.37[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(6 - 1))*0.38[in]*$
$65000[lb/in2]*1 = \mathbf{173.21}[kip]$ Eq. J3-6

Shear yielding	[Kip]	158.08	80.32	DL	0.51	Eq. J4-3

$A_g = L_p*t_p = 20.8[in]*0.38[in] = \mathbf{7.9}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.9[in2] = \mathbf{158.08}[kip]$ Eq. J4-3

Bolt bearing under axial load	[Kip]	152.83	34.99	DL	0.23	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.38[in]*$
$65000[lb/in2]*6 = \mathbf{152.83}[kip]$ Eq. J3-6

Yielding strength due to axial load	[Kip]	440.12	34.99	DL	0.08	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*14.7[in2] = \mathbf{440.12}[kip]$ Eq. D2-1

Tension rupture	[Kip]	284.40	34.99	DL	0.12	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 14.7[in2] - 6*0.38[in]*1.13[in] = \mathbf{12.14}[in2]$ Sec. D3-2

$U = 1 - x/l = 1 - 0.837[in]/3[in] = \mathbf{0.721}$ Table D3.1

$A_e = U*A_n = 0.721*12.14[in2] = \mathbf{8.75}[in2]$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*8.75[in2] = \mathbf{284.4}[kip]$ Eq. J4-2

Tear out under axial load	[Kip]	140.79	34.99	DL	0.25	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.38[in] = \mathbf{1.71}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -$
$0.5))*0.38[in] = \mathbf{1.28}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.38[in] = \mathbf{3.56}[in2]$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.28[in2] + 1*65000[lb/in2]*3.56[in2], 0.6*50000[lb/in2]*1.71[in2] + 1*65000[lb/$

in2]*3.56[in2]) = **140.79**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	51.86	DL	0.17	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 87.61$[kip]$/(0.5*4.18$[kip/in]$*1*18$[in]$) =$ **2.33** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.33/16$ [in] = **4.32**[kip/in] p. 9-5

Ratio **0.87**

Global critical strength ratio **0.87**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-9**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W27X84

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	207.00	Design
DL1	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-207.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
207.00	DL	Design
-207.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	371.23	207.00	DL	0.56	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*20$[in] = **4.42**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*4.42$[in2]$)$ = **185.62**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*20$[in] = **4.42**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*4.42$[in2]$)$ = **185.62**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 185.62$[kip] + 185.62[kip] = **371.23**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	808.75	207.00	DL	0.26	Eq. J4-4

$L_e = L_t + L_h = 20$[in] + 20[in] = **40**[in]

$A_{nv} = L_e*t_p = 40$[in]$*0.581$[in] = **23.24**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*23.24$[in2]$)$ = **808.75**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	390.00	207.00	DL	0.53	Eq. J4-4

$L_e = L_t + L_h = 20$[in] + 20[in] = **40**[in]

$A_{nv} = L_e*t_p = 40$[in]$*0.5$[in] = **20**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*20$[in2] = **390**[kip] Eq. J4-4

Block shear on gusset	[Kip]	470.00	207.00	DL	0.44	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(20$[in], 20[in]$)$ = **20**[in]

$L = L_{max} + d_w = 20$[in] + 0.5[in] = **20.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*20.5$[in]$*0.5$[in] = **20.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **20.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 10$[in]$*0.5$[in] = **5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
$0.5*\min(0.6*65000$[lb/in2]$*20.5$[in2] + $1*65000$[lb/in2]$*5$[in2], $0.6*50000$[lb/in2]$*20.5$[in2] + $1*65000$[lb/in2]$*5$[in2]$)$ = **470**[kip] Eq. J4-5

Ratio	**0.56**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	578.44	207.00	DL	0.36	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*21$[in2] = **578.44**[kip] Eq. J4-1

Tension rupture	[Kip]	477.70	207.00	DL	0.43	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 21[in2] - 2*(0.5[in] + 1/8\ [in])*0.581[in] = \mathbf{20.27}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3.75[in]/20[in] = \mathbf{0.813}$ Table D3.1

$A_e = A_n*U = 20.27[in2]*0.813 = \mathbf{16.47}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*16.47[in2] = \mathbf{477.7}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	418.53	207.00	DL	0.49	Eq. J4-1

$A_g = L_w*t_p = 27.96[in]*0.5[in] = \mathbf{13.98}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*13.98[in2] = \mathbf{418.53}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	217.32	207.00	DL1	0.95	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*21.13[in]/0.144[in])^2 = \mathbf{31596.97}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 31596.97[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/31596.97[lb/in2])}*50000[lb/in2] =$

$\mathbf{25782.51}[lb/in2]$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*25782.51[lb/in2]*14.08[in2] = \mathbf{217.32}[kip]$ Eq. E3-1

Ratio **0.95**

Calculation of the brace interface forces

Load condition :DL

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{7.01}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (7.01[in] + 13.35[in])*1.88 - 6.25[in] = \mathbf{32.05}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((32.05[in] + 6.25[in])^2 + (7.01[in] +$

$13.35[in])^2)^{1/2} = \mathbf{43.37}[in]$ p. 13-5

$H_b = \alpha*P/r = 32.05[in]*207[kip]/43.37[in] = \mathbf{152.94}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*207[kip]/43.37[in] = \mathbf{29.83}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 13.35[in]*207[kip]/43.37[in] - 20[kip] = \mathbf{43.71}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 7.01[in]*207[kip]/43.37[in] + 20[kip] = \mathbf{53.47}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(43.71[kip]*(32.05[in] - 32.05[in])) +$

$abs(20[kip]*32.05[in]) = \mathbf{53.41}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(29.83[kip]*(7.01[in] - 7.01[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

Special case 2 DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{7.01}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (7.01[in] + 13.35[in])*1.88 - 6.25[in] = \mathbf{32.05}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((32.05[in] + 6.25[in])^2 + (7.01[in] +$

$13.35[in])^2)^{1/2} = \mathbf{43.37}[in]$ p. 13-5

$H_b = \alpha*P/r = 32.05[in]*-207[kip]/43.37[in] = \mathbf{-152.94}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*-207[kip]/43.37[in] = \mathbf{-29.83}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 13.35[in]*-207[kip]/43.37[in] - -20[kip] = \mathbf{-43.71}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 7.01[in]*-207[kip]/43.37[in] + -20[kip] = \mathbf{-53.47}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-43.71[kip]*(32.05[in] - 32.05[in])) + abs(-20[kip]*32.05[in]) = **53.41**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-29.83[kip]*(7.01[in] - 7.01[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	152.94	43.71	53.41	0.00	0.00	0.00	Design
DL1	-152.94	-43.71	-53.41	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	936.99	105.15	DL	0.11	Eq. J4-1
A_g = L_p*t_p = 62.59[in]*0.5[in] = **31.3**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*31.3[in2] = **936.99**[kip]						Eq. J4-1
Shear yielding	[Kip]	625.91	152.94	DL	0.24	Eq. J4-3
A_g = L_p*t_p = 62.59[in]*0.5[in] = **31.3**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*31.3[in2] = **625.91**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	201144.90	DL	0.05	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 43.71[kip]/(0.5[in]*62.59[in]) = **1396.84**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	703730.00	DL	0.24	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 152.94[kip]/(0.5[in]*62.59[in]) = **4887.01**[lb/in2]						9
Weld capacity	[Kip]	484.50	212.23	DL	0.44	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*1.94[kip/in]*1*4*62.59[in]) = **484.5**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 43.71[kip]/62.59[in] = **0.698**[kip/in]						9
f_{uv} = H_b/l = 152.94[kip]/62.59[in] = **2.44**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 53.41[kip*ft]/(62.59[in]^2/6) = **0.982**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.698[kip/in] + 0.982[kip/in])^2 + 2.44[kip/in]^2)$^{1/2}$ = **2.97**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5*(((0.698[kip/in] - 0.982[kip/in])^2 + 2.44[kip/in]^2)$^{1/2}$ + ((0.698[kip/in] + 0.982[kip/in])^2 + 2.44[kip/in]^2)$^{1/2}$) = **2.71**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 62.59[in]*max(2.97[kip/in], 1.25*2.71[kip/in]) =
212.23[kip] 9

Beam

Weld block shear	[Kip]	653.83	152.94	DL	0.23	Eq. J4-5

$A_{gv} = l$*t_w = 62.59[in]*0.46[in] = **28.79**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (24.8[in2] - 0.46[in]*24.22[in])/2 = **6.83**[in2] 8

$A_{nv} = A_{gv}$ = **28.79**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **6.83**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*28.79[in2] + 1*65000[lb/in2]*6.83[in2], 0.6*50000[lb/in2]*28.79[in2] + 1*
65000[lb/in2]*6.83[in2]) = **653.83**[kip] Eq. J4-5

Web crippling	[Kip]	561.09	44.99	DL1	0.08	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **53.56**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.46[in]^2*(1 + 3*(53.56[in]/26.7[in])*(0.46[in]/0.64[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.64[in]/0.46[in])$^{1/2}$ = **561.09**[kip] Eq. J10-4

Local web yielding	[Kip]	916.37	44.99	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **53.56**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)$*(5*$k + N$)*$F_{yw}$*$t_w$ = 0.667*(5*1.24[in] + 53.56[in])*50000[lb/in2]*0.46[in] =
916.37[kip] Eq. J10-2

Ratio **0.44**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	53.47	29.83	0.00	0.00	0.00	Design
DL1	-53.47	-29.83	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	12.00	7.01	14.02	✔	p. 10-104
$L_{min} = T/2 = 14.02$[in]$/2 =$ **7.01**[in]						p. 10-104
$L_{max} = L =$ **14.02**[in]						
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.5$[in]$, 12$ [in]$) =$ **12**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.51	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.5$[in] $=$ **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	61.22	DL	0.91	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 4*16.87$[kip]$*1 =$ **67.5**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	132.23	53.47	DL	0.40	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*
65000[lb/in2]*1 = **132.23**[kip] Eq. J3-6

Shear yielding	[Kip]	120.00	53.47	DL	0.45	Eq. J4-3

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6[in2] = **120**[kip] Eq. J4-3

Shear rupture	[Kip]	73.13	53.47	DL	0.73	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 12[in] - 4*1.13[in] = **7.5**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 7.5[in]*0.5[in] = **3.75**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.75[in2] = **73.13**[kip] Eq. J4-4

Block shear	[Kip]	87.34	53.47	DL	0.61	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.5[in] = **0.719**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.5[in] = **3.28**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/
in2]*0.719[in2]) = **87.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	114.56	29.83	DL	0.26	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **114.56**[kip] Eq. J3-6

Tension yielding	[Kip]	179.64	29.83	DL	0.17	Eq. J4-1

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*6[in2] = **179.64**[kip] Eq. J4-1

Tension rupture	[Kip]	121.88	29.83	DL	0.24	Eq. J4-2

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (12[in] - 4*1.13[in])*0.5[in] = \mathbf{3.75}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*6[in2], 3.75[in2]) = \mathbf{3.75}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*3.75[in2] = \mathbf{121.88}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	119.44	29.83	DL	0.25	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = \mathbf{2}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = \mathbf{1.44}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = \mathbf{2.81}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*2.81[in2]) = \mathbf{119.44}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	130.31	61.22	DL	0.47	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.34[kip/in]*1*5*12[in] = \mathbf{130.31}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	335.66	29.83	DL1	0.09	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{9}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*0.80*0.515[in]^2*(1 + 3*(9[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])^{1/2} = \mathbf{335.66}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	151.97	53.47	DL	0.35	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.51[in] - 1.06[in]/2) = \mathbf{1.98}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(\min(1.2*1.98[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*65000[lb/in2]*1 = \mathbf{151.97}$[kip] Eq. J3-6

Shear yielding	[Kip]	140.24	53.47	DL	0.38	Eq. J4-3

$A_g = L_p*t_p = 14.02[in]*0.5[in] = \mathbf{7.01}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.01[in2] = \mathbf{140.24}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	134.06	29.83	DL	0.22	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **134.06**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	209.94	29.83	DL	0.14	Eq. J4-1

$A_g = L_p*t_p$ = 14.02[in]*0.5[in] = **7.01**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*7.01[in2] = **209.94**[kip] Eq. J4-1

Tension rupture	[Kip]	154.77	29.83	DL	0.19	Eq. J4-2

$A_g = L_p*t_p$ = 14.02[in]*0.5[in] = **7.01**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (14.02[in] - 4*1.13[in])*0.5[in] = **4.76**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*7.01[in2], 4.76[in2]) = **4.76**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*4.76[in2] = **154.77**[kip] Eq. J4-2

Tear out under axial load	[Kip]	124.31	29.83	DL	0.24	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*2.81[in2]) = **124.31**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	52.33	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 61.22[kip]/(0.5*4.34[kip/in]*1*12[in]) = **2.35** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.35/16 [in] = **4.36**[kip/in] p. 9-5

Ratio **0.91**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + 152.94[kip] = **152.94**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 75[kip] - 0[kip] + 43.71[kip] = **118.71**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + 0[kip] + -152.94[kip] = **-152.94**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 75$[kip] - 0[kip] + -43.71[kip] = **31.29**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	118.71	152.94	0.00	0.00	0.00	Design
DL1	31.29	-152.94	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	24.00	12.11	24.22	✔	p. 10-104
$L_{min} = T/2 = 24.22$[in]$/2 =$ **12.11**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 26.7$[in] - max(1.24[in], 0[in]) - max(1.24[in], 0[in]) = **24.22**[in]						p. 10-49
Thickness	[in]	0.75	--	1.14	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*93.08$[in] = **456.66**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*456.66$[kip*ft]$)/(50000$[lb/in2]$*24$[in]$^2) =$ **1.14**[in]						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.46$[in]$, 12$ [in]$) =$ **11.04**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.46[in], 12 [in]) = **11.04**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	216.36	193.61	DL	0.89	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (8>=10) and (8<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(*1/Ω*)R_n**BoltFactor* = 12.82*16.87[kip]*1 = **216.36**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	363.31	118.71	DL	0.33	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip]						Eq. J3-6
r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip]						Eq. J3-6
(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*12.82*min(56.67[kip], 113.34[kip]) = **363.31**[kip]						p. 7-18
Shear yielding	[Kip]	360.00	118.71	DL	0.33	Eq. J4-3
A_g = L_p*t_p = 24[in]*0.75[in] = **18**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*18[in2] = **360**[kip]						Eq. J4-3
Shear rupture	[Kip]	219.38	118.71	DL	0.54	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 24[in] - 8*1.13[in] = **15**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 15[in]*0.75[in] = **11.25**[in2]						Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*11.25$[in2] = **219.38**[kip] Eq. J4-4

Block shear	[Kip]	246.04	118.71	DL	0.48	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] $+ (2 - 1)*3$[in] $- (2 - 0.5)*1.13$[in]$)*0.75$[in] $=$ **2.48**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] $+ (8 - 1)*3$[in]$)*0.75$[in] $=$ **16.88**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] $+ (8 - 1)*(3$[in] $- 1.13$[in]$) - 1.13$[in]$/2)*0.75$[in] $=$ **10.55**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **False**

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000$[lb/in2]$*10.55$[in2] $+ 0.5*65000$[lb/in2]$*2.48$[in2]$, 0.6*50000$[lb/in2]$*16.88$[in2] $+ 0.5*65000$[lb/in2]$*2.48$[in2]$) =$ **246.04**[kip] Eq. J4-5

Flexural rupture	[Kip]	738.11	118.71	DL	0.16	p. 9-6

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75$[in]$/4*(24$[in]$^2 - 3$[in]$^2*8*(8^2 - 1)*1.13$[in]$/24$[in]$) =$ **68.13**[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*68.13$[in3]$/3$[in] $=$ **738.11**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	550.83	152.94	DL	0.28	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in] $- 1.06$[in]$/2) =$ **1.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) =$ **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.47$[in]$*0.75$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.75$[in]$*65000$[lb/in2]$) =$ **85.92**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.75$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.75$[in]$*65000$[lb/in2]$) =$ **113.34**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*12.82*\min(85.92$[kip]$, 113.34$[kip]$) =$ **550.83**[kip] p. 7-18

Tension yielding	[Kip]	538.92	152.94	DL	0.28	Eq. J4-1

$A_g = L_p*t_p = 24$[in]$*0.75$[in] $=$ **18**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*18$[in2] $=$ **538.92**[kip] Eq. J4-1

Tension rupture	[Kip]	365.63	152.94	DL	0.42	Eq. J4-2

$A_g = L_p*t_p = 24$[in]$*0.75$[in] $=$ **18**[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (24$[in]$ - 8*1.13$[in]$)*0.75$[in] $=$ **11.25**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*18$[in2]$, 11.25$[in2]$) =$ **11.25**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*11.25$[in2] $=$ **365.63**[kip] Eq. J4-2

Tear out under axial load	[Kip]	416.81	152.94	DL	0.37	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $=$ **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 8>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(8 - 1)*0.75[in] = **9.84**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*4.97$[in2] + 1*65000[lb/in2]*9.84[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*9.84[in2]) = **416.81**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	481.49	193.61	DL	0.40	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*5.02$[kip/in]*1*8*24[in] = **481.49**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	249.08	29.68	DL	0.12	p. 10-103

$A_g = L_p*t_p = 24$[in]*0.75[in] = **18**[in2] Sec. D3-1

$f_v = V/A_g = 118.71$[kip]/18[in2] = **6595.26**[lb/in2] p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000$[lb/in2])$^2 - 3*6595.26$[lb/in2]$^2))^{1/2}$ = **27675.23**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.75$[in]*24[in]$^2/4$ = **108**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 27675.23$[lb/in2]*108[in3] = **249.08**[kip*ft] p. 10-103

Web crippling	[Kip]	569.58	152.94	DL1	0.27	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **21**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515$[in]$^2*(1 + 3*(21$[in]$/12.5$[in]$)*(0.515$[in]$/0.81$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.81[in]$/0.515$[in]$)^{1/2}$ = **569.58**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	445.66	118.71	DL	0.27	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.85$[in] - 1.06[in]/2) = **2.32**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.32$[in]*0.46[in]*65000[lb/in2], 2.4*1[in]*0.46[in]*65000[lb/in2]) = **71.76**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]*0.46[in]*65000[lb/in2], 2.4*1[in]*0.46[in]*65000[lb/in2]) = **69.52**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*12.82*\min(71.76$[kip], 69.52[kip]) = **445.66**[kip] p. 7-18

Shear yielding	[Kip]	245.64	118.71	DL	0.48	Eq. J4-3

$A_g = L_p*t_p = 26.7$[in]*0.46[in] = **12.28**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]*12.28[in2] = **245.64**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	524.75	152.94	DL	0.29	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.46[in]*
65000[lb/in2]*8 = **524.75**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	742.51	152.94	DL	0.21	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*24.8[in2] = **742.51**[kip] Eq. D2-1

Tension rupture	[Kip]	519.10	152.94	DL	0.29	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 24.8[in2] - 8*0.46[in]*1.13[in] = **20.66**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.36[in]/6[in] = **0.773** Table D3.1

A_e = U*A_n = 0.773*20.66[in2] = **15.97**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*15.97[in2] = **519.1**[kip] Eq. J4-2

Tear out under axial load	[Kip]	260.13	152.94	DL	0.59	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 8>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.46[in] = **4.83**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 -
0.5))*0.46[in] = **3.28**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(8 - 1)*0.46[in] = **6.04**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*6.04[in2], 0.6*50000[lb/in2]*4.83[in2] + 1*65000[lb/
in2]*6.04[in2]) = **260.13**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	71.65	DL	0.19	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

D_{min} = P/(($1/\Omega$)*C*C_1*L) = 193.61[kip]/(0.5*5.02[kip/in]*1*24[in]) = **3.22** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*3.22/16 [in] = **5.97**[kip/in] p. 9-5

Ratio **0.89**

Global critical strength ratio **0.95**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 11:50 AM

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : CBB_DA
Connection ID : VB-03-10

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W24x84

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	157.00	0.00	0.00	0.00	Design
DL1	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	-157.00	0.00	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
157.00	DL	Design
-157.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Brace - Directly welded Connection						
Total weld design strength	[Kip]	296.98	157.00	DL	0.53	Eq. J2-4,

Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*16$[in] = **3.54**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.54$[in2]$)$ = **148.49**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*16$[in] = **3.54**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.54$[in2]$)$ = **148.49**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 148.49$[kip] + 148.49[kip] = **296.98**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	647.00	157.00	DL	0.24	Eq. J4-4

$L_e = L_t + L_h = 16$[in] + 16[in] = **32**[in]

$A_{nv} = L_e*t_p = 32$[in]$*0.581$[in] = **18.59**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*18.59$[in2]$)$ = **647**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	312.00	157.00	DL	0.50	Eq. J4-4

$L_e = L_t + L_h = 16$[in] + 16[in] = **32**[in]

$A_{nv} = L_e*t_p = 32$[in]$*0.5$[in] = **16**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*16$[in2] = **312**[kip] Eq. J4-4

Block shear on gusset	[Kip]	393.75	157.00	DL	0.40	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(16$[in], 16[in]$) =$ **16**[in]

$L = L_{max} + d_w = 16$[in] + 0.5[in] = **16.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*16.5$[in]$*0.5$[in] = **16.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **16.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*16.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*16.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2]$) =$ **393.75**[kip] Eq. J4-5

Ratio **0.53**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	515.09	157.00	DL	0.30	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*18.7$[in2] = **515.09**[kip] Eq. J4-1

Tension rupture	[Kip]	411.29	157.00	DL	0.38	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 18.7$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.581$[in] = **17.97**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3.38$[in]$/16$[in] = **0.789** Table D3.1

$A_e = A_n*U = 17.97$[in2]$*0.789 =$ **14.18**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*14.18$[in2] = **411.29**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	338.60	157.00	DL	0.46	Eq. J4-1

$A_g = L_w*t_p$ = 22.62[in]*0.5[in] = **11.31**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*11.31[in2] = **338.6**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	192.09	157.00	DL1	0.82	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*19.72[in]/0.144[in])^2 = **36289.72**[lb/in2] Eq. E3-4

F_e>=0.44*$Q*F_y \rightarrow$ 36289.72[lb/in2]>=0.44*1*50000[lb/in2] $\rightarrow$ **True**

F_{cr} = 0.658$^{(Q*Fy/Fe)}$*F_y = 0.658$^{(1*50000}$[lb/in2]$^{/36289.72}$[lb/in2]$^{)}$*50000[lb/in2] =

28088.04[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*28088.04[lb/in2]*11.42[in2] = **192.09**[kip] Eq. E3-1

Ratio **0.82**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c$ = 13.35[in]*2.05 - 6.15[in] = **21.22**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 29.76[in]*(2.05 + 29.76[in]/4.16[in]) = **273.7**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = $(2.05)^2$ + (29.76[in]/4.16[in])^2 = **55.29** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (273.7[in]*2.05 + 21.22[in]*(29.76[in]/

4.16[in])^2)/55.29 = **29.76**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D$ = (273.7[in] - 21.22[in]*2.05)/55.29 = **4.16**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((29.76[in] + 6.15[in])^2 + (4.16[in] +

13.35[in])^2)$^{1/2}$ = **39.95**[in] p. 13-5

$H_b = \alpha*P/r$ = 29.76[in]*157[kip]/39.95[in] = **116.94**[kip] p. 13-5

$H_c = e_c*P/r$ = 6.15[in]*157[kip]/39.95[in] = **24.17**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 13.35[in]*157[kip]/39.95[in] - 0[kip] = **52.46**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 4.16[in]*157[kip]/39.95[in] + 0[kip] = **16.36**[kip] p. 13-5

M_b = abs(V_b*($\alpha - \alpha_{bar}$)) + abs(ΔV*α) = abs(52.46[kip]*(29.76[in] - 29.76[in])) +

abs(0[kip]*29.76[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*($\beta - \beta_{bar}$)) = abs(24.17[kip]*(4.16[in] - 4.16[in])) = **1.34E-15**[kip*ft] p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c$ = 13.35[in]*2.05 - 6.15[in] = **21.22**[in] p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar})$ = 29.76[in]*(2.05 + 29.76[in]/4.16[in]) = **273.7**[in] p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2$ = $(2.05)^2$ + (29.76[in]/4.16[in])^2 = **55.29** p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D$ = (273.7[in]*2.05 + 21.22[in]*(29.76[in]/

4.16[in])^2)/55.29 = **29.76**[in] p. 13-10

$\beta = (K' - K*tan\theta)/D$ = (273.7[in] - 21.22[in]*2.05)/55.29 = **4.16**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$ = ((29.76[in] + 6.15[in])^2 + (4.16[in] +

13.35[in])^2)$^{1/2}$ = **39.95**[in] p. 13-5

$H_b = \alpha*P/r$ = 29.76[in]*-157[kip]/39.95[in] = **-116.94**[kip] p. 13-5

$H_c = e_c*P/r$ = 6.15[in]*-157[kip]/39.95[in] = **-24.17**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$ = 13.35[in]*-157[kip]/39.95[in] - 0[kip] = **-52.46**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$ = 4.16[in]*-157[kip]/39.95[in] + 0[kip] = **-16.36**[kip] p. 13-5

M_b = abs(V_b*($\alpha - \alpha_{bar}$)) + abs(ΔV*α) = abs(-52.46[kip]*(29.76[in] - 29.76[in])) +

abs(0[kip]*29.76[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - $β_{bar}$)) = abs(-24.17[kip]*(4.16[in] - 4.16[in])) = **1.34E-15**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	116.94	52.46	0.00	0.00	0.00	0.00	Design
DL1	-116.94	-52.46	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	868.51	52.46	DL	0.06	Eq. J4-1
$A_g = L_p*t_p$ = 58.02[in]*0.5[in] = **29.01**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)*F_y*A_g$ = 0.599*50000[lb/in2]*29.01[in2] = **868.51**[kip]						Eq. J4-1
Shear yielding	[Kip]	580.16	116.94	DL	0.20	Eq. J4-3
$A_g = L_p*t_p$ = 58.02[in]*0.5[in] = **29.01**[in2]						Sec. D3-1
$(1/Ω)R_n = (1/Ω)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*29.01[in2] = **580.16**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	260429.90	DL	0.06	J4-1
$(1/Ω)F_n = (1/Ω)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 52.46[kip]/(0.5[in]*58.02[in]) = **1808.54**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	580517.60	DL	0.20	J4-1
$(1/Ω)F_n = (1/Ω)$*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 116.94[kip]/(0.5[in]*58.02[in]) = **4031.37**[lb/in2]						9
Weld capacity	[Kip]	487.15	160.21	DL	0.33	Tables 8-4 .. 8-11
$(1/Ω)R_n = 2 * ((1/Ω)*C*C_1*D*L)$ = 2 * (0.5*2.1[kip/in]*1*4*58.02[in]) = **487.15**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 52.46[kip]/58.02[in] = **0.904**[kip/in]						9
$f_{uv} = H_b/l$ = 116.94[kip]/58.02[in] = **2.02**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 0[kip*ft]/(58.02[in]^2/6) = **0**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.904[kip/in] + 0[kip/in])^2 + 2.02[kip/in]^2)$^{1/2}$ = **2.21**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0.904[kip/in] - 0[kip/in])^2 + 2.02[kip/in]^2)$^{1/2}$ + ((0.904[kip/in] + 0[kip/in])^2 + 2.02[kip/in]^2)$^{1/2}$) = **2.21**[kip/in]						9
$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 58.02[in]*max(2.21[kip/in], 1.25*2.21[kip/in]) = **160.21**[kip]						9
Beam						

Weld block shear	[Kip]	622.27	116.94	DL	0.19	Eq. J4-5

$A_{gv} = l*t_w = 58.02$[in]$*0.46$[in] = **26.69**[in2] — Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2 = (24.8$[in2] $- 0.46$[in]$*24.22$[in]$)/2 =$ **6.83**[in2] — 8

$A_{nv} = A_{gv} =$ **26.69**[in2] — Sec. J4.3

$A_{nt} = A_{gt} =$ **6.83**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*26.69$[in2] $+ 1*65000$[lb/in2]$*6.83$[in2]$, 0.6*50000$[lb/in2]$*26.69$[in2] $+ 1*$

65000[lb/in2]$*6.83$[in2]$) =$ **622.27**[kip] — Eq. J4-5

Web crippling	[Kip]	597.74	52.46	DL1	0.09	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **58.02**[in] — Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$

$0.80*0.46$[in]$^2*(1 + 3*(58.02$[in]$/26.7$[in]$)*(0.46$[in]$/0.64$[in]$)^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$

0.64[in]$/0.46$[in]$)^{1/2} =$ **597.74**[kip] — Eq. J10-4

Local web yielding	[Kip]	984.65	52.46	DL	0.05	Eq. J10-2

IsBeamReaction → **False**

$N = N =$ **58.02**[in] — Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.24$[in] $+ 58.02$[in]$)*50000$[lb/in2]$*0.46$[in] =

984.65[kip] — Eq. J10-2

Ratio **0.33**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	16.36	24.17	0.00	0.00	0.00	Design
DL1	-16.36	-24.17	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	6.00	4.16	8.33	✔	p. 10-104

$L_{min} = T/2 = 8.33$[in]$/2 =$ **4.16**[in] — p. 10-104

$L_{max} = L =$ **8.33**[in]

Thickness	[in]	0.38	--	0.56	✔	p. 10-102

$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in] — p. 10-102

Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in], 12 [in]$) =$ **9**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.66	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	33.75	29.19	DL	0.86	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*16.87$[kip]$*1 =$ **33.75**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	42.50	16.36	DL	0.38	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 1.5$[in]$ - 1.06$[in]$/2) =$ **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in]$ - 1.06$[in]$) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ $F_u*n_c = 0.5*(\min(1.2*0.969$[in]$, 2.4*1$[in]$) + \min(1.2*1.94$[in]$, 2.4*1$[in]$)*(2 - 1))*0.375$[in]$*$ 65000[lb/in2]$*1 =$ **42.5**[kip]						Eq. J3-6
Shear yielding	[Kip]	45.00	16.36	DL	0.36	Eq. J4-3
$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2]						Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]$*2.25$[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	16.36	DL	0.60	Eq. J4-4

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h = 6$[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p = 3.75$[in]$*0.375$[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*1.41$[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	16.36	DL	0.43	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	24.17	DL	0.56	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.47$[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	24.17	DL	0.36	Eq. J4-1

$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*2.25$[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	24.17	DL	0.53	Eq. J4-2

$A_g = L_p*t_p = 6$[in]$*0.375$[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6$[in] - 2*1.13[in])*0.375[in] = **1.41**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25$[in2], 1.41[in2]) = **1.41**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*1.41$[in2] = **45.7**[kip] Eq. J4-2

Tear out under axial load	[Kip]	43.88	24.17	DL	0.55	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (1 - 1)*3[in])*0.375[in] = **1.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.375[in] = **1.08**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(2 - 1)*0.375[in] = **0.703**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

0.5*min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*0.703[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*0.703[in2]) = **43.88**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	61.33	29.19	DL	0.48	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*5.11[kip/in]*1*4*6[in] = **61.33**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	152.99	24.17	DL1	0.16	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **3**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*

0.80*0.43[in]^2*(1 + 3*(3[in]/12.3[in])*(0.43[in]/0.67[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*

0.67[in]/0.43[in])$^{1/2}$ = **152.99**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	16.36	DL	0.21	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.66\text{[in]} - 1.06\text{[in]}/2) =$ **2.13**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*2.13[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*

65000[lb/in2]*1 = **76.78**[kip] Eq. J3-6

Shear yielding	[Kip]	83.27	16.36	DL	0.20	Eq. J4-3

$A_g = L_p*t_p$ = 8.33[in]*0.5[in] = **4.16**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*4.16[in2] = **83.27**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	24.17	DL	0.31	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5\text{[in]} - 1.06\text{[in]}/2) =$ **1.97**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) =$ **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*

65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	124.66	24.17	DL	0.19	Eq. J4-1

$A_g = L_p*t_p$ = 8.33[in]*0.5[in] = **4.16**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.16[in2] = **124.66**[kip] Eq. J4-1

Tension rupture	[Kip]	98.75	24.17	DL	0.24	Eq. J4-2

$A_g = L_p*t_p$ = 8.33[in]*0.5[in] = **4.16**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.33[in] - 2*1.13[in])*0.5[in] = **3.04**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*4.16\text{[in2]}, 3.04\text{[in2]}) =$ **3.04**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.04[in2] = **98.75**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	24.17	DL	0.36	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5$[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5$[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	42.40	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 29.19$[kip]/(0.5*5.11[kip/in]*1*6[in]) = **1.9** tables 8-4..11

HasWeldsOnBothSides $\rightarrow$ **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.9/16 [in] = **3.53**[kip/in] p. 9-5

Ratio **0.86**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + 116.94[kip] + 0[kip] = **116.94**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 75$[kip] - 52.46[kip] + 0[kip] = **22.54**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + -116.94[kip] + 0[kip] = **-116.94**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 75$[kip] - -52.46[kip] + 0[kip] = **127.46**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	22.54	116.94	0.00	0.00	0.00	Design
DL1	127.46	-116.94	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	24.00	12.11	24.22	✔	p. 10-104
L_{min} = T/2 = 24.22[in]/2 = **12.11**[in]						p. 10-104
L_{max} = d - max(k, d_{ct}) - max(k, d_{cb}) = 26.7[in] - max(1.24[in], 0[in]) - max(1.24[in], 0[in]) = **24.22**[in]						p. 10-49
Thickness	[in]	0.75	--	1.14	✔	p. 10-103
M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*93.08[in] = **456.66**[kip*ft]						p. 10-103
t_{max} = (6*M_{max})/(F_y*d^2) = (6*456.66[kip*ft])/(50000[lb/in2]*24[in]^2) = **1.14**[in]						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.46[in], 12 [in]) = **11.04**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.46[in], 12 [in]) = **11.04**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	212.99	172.98	DL1	0.81	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (8>=10) and (8<=12) and (True) → **False**

BoltFactor = 1 p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip] Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 12.62*16.87[kip]*1 = **212.99**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	357.65	127.46	DL1	0.36	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*12.62*min(56.67[kip], 113.34[kip]) = **357.65**[kip] p. 7-18

Shear yielding	[Kip]	360.00	127.46	DL1	0.35	Eq. J4-3

A_g = L_p*t_p = 24[in]*0.75[in] = **18**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*18[in2] = **360**[kip] Eq. J4-3

Shear rupture	[Kip]	219.38	127.46	DL1	0.58	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 24[in] - 8*1.13[in] = **15**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 15[in]*0.75[in] = **11.25**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*11.25[in2] = **219.38**[kip] Eq. J4-4

Block shear	[Kip]	246.04	127.46	DL1	0.52	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.13[in])*0.75[in] = **2.48**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (8 - 1)*3[in])*0.75[in] = **16.88**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (8 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.75[in] = **10.55**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*10.55[in2] + 0.5*65000[lb/in2]*2.48[in2], 0.6*50000[lb/in2]*16.88[in2] + 0.5*65000[lb/in2]*2.48[in2]) = **246.04**[kip] Eq. J4-5

Flexural rupture	[Kip]	738.11	127.46	DL1	0.17	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75[in]/4*(24[in]^2 - 3[in]^2*8*(8^2 - 1)*1.13[in]/24[in]) = **68.13**[in3] 4

(1/Ω)R_n = *(1/Ω)*F_u*Z_{net}/e = 0.5*65000[lb/in2]*68.13[in3]/3[in] = **738.11**[kip] p. 9-6

Bolt bearing under axial load	[Kip]	614.40	116.94	DL	0.19	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.47[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **85.92**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip] Eq. J3-6

(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*14.3*min(85.92[kip], 113.34[kip]) = **614.4**[kip] p. 7-18

Tension yielding	[Kip]	538.92	116.94	DL	0.22	Eq. J4-1

A_g = L_p*t_p = 24[in]*0.75[in] = **18**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*18[in2] = **538.92**[kip] Eq. J4-1

Tension rupture	[Kip]	365.63	116.94	DL	0.32	Eq. J4-2

A_g = L_p*t_p = 24[in]*0.75[in] = **18**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (24[in] - 8*1.13[in])*0.75[in] = **11.25**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*18[in2], 11.25[in2]) = **11.25**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*11.25[in2] = **365.63**[kip] Eq. J4-2

Tear out under axial load	[Kip]	416.81	116.94	DL	0.28	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 8>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(8 - 1)*0.75[in] = **9.84**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*4.97[in2] + 1*65000[lb/in2]*9.84[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*9.84[in2]) = **416.81**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	455.43	172.98	DL1	0.38	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*4.74[kip/in]*1*8*24[in] = **455.43**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	245.81	31.87	DL1	0.13	p. 10-103

A_g = L_p*t_p = 24[in]*0.75[in] = **18**[in2] Sec. D3-1

f_v = V/A_g = 127.46[kip]/18[in2] = **7081.24**[lb/in2] p. 10-103

(1/Ω)F_{cr} = (max(0, ((*(1/Ω)*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*7081.24[lb/in2]^2))$^{1/2}$ = **27312.61**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.75[in]*24[in]^2/4 = **108**[in3] T. 17-27

(1/Ω)M_n = *(1/Ω)*F_{cr}*Z = 27312.61[lb/in2]*108[in3] = **245.81**[kip*ft] p. 10-103

Web crippling	[Kip]	403.93	116.94	DL1	0.29	Eq. J10-4

IsBeamReaction → **False**

N = N = **21**[in] Sec. J10-2

(1/Ω)R_n = *(1/Ω)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ = 0.5*

$0.80*0.43_{[in]}^2*(1 + 3*(21_{[in]}/12.3_{[in]})*(0.43_{[in]}/0.67_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*0.67_{[in]}/0.43_{[in]})^{1/2}$ = **403.93**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	438.71	127.46	DL1	0.29	Eq. J3-6, p. 7-18

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.85[in] - 1.06[in]/2) = **2.32**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*2.32[in]*0.46[in]*65000[lb/in2], 2.4*1[in]*0.46[in]*65000[lb/in2]) = **71.76**[kip] Eq. J3-6

r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.46[in]*65000[lb/in2], 2.4*1[in]*0.46[in]*65000[lb/in2]) = **69.52**[kip] Eq. J3-6

$(1/\Omega)R_n$ = $(1/\Omega)$*C*min(r_{n1}, r_{n2}) = 0.5*12.62*min(71.76[kip], 69.52[kip]) = **438.71**[kip] p. 7-18

Shear yielding	[Kip]	245.64	127.46	DL1	0.52	Eq. J4-3

A_g = L_p*t_p = 26.7[in]*0.46[in] = **12.28**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*12.28[in2] = **245.64**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	524.75	116.94	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.46[in]*65000[lb/in2]*8 = **524.75**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	742.51	116.94	DL	0.16	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*24.8[in2] = **742.51**[kip] Eq. D2-1

Tension rupture	[Kip]	519.10	116.94	DL	0.23	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 24.8[in2] - 8*0.46[in]*1.13[in] = **20.66**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.36[in]/6[in] = **0.773** Table D3.1

A_e = U*A_n = 0.773*20.66[in2] = **15.97**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*15.97[in2] = **519.1**[kip] Eq. J4-2

Tear out under axial load	[Kip]	260.13	116.94	DL	0.45	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 8>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.46[in] = **4.83**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.46[in] = **3.28**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(8 - 1)*0.46[in] = **6.04**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*6.04[in2], 0.6*50000[lb/in2]*4.83[in2] + 1*65000[lb/in2]*6.04[in2]) = **260.13**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	67.68	DL1	0.22	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 172.98$[kip]$/(0.5*4.74$[kip/in]$*1*24$[in]$) =$ **3.04** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*3.04/16$ [in] = **5.64**[kip/in] p. 9-5

Ratio **0.81**

Global critical strength ratio **0.86**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-11**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W27X84

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	157.00	Design
DL1	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-157.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
157.00	DL	Design
-157.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	157.00	DL	0.60	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	566.13	157.00	DL	0.28	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.581$[in] = **16.27**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*16.27$[in2]$)$ = **566.13**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	157.00	DL	0.58	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	363.75	157.00	DL	0.43	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2]$) =$ **363.75**[kip] — Eq. J4-5

Ratio	**0.60**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	515.09	157.00	DL	0.30	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*18.7$[in2] = **515.09**[kip] — Eq. J4-1

Tension rupture	[Kip]	395.58	157.00	DL	0.40	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 18.7[in2] - 2*(0.5[in] + 1/8\ [in])*0.581[in] = \mathbf{17.97}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3.38[in]/14[in] = \mathbf{0.759}$ Table D3.1

$A_e = A_n*U = 17.97[in2]*0.759 = \mathbf{13.64}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*13.64[in2] = \mathbf{395.58}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	314.60	157.00	DL	0.50	Eq. J4-1

$A_g = L_w*t_p = 21.02[in]*0.5[in] = \mathbf{10.51}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*10.51[in2] = \mathbf{314.6}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	172.52	157.00	DL1	0.91	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*20.23[in]/0.144[in])^2 = \mathbf{34476.22}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 34476.22[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/34476.22[lb/in2])}*50000[lb/in2] =$

27248.81[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*27248.81[lb/in2]*10.57[in2] = \mathbf{172.52}[kip]$ Eq. E3-1

Ratio **0.91**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{3.75}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (3.75[in] + 13.35[in])*2.05 - 6.25[in] = \mathbf{28.81}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((28.81[in] + 6.25[in])^2 + (3.75[in] +$
$13.35[in])^2)^{1/2} = \mathbf{39.01}[in]$ p. 13-5

$H_b = \alpha*P/r = 28.81[in]*157[kip]/39.01[in] = \mathbf{115.95}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*157[kip]/39.01[in] = \mathbf{25.16}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 13.35[in]*157[kip]/39.01[in] - 0[kip] = \mathbf{53.73}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 3.75[in]*157[kip]/39.01[in] + 0[kip] = \mathbf{15.09}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(53.73[kip]*(28.81[in] - 28.81[in])) +$
$abs(0[kip]*28.81[in]) = \mathbf{2.39E-14}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(25.16[kip]*(3.75[in] - 3.75[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{3.75}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (3.75[in] + 13.35[in])*2.05 - 6.25[in] = \mathbf{28.81}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((28.81[in] + 6.25[in])^2 + (3.75[in] +$
$13.35[in])^2)^{1/2} = \mathbf{39.01}[in]$ p. 13-5

$H_b = \alpha*P/r = 28.81[in]*-157[kip]/39.01[in] = \mathbf{-115.95}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*-157[kip]/39.01[in] = \mathbf{-25.16}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 13.35[in]*-157[kip]/39.01[in] - 0[kip] = \mathbf{-53.73}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 3.75[in]*-157[kip]/39.01[in] + 0[kip] = \mathbf{-15.09}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-53.73[kip]*(28.81[in] - 28.81[in])) +
abs(0[kip]*28.81[in]) = **2.39E-14**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-25.16[kip]*(3.75[in] - 3.75[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	115.95	53.73	0.00	0.00	0.00	0.00	Design
DL1	-115.95	-53.73	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	840.10	53.73	DL	0.06	Eq. J4-1
A_g = L_p*t_p = 56.12[in]*0.5[in] = **28.06**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*28.06[in2] = **840.1**[kip]						Eq. J4-1
Shear yielding	[Kip]	561.19	115.95	DL	0.21	Eq. J4-3
A_g = L_p*t_p = 56.12[in]*0.5[in] = **28.06**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*28.06[in2] = **561.19**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	275754.30	DL	0.06	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 53.73[kip]/(0.5[in]*56.12[in]) = **1914.96**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	595078.70	DL	0.21	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 115.95[kip]/(0.5[in]*56.12[in]) = **4132.49**[lb/in2]						9
Weld capacity	[Kip]	473.46	159.75	DL	0.34	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.11[kip/in]*1*4*56.12[in]) = **473.46**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 53.73[kip]/56.12[in] = **0.957**[kip/in]						9
f_{uv} = H_b/l = 115.95[kip]/56.12[in] = **2.07**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 2.39E-14[kip*ft]/(56.12[in]^2/6) = **5.46E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.957[kip/in] + 5.46E-16[kip/in])^2 + 2.07[kip/in^2])$^{1/2}$ = **2.28**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.957[kip/in] - 5.46E-16[kip/in])^2 + 2.07[kip/in]^2)$^{1/2}$ + ((0.957[kip/in] + 5.46E-16[kip/in])^2 + 2.07[kip/in]^2)$^{1/2}$) = **2.28**[kip/in]						9

$f_{uWeld} = l^*\max(f_{uPeak}, 1.25^*f_{uAve}) = 56.12\text{[in]}^*\max(2.28\text{[kip/in]}, 1.25^*2.28\text{[kip/in]}) =$
159.75[kip] 9

Beam

Weld block shear	[Kip]	609.17	115.95	DL	0.19	Eq. J4-5

$A_{gv} = l^*t_w = 56.12\text{[in]}^*0.46\text{[in]} = \mathbf{25.81}\text{[in2]}$ Sec. J4.3

$A_{gt} = (A_g - t_w^*T)/2 = (24.8\text{[in2]} - 0.46\text{[in]}^*24.22\text{[in]})/2 = \mathbf{6.83}\text{[in2]}$ 8

$A_{nv} = A_{gv} = \mathbf{25.81}\text{[in2]}$ Sec. J4.3

$A_{nt} = A_{gt} = \mathbf{6.83}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)^*\min(0.6^*F_u^*A_{nv} + U_{bs}^*F_u^*A_{nt}, 0.6^*F_y^*A_{gv} + U_{bs}^*F_u^*A_{nt}) =$
$0.5^*\min(0.6^*65000\text{[lb/in2]}^*25.81\text{[in2]} + 1^*65000\text{[lb/in2]}^*6.83\text{[in2]}, 0.6^*50000\text{[lb/in2]}^*25.81\text{[in2]} + 1^*$
$65000\text{[lb/in2]}^*6.83\text{[in2]}) = \mathbf{609.17}\text{[kip]}$ Eq. J4-5

Web crippling	[Kip]	582.13	53.73	DL1	0.09	Eq. J10-4

IsBeamReaction → **False**

$N = N = \mathbf{56.12}\text{[in]}$ Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)^*0.80^*t_w^2{}^*(1 + 3^*(N/d)^*(t_w/t_f)^{1.5})^*(E^*F_{yw}^*t_f/t_w)^{1/2} = 0.5^*$
$0.80^*0.46\text{[in]}^2{}^*(1 + 3^*(56.12\text{[in]}/26.7\text{[in]})^*(0.46\text{[in]}/0.64\text{[in]})^{1.5})^*(2.90\text{E+07}\text{[lb/in2]}^*50000\text{[lb/in2]}^*$
$0.64\text{[in]}/0.46\text{[in]})^{1/2} = \mathbf{582.13}\text{[kip]}$ Eq. J10-4

Local web yielding	[Kip]	955.55	53.73	DL	0.06	Eq. J10-2

IsBeamReaction → **False**

$N = N = \mathbf{56.12}\text{[in]}$ Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)^*(5^*k + N)^*F_{yw}^*t_w = 0.667^*(5^*1.24\text{[in]} + 56.12\text{[in]})^*50000\text{[lb/in2]}^*0.46\text{[in]} =$
955.55[kip] Eq. J10-2

Ratio **0.34**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	15.09	25.16	0.00	0.00	0.00	Design
DL1	-15.09	-25.16	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	6.00	3.75	7.50	✔	p. 10-104
$L_{min} = T/2 = 7.5$[in]$/2 =$ **3.75**[in]						p. 10-104
$L_{max} = L =$ **7.5**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.25	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	29.34	DL	0.87	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*16.87$[kip]$*1 =$ **33.75**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	15.09	DL	0.36	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	15.09	DL	0.34	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	15.09	DL	0.55	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	15.09	DL	0.40	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	25.16	DL	0.59	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	25.16	DL	0.37	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	25.16	DL	0.55	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6[in] - 2*1.13[in])*0.375[in] = \mathbf{1.41}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25[in2], 1.41[in2]) = \mathbf{1.41}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*1.41[in2] = \mathbf{45.7}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	43.88	25.16	DL	0.57	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.375[in] = \mathbf{0.703}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*0.703[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*0.703[in2]) = \mathbf{43.88}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	62.23	29.34	DL	0.47	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*5.19[kip/in]*1*4*6[in] = \mathbf{62.23}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	218.69	25.16	DL1	0.12	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{3}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515[in]^2*(1 + 3*(3[in]/12.5[in])*(0.515[in]/0.81[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.81[in]/0.515[in])^{1/2} = \mathbf{218.69}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	71.29	15.09	DL	0.21	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*$
$65000[lb/in2]*1 = \mathbf{71.29}$[kip] Eq. J3-6

Shear yielding	[Kip]	74.99	15.09	DL	0.20	Eq. J4-3

$A_g = L_p*t_p = 7.5[in]*0.5[in] = \mathbf{3.75}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*3.75[in2] = \mathbf{74.99}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	67.03	25.16	DL	0.38	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*2 = **67.03**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	112.26	25.16	DL	0.22	Eq. J4-1

$A_g = L_p*t_p$ = 7.5[in]*0.5[in] = **3.75**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*3.75[in2] = **112.26**[kip] Eq. J4-1

Tension rupture	[Kip]	85.30	25.16	DL	0.29	Eq. J4-2

$A_g = L_p*t_p$ = 7.5[in]*0.5[in] = **3.75**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (7.5[in] - 2*1.13[in])*0.5[in] = **2.62**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*3.75[in2], 2.62[in2]) = **2.62**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*2.62[in2] = **85.3**[kip] Eq. J4-2

Tear out under axial load	[Kip]	63.38	25.16	DL	0.40	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.5[in] = **2.25**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.69**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.69[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.25[in2] + 1*65000[lb/in2]*0.938[in2]) = **63.38**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	42.00	DL	0.11	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 29.34[kip]/(0.5*5.19[kip/in]*1*6[in]) = **1.89** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.89/16 [in] = **3.5**[kip/in] p. 9-5

Ratio **0.87**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 0[kip] + 115.95[kip] = **115.95**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 75[kip] - 0[kip] + 53.73[kip] = **128.73**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0$[kip] + 0[kip] + -115.95[kip] = **-115.95**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 75$[kip] - 0[kip] + -53.73[kip] = **21.27**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	128.73	115.95	0.00	0.00	0.00	Design
DL1	21.27	-115.95	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	24.00	12.11	24.22	✔	p. 10-104
$L_{min} = T/2 = 24.22$[in]$/2 =$ **12.11**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 26.7$[in] - max(1.24[in], 0[in]) - max(1.24[in], 0[in]) = **24.22**[in]						p. 10-49
Thickness	[in]	0.75	--	1.14	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000$[lb/in2]$*0.785$[in2]$*93.08$[in] = **456.66**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*456.66$[kip*ft]$)/(50000$[lb/in2]$*24$[in]$^2) =$ **1.14**[in]						p. 10-103
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.46$[in]$, 12$ [in]$) =$ **11.04**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						

s_{max} = min(24*t_p, 12 [in]) = min(24*0.46[in], 12 [in]) = **11.04**[in] Sec. J3.5

Beam

Vertical edge distance	[in]	2.85	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	8	8	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.75[in] = **0.0391**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	212.86	173.26	DL	0.81	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (8>=10) and (8<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = *C*(1/Ω)*R_n**BoltFactor* = 12.61*16.87[kip]*1 = **212.86**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	357.43	128.73	DL	0.36	Eq. J3-6, p. 7-18
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
r_{n1} = min(k_1*$L_{c\text{-}end}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*0.969[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **56.67**[kip]						Eq. J3-6
r_{n2} = min(k_1*$L_{c\text{-}spa}$*t_p*F_u, k_2*d*t_p*F_u) = min(1.2*1.94[in]*0.75[in]*65000[lb/in2], 2.4*1[in]*0.75[in]*65000[lb/in2]) = **113.34**[kip]						Eq. J3-6
(1/Ω)R_n = *(1/Ω)*C*min(r_{n1}, r_{n2}) = 0.5*12.61*min(56.67[kip], 113.34[kip]) = **357.43**[kip]						p. 7-18
Shear yielding	[Kip]	360.00	128.73	DL	0.36	Eq. J4-3
A_g = L_p*t_p = 24[in]*0.75[in] = **18**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*18[in2] = **360**[kip]						Eq. J4-3
Shear rupture	[Kip]	219.38	128.73	DL	0.59	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 24[in] - 8*1.13[in] = **15**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 15[in]*0.75[in] = **11.25**[in2]						Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*11.25$[in2] $= \mathbf{219.38}$[kip] Eq. J4-4

Block shear	[Kip]	246.04	128.73	DL	0.52	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2$[in] $+ (2 - 1)*3$[in] $- (2 - 0.5)*1.13$[in]$)*0.75$[in] $= \mathbf{2.48}$[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5$[in] $+ (8 - 1)*3$[in]$)*0.75$[in] $= \mathbf{16.88}$[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5$[in] $+ (8 - 1)*(3$[in] $- 1.13$[in]$) - 1.13$[in]$/2)*0.75$[in] $= \mathbf{10.55}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **False**

$U_{bs} = 0.5$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*\min(0.6*65000$[lb/in2]$*10.55$[in2] $+ 0.5*65000$[lb/in2]$*2.48$[in2]$, 0.6*50000$[lb/in2]$*16.88$[in2] $+ 0.5*65000$[lb/in2]$*2.48$[in2]$) = \mathbf{246.04}$[kip] Eq. J4-5

Flexural rupture	[Kip]	738.11	128.73	DL	0.17	p. 9-6

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.75$[in]$/4*(24$[in]$^2 - 3$[in]$^2*8*(8^2 - 1)*1.13$[in]$/24$[in]$) = \mathbf{68.13}$[in3] 4

$(1/\Omega)R_n = (1/\Omega)*F_u*Z_{net}/e = 0.5*65000$[lb/in2]$*68.13$[in3]$/3$[in] $= \mathbf{738.11}$[kip] p. 9-6

Bolt bearing under axial load	[Kip]	541.91	115.95	DL	0.21	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2$[in] $- 1.06$[in]$/2) = \mathbf{1.47}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3$[in] $- 1.06$[in]$) = \mathbf{1.94}$[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.47$[in]$*0.75$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.75$[in]$*65000$[lb/in2]$) = \mathbf{85.92}$[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]$*0.75$[in]$*65000$[lb/in2]$, 2.4*1$[in]$*0.75$[in]$*65000$[lb/in2]$) = \mathbf{113.34}$[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*12.61*\min(85.92$[kip]$, 113.34$[kip]$) = \mathbf{541.91}$[kip] p. 7-18

Tension yielding	[Kip]	538.92	115.95	DL	0.22	Eq. J4-1

$A_g = L_p*t_p = 24$[in]$*0.75$[in] $= \mathbf{18}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*18$[in2] $= \mathbf{538.92}$[kip] Eq. J4-1

Tension rupture	[Kip]	365.63	115.95	DL	0.32	Eq. J4-2

$A_g = L_p*t_p = 24$[in]$*0.75$[in] $= \mathbf{18}$[in2] Sec. D3-1

IsBoltedConnection $\rightarrow$ **True**

$L_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (24$[in]$ - 8*1.13$[in]$)*0.75$[in] $= \mathbf{11.25}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*18$[in2]$, 11.25$[in2]$) = \mathbf{11.25}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000$[lb/in2]$*11.25$[in2] $= \mathbf{365.63}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	416.81	115.95	DL	0.28	Eq. J4-5

$dh_h = d_h + 1/16$ [in] $= 1.06$[in] $+ 1/16$ [in] $= \mathbf{1.13}$[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 8>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2$[in] + (2 - 1)*3[in])*0.75[in] = **7.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2$[in] + (2 - 1)*3[in] - 1.13[in]*(2 - 0.5))*0.75[in] = **4.97**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3$[in] - 1.13[in])*(8 - 1)*0.75[in] = **9.84**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*4.97$[in2] + 1*65000[lb/in2]*9.84[in2], 0.6*50000[lb/in2]*7.5[in2] + 1*65000[lb/in2]*9.84[in2]) = **416.81**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	453.95	173.26	DL	0.38	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.73$[kip/in]*1*8*24[in] = **453.95**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	245.32	32.18	DL	0.13	p. 10-103

$A_g = L_p*t_p = 24$[in]*0.75[in] = **18**[in2] Sec. D3-1

$f_v = V/A_g = 128.73$[kip]/18[in2] = **7151.81**[lb/in2] p. 10-103

$(1/\Omega)F_{cr} = (\max(0, ((1/\Omega)*F_y)^2 - 3*f_v^2))^{1/2} = (\max(0, (0.599*50000$[lb/in2])$^2 - 3*7151.81$[lb/in2]$^2))^{1/2}$ = **27257.4**[lb/in2] p. 10-103

$Z_x = t_p*L^2/4 = 0.75$[in]*24[in]$^2/4$ = **108**[in3] T. 17-27

$(1/\Omega)M_n = (1/\Omega)F_{cr}*Z = 27257.4$[lb/in2]*108[in3] = **245.32**[kip*ft] p. 10-103

Web crippling	[Kip]	569.58	115.95	DL1	0.20	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N =$ **21**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515$[in]$^2*(1 + 3*(21$[in]$/12.5$[in])$*(0.515$[in]$/0.81$[in])$^{1.5})*(2.90E+07$[lb/in2]$*50000$[lb/in2]$*$
0.81[in]$/0.515$[in])$^{1/2}$ = **569.58**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	438.45	128.73	DL	0.29	Eq. J3-6, p. 7-18

$L_{c\text{-}end} = \max(0.0, L_e - d_h/2) = \max(0.0, 2.85$[in] - 1.06[in]/2) = **2.32**[in] Sec. J4.10

$L_{c\text{-}spa} = \max(0.0, s - d_h) = \max(0.0, 3$[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$r_{n1} = \min(k_1*L_{c\text{-}end}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*2.32$[in]*0.46[in]*65000[lb/in2], 2.4*1[in]*0.46[in]*65000[lb/in2]) = **71.76**[kip] Eq. J3-6

$r_{n2} = \min(k_1*L_{c\text{-}spa}*t_p*F_u, k_2*d*t_p*F_u) = \min(1.2*1.94$[in]*0.46[in]*65000[lb/in2], 2.4*1[in]*0.46[in]*65000[lb/in2]) = **69.52**[kip] Eq. J3-6

$(1/\Omega)R_n = (1/\Omega)*C*\min(r_{n1}, r_{n2}) = 0.5*12.61*\min(71.76$[kip], 69.52[kip]) = **438.45**[kip] p. 7-18

Shear yielding	[Kip]	245.64	128.73	DL	0.52	Eq. J4-3

$A_g = L_p*t_p = 26.7$[in]*0.46[in] = **12.28**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000$[lb/in2]*12.28[in2] = **245.64**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	524.75	115.95	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.25[in] - 1.06[in]/2) = **1.72**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.72[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.46[in]*
65000[lb/in2]*8 = **524.75**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	742.51	115.95	DL	0.16	Eq. D2-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*24.8[in2] = **742.51**[kip] Eq. D2-1

Tension rupture	[Kip]	519.10	115.95	DL	0.22	Eq. J4-2

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = A_g - n_h*t_p*L_h = 24.8[in2] - 8*0.46[in]*1.13[in] = **20.66**[in2] Sec. D3-2

U = 1 - x/l = 1 - 1.36[in]/6[in] = **0.773** Table D3.1

A_e = U*A_n = 0.773*20.66[in2] = **15.97**[in2] Sec. D3-3

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*A_e = 0.5*65000[lb/in2]*15.97[in2] = **519.1**[kip] Eq. J4-2

Tear out under axial load	[Kip]	260.13	115.95	DL	0.45	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 8>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (2 - 1)*3[in])*0.46[in] = **4.83**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (2 - 1)*3[in] - 1.13[in]*(2 -
0.5))*0.46[in] = **3.28**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(8 - 1)*0.46[in] = **6.04**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*6.04[in2], 0.6*50000[lb/in2]*4.83[in2] + 1*65000[lb/
in2]*6.04[in2]) = **260.13**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	68.01	DL	0.18	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

D_{min} = P/(($1/\Omega$)*C*C_1*L) = 173.26[kip]/(0.5*4.73[kip/in]*1*24[in]) = **3.05** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*3.05/16 [in] = **5.67**[kip/in] p. 9-5

Ratio **0.81**

Global critical strength ratio **0.91**

NOTATION

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_o: Reduced beam depth

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

λ: Slenderness

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

r_{n1}: Nominal strength of one bolt

r_{n2}: Nominal strength of one bolt

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_{max}: Maximum thickness

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V: Shear load

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Current Date: 2016-05-25 1:08 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-12**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W27x84

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	60.00	0.00	0.00	0.00	Design
DL1	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	-60.00	0.00	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
60.00	DL	Design
-60.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	60.00	DL	0.23	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	453.10	60.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.465$[in] = **13.02**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*13.02$[in2]$)$ = **453.1**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	60.00	DL	0.22	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	363.75	60.00	DL	0.16	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2]$) =$ **363.75**[kip] Eq. J4-5

Ratio **0.23**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	421.44	60.00	DL	0.14	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*15.3$[in2] = **421.44**[kip] Eq. J4-1

Tension rupture	[Kip]	323.94	60.00	DL	0.19	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 15.3[in2] - 2*(0.5[in] + 1/8\ [in])*0.465[in] = \mathbf{14.72}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3.38[in]/14[in] = \mathbf{0.759}$ Table D3.1

$A_e = A_n*U = 14.72[in2]*0.759 = \mathbf{11.17}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*11.17[in2] = \mathbf{323.94}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	318.06	60.00	DL	0.19	Eq. J4-1

$A_g = L_w*t_p = 21.25[in]*0.5[in] = \mathbf{10.62}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*10.62[in2] = \mathbf{318.06}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	180.81	60.00	DL1	0.33	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*19.61[in]/0.144[in])^2 = \mathbf{36715.47}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 36715.47[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/36715.47[lb/in2])}*50000[lb/in2] =$

$\mathbf{28276.5}[lb/in2]$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*28276.5[lb/in2]*10.68[in2] = \mathbf{180.81}[kip]$ Eq. E3-1

Ratio **0.33**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.04}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.04[in] + 13.35[in])*1.96 - 6.15[in] = \mathbf{27.98}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((27.98[in] + 6.15[in])^2 + (4.04[in] +$

$13.35[in])^2)^{1/2} = \mathbf{38.3}[in]$ p. 13-5

$H_b = \alpha*P/r = 27.98[in]*60[kip]/38.3[in] = \mathbf{43.83}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*60[kip]/38.3[in] = \mathbf{9.63}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 13.35[in]*60[kip]/38.3[in] - 0[kip] = \mathbf{20.91}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.04[in]*60[kip]/38.3[in] + 0[kip] = \mathbf{6.33}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(20.91[kip]*(27.98[in] - 27.98[in])) +$

$abs(0[kip]*27.98[in]) = \mathbf{9.29E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.63[kip]*(4.04[in] - 4.04[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.04}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.04[in] + 13.35[in])*1.96 - 6.15[in] = \mathbf{27.98}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((27.98[in] + 6.15[in])^2 + (4.04[in] +$

$13.35[in])^2)^{1/2} = \mathbf{38.3}[in]$ p. 13-5

$H_b = \alpha*P/r = 27.98[in]*-60[kip]/38.3[in] = \mathbf{-43.83}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.15[in]*-60[kip]/38.3[in] = \mathbf{-9.63}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 13.35[in]*-60[kip]/38.3[in] - 0[kip] = \mathbf{-20.91}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.04[in]*-60[kip]/38.3[in] + 0[kip] = \mathbf{-6.33}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-20.91[kip]*(27.98[in] - 27.98[in])) +
abs(0[kip]*27.98[in]) = **9.29E-15**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-9.63[kip]*(4.04[in] - 4.04[in])) = **0**[kip*ft] p. 13-10

Upper right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	43.83	20.91	0.00	0.00	0.00	0.00	Design
DL1	-43.83	-20.91	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	815.23	20.91	DL	0.03	Eq. J4-1
A_g = L_p*t_p = 54.46[in]*0.5[in] = **27.23**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*27.23[in2] = **815.23**[kip]						Eq. J4-1
Shear yielding	[Kip]	544.58	43.83	DL	0.08	Eq. J4-3
A_g = L_p*t_p = 54.46[in]*0.5[in] = **27.23**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*27.23[in2] = **544.58**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	110592.60	DL	0.03	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 20.91[kip]/(0.5[in]*54.46[in]) = **768**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	231779.00	DL	0.08	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 43.83[kip]/(0.5[in]*54.46[in]) = **1609.58**[lb/in2]						9
Weld capacity	[Kip]	461.46	60.70	DL	0.13	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.12[kip/in]*1*4*54.46[in]) = **461.46**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 20.91[kip]/54.46[in] = **0.384**[kip/in]						9
f_{uv} = H_b/l = 43.83[kip]/54.46[in] = **0.805**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 9.29E-15[kip*ft]/(54.46[in]^2/6) = **2.25E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.384[kip/in] + 2.25E-16[kip/in])^2 + 0.805[kip/in^2])$^{1/2}$ = **0.892**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.384[kip/in] - 2.25E-16[kip/in])^2 + 0.805[kip/in^2])$^{1/2}$ + ((0.384[kip/in] + 2.25E-16[kip/in])^2 + 0.805[kip/in^2])$^{1/2}$) = **0.892**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 54.46[in]*max(0.892[kip/in], 1.25*0.892[kip/in]) =
60.7[kip] 9

Beam

Weld block shear	[Kip]	597.71	43.83	DL	0.07	Eq. J4-5

$A_{gv} = l$*t_w = 54.46[in]*0.46[in] = **25.05**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (24.8[in2] - 0.46[in]*24.22[in])/2 = **6.83**[in2] 8

$A_{nv} = A_{gv}$ = **25.05**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **6.83**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*25.05[in2] + 1*65000[lb/in2]*6.83[in2], 0.6*50000[lb/in2]*25.05[in2] + 1*
65000[lb/in2]*6.83[in2]) = **597.71**[kip] Eq. J4-5

Web crippling	[Kip]	568.45	20.91	DL1	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **54.46**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.46[in]^2*(1 + 3*(54.46[in]/26.7[in])*(0.46[in]/0.64[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.64[in]/0.46[in])$^{1/2}$ = **568.45**[kip] Eq. J10-4

Local web yielding	[Kip]	930.08	20.91	DL	0.02	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **54.46**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)$*(5*$k$ + N)*F_{yw}*t_w = 0.667*(5*1.24[in] + 54.46[in])*50000[lb/in2]*0.46[in] =
930.08[kip] Eq. J10-2

Ratio **0.13**

Upper right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	6.33	9.63	0.00	0.00	0.00	Design
DL1	-6.33	-9.63	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	6.00	4.04	8.08	✔	p. 10-104
$L_{min} = T/2 = 8.08$[in]$/2 =$ **4.04**[in]						p. 10-104
$L_{max} = L =$ **8.08**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.54	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	11.53	DL	0.34	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*16.87$[kip]$*1 =$ **33.75**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	6.33	DL	0.15	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	6.33	DL	0.14	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	6.33	DL	0.23	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	6.33	DL	0.17	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	9.63	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	9.63	DL	0.14	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	9.63	DL	0.21	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6[in] - 2*1.13[in])*0.375[in] = \mathbf{1.41}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25[in2], 1.41[in2]) = \mathbf{1.41}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*1.41[in2] = \mathbf{45.7}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	43.88	9.63	DL	0.22	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.375[in] = \mathbf{0.703}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*0.703[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*0.703[in2]) = \mathbf{43.88}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	61.57	11.53	DL	0.19	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*5.13[kip/in]*1*4*6[in] = \mathbf{61.57}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	152.99	9.63	DL1	0.06	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{3}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43[in]^2*(1 + 3*(3[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.67[in]/0.43[in])^{1/2} = \mathbf{152.99}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	6.33	DL	0.08	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.54[in] - 1.06[in]/2) = \mathbf{2.01}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.01[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*$
$65000[lb/in2]*1 = \mathbf{76.78}$[kip] Eq. J3-6

Shear yielding	[Kip]	80.79	6.33	DL	0.08	Eq. J4-3

$A_g = L_p*t_p = 8.08[in]*0.5[in] = \mathbf{4.04}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.04[in2] = \mathbf{80.79}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	9.63	DL	0.13	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5[in] - 1.06[in]/2) = \mathbf{1.97}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	120.94	9.63	DL	0.08	Eq. J4-1

$A_g = L_p*t_p$ = 8.08[in]*0.5[in] = **4.04**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.04[in2] = **120.94**[kip] Eq. J4-1

Tension rupture	[Kip]	94.72	9.63	DL	0.10	Eq. J4-2

$A_g = L_p*t_p$ = 8.08[in]*0.5[in] = **4.04**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.08[in] - 2*1.13[in])*0.5[in] = **2.91**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.04[in2], 2.91[in2]) = **2.91**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*2.91[in2] = **94.72**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	9.63	DL	0.14	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + $U_{bs}*F_u*A_{nt}$, 0.6*F_y*A_{gv} + $U_{bs}*F_u*A_{nt}$) =
0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	16.68	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.67[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 11.53[kip]/(0.5*5.13[kip/in]*1*6[in]) = **0.749** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.749/16 [in] = **1.39**[kip/in] p. 9-5

Ratio **0.34**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 0[kip] + 43.83[kip] + 0[kip] = **43.83**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 75[kip] - 20.91[kip] + 0[kip] = **54.09**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 0[kip] + -43.83[kip] + 0[kip] = \mathbf{-43.83}[kip]$

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 75[kip] - -20.91[kip] + 0[kip] = \mathbf{95.91}[kip]$

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	54.09	43.83	0.00	0.00	0.00	Design
DL1	95.91	-43.83	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	21.00	12.11	24.22	✔	p. 10-104
$L_{min} = T/2 = 24.22[in]/2 = \mathbf{12.11}[in]$						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 26.7[in] - \max(1.24[in], 0[in]) - \max(1.24[in], 0[in]) = \mathbf{24.22}[in]$						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16\ [in] = 1[in]/2 + 1/16\ [in] = \mathbf{0.563}[in]$						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1[in] = \mathbf{2}[in]$						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	11.04	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1[in] = \mathbf{2.67}[in]$						Sec. J3.3
$IsCorrosionConsidered \rightarrow \mathbf{False}$						
$s_{max} = \min(24*t_p, 12\ [in]) = \min(24*0.46[in], 12\ [in]) = \mathbf{11.04}[in]$						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = \mathbf{1.25}[in]$						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	118.12	105.45	DL1	0.89	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (7>=10) and (7<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 7*16.87[kip]*1 = **118.12**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	245.58	95.91	DL1	0.39	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(7 - 1))*0.5[in]*						
65000[lb/in2]*1 = **245.58**[kip]						Eq. J3-6
Shear yielding	[Kip]	210.00	95.91	DL1	0.46	Eq. J4-3
A_g = L_p*t_p = 21[in]*0.5[in] = **10.5**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*10.5[in2] = **210**[kip]						Eq. J4-3
Shear rupture	[Kip]	127.97	95.91	DL1	0.75	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 21[in] - 7*1.13[in] = **13.13**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 13.13[in]*0.5[in] = **6.56**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*6.56[in2] = **127.97**[kip]						Eq. J4-4
Block shear	[Kip]	142.19	95.91	DL1	0.67	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (7 - 1)*3[in])*0.5[in] = **9.75**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (7 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **6.09**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*6.09[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*9.75[in2] + 1*65000[lb/in2]*0.719[in2]) = **142.19**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	200.48	43.83	DL	0.22	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*7 = **200.48**[kip] Eq. J3-6

Tension yielding	[Kip]	314.37	43.83	DL	0.14	Eq. J4-1

A_g = L_p*t_p = 21[in]*0.5[in] = **10.5**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*10.5[in2] = **314.37**[kip] Eq. J4-1

Tension rupture	[Kip]	213.28	43.83	DL	0.21	Eq. J4-2

A_g = L_p*t_p = 21[in]*0.5[in] = **10.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (21[in] - 7*1.13[in])*0.5[in] = **6.56**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*10.5[in2], 6.56[in2]) = **6.56**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*6.56[in2] = **213.28**[kip] Eq. J4-2

Tear out under axial load	[Kip]	210.84	43.83	DL	0.21	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 7>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(7 - 1)*0.5[in] = **5.63**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*5.63[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*5.63[in2]) = **210.84**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	221.01	105.45	DL1	0.48	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*4.21[kip/in]*1*5*21[in] = **221.01**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	362.11	43.83	DL1	0.12	Eq. J10-4

IsBeamReaction → **False**

N = N = **18**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.43[in]^2*(1 + 3*(18[in]/12.3[in])*(0.43[in]/0.67[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.67[in]/0.43[in])^{1/2} = \mathbf{362.11}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	244.43	95.91	DL1	0.39	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35[in] - 1.06[in]/2) = \mathbf{3.82}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*3.82[in], 2.4*1[in]) + \text{min}(1.2*1.94[in], 2.4*1[in])*(7 - 1))*0.46[in]*$
$65000[lb/in2]*1 = \mathbf{244.43}[kip]$ Eq. J3-6

Shear yielding	[Kip]	245.64	95.91	DL1	0.39	Eq. J4-3

$A_g = L_p*t_p = 26.7[in]*0.46[in] = \mathbf{12.28}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*12.28[in2] = \mathbf{245.64}[kip]$ Eq. J4-3

Bolt bearing under axial load	[Kip]	215.84	43.83	DL	0.20	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\text{min}(k_1*L_{c\text{-}end}, k_2*d) + \text{min}(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\text{min}(1.2*1.72[in], 2.4*1[in]) + \text{min}(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.46[in]*$
$65000[lb/in2]*7 = \mathbf{215.84}[kip]$ Eq. J3-6

Yielding strength due to axial load	[Kip]	742.51	43.83	DL	0.06	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*24.8[in2] = \mathbf{742.51}[kip]$ Eq. D2-1

Tension rupture	[Kip]	375.94	43.83	DL	0.12	Eq. J4-2

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 24.8[in2] - 7*0.46[in]*1.13[in] = \mathbf{21.18}[in2]$ Sec. D3-2

$U = 1 - x/l = 1 - 1.36[in]/3[in] = \mathbf{0.546}$ Table D3.1

$A_e = U*A_n = 0.546*21.18[in2] = \mathbf{11.57}[in2]$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*11.57[in2] = \mathbf{375.94}[kip]$ Eq. J4-2

Tear out under axial load	[Kip]	198.46	43.83	DL	0.22	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$n>1 \rightarrow 7>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.46[in] = \mathbf{2.07}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -$
$0.5))*0.46[in] = \mathbf{1.55}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(7 - 1)*0.46[in] = \mathbf{5.18}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\text{min}(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\text{min}(0.6*65000[lb/in2]*1.55[in2] + 1*65000[lb/in2]*5.18[in2], 0.6*50000[lb/in2]*2.07[in2] + 1*65000[lb/$

in2]*5.18[in2]) = **198.46**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	313.56	53.14	DL1	0.17	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.67$[in] = **26.13**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 105.45$[kip]$/(0.5*4.21$[kip/in]$*1*21$[in]$) =$ **2.39** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.39/16$ [in] = **4.43**[kip/in] p. 9-5

Ratio **0.89**

Global critical strength ratio **0.89**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

Current Date: 2016-05-25 1:10 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-13**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W24X68

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	35.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.00	Design
DL1	-35.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-60.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
60.00	DL	Design
-60.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	259.86	60.00	DL	0.23	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*14$[in] = **3.09**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*3.09$[in2]$)$ = **129.93**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 129.93$[kip] + 129.93[kip] = **259.86**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	453.10	60.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.465$[in] = **13.02**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*13.02$[in2]$)$ = **453.1**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	273.00	60.00	DL	0.22	Eq. J4-4

$L_e = L_t + L_h = 14$[in] + 14[in] = **28**[in]

$A_{nv} = L_e*t_p = 28$[in]$*0.5$[in] = **14**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*14$[in2] = **273**[kip] Eq. J4-4

Block shear on gusset	[Kip]	363.75	60.00	DL	0.16	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(14$[in], 14[in]$) =$ **14**[in]

$L = L_{max} + d_w = 14$[in] + 0.5[in] = **14.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*14.5$[in]$*0.5$[in] = **14.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **14.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 9$[in]$*0.5$[in] = **4.5**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2], $0.6*50000$[lb/in2]$*14.5$[in2] + $1*65000$[lb/in2]$*4.5$[in2]$) =$ **363.75**[kip] Eq. J4-5

Ratio **0.23**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	421.44	60.00	DL	0.14	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*15.3$[in2] = **421.44**[kip] Eq. J4-1

Tension rupture	[Kip]	323.94	60.00	DL	0.19	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 15.3[in2] - 2*(0.5[in] + 1/8\ [in])*0.465[in] = \mathbf{14.72}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3.38[in]/14[in] = \mathbf{0.759}$ Table D3.1

$A_e = A_n*U = 14.72[in2]*0.759 = \mathbf{11.17}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*11.17[in2] = \mathbf{323.94}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	314.64	60.00	DL	0.19	Eq. J4-1

$A_g = L_w*t_p = 21.02[in]*0.5[in] = \mathbf{10.51}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*10.51[in2] = \mathbf{314.64}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	210.82	60.00	DL1	0.28	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*16.82[in]/0.144[in])^2 = \mathbf{49877.35}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 49877.35[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/49877.35[lb/in2])}*50000[lb/in2] =$

32866.16[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*32866.16[lb/in2]*10.71[in2] = \mathbf{210.82}[kip]$ Eq. E3-1

Ratio **0.28**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.36}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.36[in] + 11.85[in])*1.96 - 6.25[in] = \mathbf{25.57}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((25.57[in] + 6.25[in])^2 + (4.36[in] +$

$11.85[in])^2)^{1/2} = \mathbf{35.71}[in]$ p. 13-5

$H_b = \alpha*P/r = 25.57[in]*60[kip]/35.71[in] = \mathbf{42.96}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*60[kip]/35.71[in] = \mathbf{10.5}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.85[in]*60[kip]/35.71[in] - 0[kip] = \mathbf{19.91}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.36[in]*60[kip]/35.71[in] + 0[kip] = \mathbf{7.33}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(19.91[kip]*(25.57[in] - 25.57[in])) +$

$abs(0[kip]*25.57[in]) = \mathbf{8.84E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(10.5[kip]*(4.36[in] - 4.36[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.36}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.36[in] + 11.85[in])*1.96 - 6.25[in] = \mathbf{25.57}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((25.57[in] + 6.25[in])^2 + (4.36[in] +$

$11.85[in])^2)^{1/2} = \mathbf{35.71}[in]$ p. 13-5

$H_b = \alpha*P/r = 25.57[in]*-60[kip]/35.71[in] = \mathbf{-42.96}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.25[in]*-60[kip]/35.71[in] = \mathbf{-10.5}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 11.85[in]*-60[kip]/35.71[in] - 0[kip] = \mathbf{-19.91}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.36[in]*-60[kip]/35.71[in] + 0[kip] = \mathbf{-7.33}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-19.91[kip]*(25.57[in] - 25.57[in])) +
abs(0[kip]*25.57[in]) = **8.84E-15**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-10.5[kip]*(4.36[in] - 4.36[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	42.96	19.91	0.00	0.00	0.00	0.00	Design
DL1	-42.96	-19.91	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	742.99	19.91	DL	0.03	Eq. J4-1
A_g = L_p*t_p = 49.63[in]*0.5[in] = **24.82**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*24.82[in2] = **742.99**[kip]						Eq. J4-1
Shear yielding	[Kip]	496.32	42.96	DL	0.09	Eq. J4-3
A_g = L_p*t_p = 49.63[in]*0.5[in] = **24.82**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*24.82[in2] = **496.32**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	115542.20	DL	0.03	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 19.91[kip]/(0.5[in]*49.63[in]) = **802.38**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	249277.10	DL	0.09	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 42.96[kip]/(0.5[in]*49.63[in]) = **1731.09**[lb/in2]						9
Weld capacity	[Kip]	418.74	59.19	DL	0.14	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.11[kip/in]*1*4*49.63[in]) = **418.74**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 19.91[kip]/49.63[in] = **0.401**[kip/in]						9
f_{uv} = H_b/l = 42.96[kip]/49.63[in] = **0.866**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 8.84E-15[kip*ft]/(49.63[in]^2/6) = **2.58E-16**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.401[kip/in] + 2.58E-16[kip/in])^2 + 0.866[kip/in^2])$^{1/2}$ = **0.954**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.401[kip/in] - 2.58E-16[kip/in])^2 + 0.866[kip/in^2])$^{1/2}$ + ((0.401[kip/in] + 2.58E-16[kip/in])^2 + 0.866[kip/in^2])$^{1/2}$) = **0.954**[kip/in]						9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve}) = 49.63[in]*\max(0.954[kip/in], 1.25*0.954[kip/in]) =$
59.19[kip] 9

Beam

Weld block shear	[Kip]	490.46	42.96	DL	0.09	Eq. J4-5

$A_{gv} = l*t_w = 49.63[in]*0.415[in] =$ **20.6**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2 = (20.1[in2] - 0.415[in]*21.52[in])/2 =$ **5.58**[in2] 8

$A_{nv} = A_{gv} =$ **20.6**[in2] Sec. J4.3

$A_{nt} = A_{gt} =$ **5.58**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*20.6[in2] + 1*65000[lb/in2]*5.58[in2], 0.6*50000[lb/in2]*20.6[in2] + 1*65000[lb/in2]*5.58[in2]) =$ **490.46**[kip] Eq. J4-5

Web crippling	[Kip]	468.20	19.91	DL1	0.04	Eq. J10-4

IsBeamReaction → **False**

$N = N =$ **49.63**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.415[in]^2*(1 + 3*(49.63[in]/23.7[in])*(0.415[in]/0.585[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.585[in]/0.415[in])^{1/2} =$ **468.2**[kip] Eq. J10-4

Local web yielding	[Kip]	761.96	19.91	DL	0.03	Eq. J10-2

IsBeamReaction → **False**

$N = N =$ **49.63**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w = 0.667*(5*1.09[in] + 49.63[in])*50000[lb/in2]*0.415[in] =$
761.96[kip] Eq. J10-2

Ratio **0.14**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	7.33	10.50	0.00	0.00	0.00	Design
DL1	-7.33	-10.50	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	6.00	4.36	8.72	✔	p. 10-104
$L_{min} = T/2 = 8.72$[in]$/2 =$ **4.36**[in]						p. 10-104
$L_{max} = L =$ **8.72**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.86	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	33.75	12.81	DL	0.38	Tables (7-1..14)
(*n*>=10) and (*n*<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*16.87$[kip]$*1 =$ **33.75**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	37.93	7.33	DL	0.19	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
58000[lb/in2]*1 = **37.93**[kip] Eq. J3-6

Shear yielding	[Kip]	32.40	7.33	DL	0.23	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*36000[lb/in2]*2.25[in2] = **32.4**[kip] Eq. J4-3

Shear rupture	[Kip]	24.47	7.33	DL	0.30	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*58000[lb/in2]*1.41[in2] = **24.47**[kip] Eq. J4-4

Block shear	[Kip]	33.86	7.33	DL	0.22	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*58000[lb/in2]*1.05[in2] + 1*58000[lb/in2]*0.539[in2], 0.6*36000[lb/in2]*1.69[in2] + 1*58000[lb/
in2]*0.539[in2]) = **33.86**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	38.33	10.50	DL	0.27	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
58000[lb/in2]*2 = **38.33**[kip] Eq. J3-6

Tension yielding	[Kip]	48.50	10.50	DL	0.22	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*36000[lb/in2]*2.25[in2] = **48.5**[kip] Eq. J4-1

Tension rupture	[Kip]	40.78	10.50	DL	0.26	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (6[in] - 2*1.13[in])*0.375[in] = **1.41**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*2.25[in2], 1.41[in2]) = **1.41**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*58000[lb/in2]*1.41[in2] = **40.78**[kip] Eq. J4-2

Tear out under axial load	[Kip]	36.59	10.50	DL	0.29	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = **1.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = **1.08**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.375[in] = **0.703**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*58000[lb/in2]*1.08[in2] + 1*58000[lb/in2]*0.703[in2], 0.6*36000[lb/in2]*1.5[in2] + 1*58000[lb/in2]*0.703[in2]) = **36.59**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	61.09	12.81	DL	0.21	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)*C*C_1*D*L = 0.5*5.09[kip/in]*1*4*6[in] = **61.09**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	218.69	10.50	DL1	0.05	Eq. J10-4

IsBeamReaction → **False**

N = N = **3**[in] Sec. J10-2

(1/Ω)R_n = *(1/Ω)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ = 0.5*0.80*0.515[in]^2*(1 + 3*(3[in]/12.5[in])*(0.515[in]/0.81[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.81[in]/0.515[in])$^{1/2}$ = **218.69**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	7.33	DL	0.10	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.86[in] - 1.06[in]/2) = **2.33**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*2.33[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*65000[lb/in2]*1 = **76.78**[kip] Eq. J3-6

Shear yielding	[Kip]	87.22	7.33	DL	0.08	Eq. J4-3

A_g = L_p*t_p = 8.72[in]*0.5[in] = **4.36**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.36[in2] = **87.22**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	10.50	DL	0.14	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2.5[in] - 1.06[in]/2) = **1.97**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	130.57	10.50	DL	0.08	Eq. J4-1

$A_g = L_p*t_p$ = 8.72[in]*0.5[in] = **4.36**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*4.36[in2] = **130.57**[kip] Eq. J4-1

Tension rupture	[Kip]	105.17	10.50	DL	0.10	Eq. J4-2

$A_g = L_p*t_p$ = 8.72[in]*0.5[in] = **4.36**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.72[in] - 2*1.13[in])*0.5[in] = **3.24**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.36[in2], 3.24[in2]) = **3.24**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3.24[in2] = **105.17**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	10.50	DL	0.15	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	18.68	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.81[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 12.81[kip]/(0.5*5.09[kip/in]*1*6[in]) = **0.838** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.838/16 [in] = **1.56**[kip/in] p. 9-5

Ratio **0.38**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 35[kip] + 0[kip] + 42.96[kip] = **77.96**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 35[kip] - 0[kip] + 19.91[kip] = **54.91**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = -35[kip] + 0[kip] + -42.96[kip] = **-77.96**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 35[kip] - 0[kip] + -19.91[kip] = **15.09**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	54.91	77.96	0.00	0.00	0.00	Design
DL1	15.09	-77.96	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	18.00	10.76	21.52	✔	p. 10-104
$L_{min} = T/2$ = 21.52[in]/2 = **10.76**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 23.7[in] - max(1.09[in], 0[in]) - max(1.09[in], 0[in]) = **21.52**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2$ + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d$ = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.96	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d$ = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.415[in], 12 [in]) = **9.96**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	101.25	95.36	DL	0.94	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (6>=10) and (6<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 6*16.87[kip]*1 = **101.25**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	207.80	54.91	DL	0.26	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(6 - 1))*0.5[in]*						
65000[lb/in2]*1 = **207.8**[kip]						Eq. J3-6
Shear yielding	[Kip]	180.00	54.91	DL	0.31	Eq. J4-3
A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*9[in2] = **180**[kip]						Eq. J4-3
Shear rupture	[Kip]	109.69	54.91	DL	0.50	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 18[in] - 6*1.13[in] = **11.25**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 11.25[in]*0.5[in] = **5.63**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*5.63[in2] = **109.69**[kip]						Eq. J4-4
Block shear	[Kip]	123.91	54.91	DL	0.44	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (6 - 1)*3[in])*0.5[in] = **8.25**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (6 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **5.16**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*5.16[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*8.25[in2] + 1*65000[lb/in2]*0.719[in2]) = **123.91**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	171.84	77.96	DL	0.45	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*6 = **171.84**[kip] Eq. J3-6

Tension yielding	[Kip]	269.46	77.96	DL	0.29	Eq. J4-1

A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*9[in2] = **269.46**[kip] Eq. J4-1

Tension rupture	[Kip]	182.81	77.96	DL	0.43	Eq. J4-2

A_g = L_p*t_p = 18[in]*0.5[in] = **9**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (18[in] - 6*1.13[in])*0.5[in] = **5.63**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*9[in2], 5.63[in2]) = **5.63**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*5.63[in2] = **182.81**[kip] Eq. J4-2

Tear out under axial load	[Kip]	180.38	77.96	DL	0.43	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 6>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(6 - 1)*0.5[in] = **4.69**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*4.69[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*4.69[in2]) = **180.38**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	228.80	95.36	DL	0.42	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*5.08[kip/in]*1*5*18[in] = **228.8**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	452.62	77.96	DL1	0.17	Eq. J10-4

IsBeamReaction → **False**

N = N = **15**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.515_{[in]}{}^2*(1 + 3*(15_{[in]}/12.5_{[in]})*(0.515_{[in]}/0.81_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*$
$0.81_{[in]}/0.515_{[in]})^{1/2} = \mathbf{452.62}_{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	189.16	54.91	DL	0.29	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35_{[in]} - 1.06_{[in]}/2) = \mathbf{3.82}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 1.06_{[in]}) = \mathbf{1.94}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.82_{[in]}, 2.4*1_{[in]}) + \min(1.2*1.94_{[in]}, 2.4*1_{[in]})*(6 - 1))*0.415_{[in]}*$
$65000_{[lb/in2]}*1 = \mathbf{189.16}_{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	196.71	54.91	DL	0.28	Eq. J4-3

$A_g = L_p*t_p = 23.7_{[in]}*0.415_{[in]} = \mathbf{9.84}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*9.84_{[in2]} = \mathbf{196.71}_{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	166.91	77.96	DL	0.47	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25_{[in]} - 1.06_{[in]}/2) = \mathbf{1.72}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 1.06_{[in]}) = \mathbf{1.94}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72_{[in]}, 2.4*1_{[in]}) + \min(1.2*1.94_{[in]}, 2.4*1_{[in]})*(1 - 1))*0.415_{[in]}*$
$65000_{[lb/in2]}*6 = \mathbf{166.91}_{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	601.80	77.96	DL	0.13	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*20.1_{[in2]} = \mathbf{601.8}_{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	330.80	77.96	DL	0.24	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16_{[in]} = 1.06_{[in]} + 1/16_{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 20.1_{[in2]} - 6*0.415_{[in]}*1.13_{[in]} = \mathbf{17.3}_{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 1.23_{[in]}/3_{[in]} = \mathbf{0.588}$ Table D3.1

$A_e = U*A_n = 0.588*17.3_{[in2]} = \mathbf{10.18}_{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000_{[lb/in2]}*10.18_{[in2]} = \mathbf{330.8}_{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	153.76	77.96	DL	0.51	Eq. J4-5

$dh_h = d_h + 1/16_{[in]} = 1.06_{[in]} + 1/16_{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16_{[in]} = 1.06_{[in]} + 1/16_{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 6>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25_{[in]} + (1 - 1)*3_{[in]})*0.415_{[in]} = \mathbf{1.87}_{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25_{[in]} + (1 - 1)*3_{[in]} - 1.13_{[in]}*(1 -$
$0.5))*0.415_{[in]} = \mathbf{1.4}_{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3_{[in]} - 1.13_{[in]})*(6 - 1)*0.415_{[in]} = \mathbf{3.89}_{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000_{[lb/in2]}*1.4_{[in2]} + 1*65000_{[lb/in2]}*3.89_{[in2]}, 0.6*50000_{[lb/in2]}*1.87_{[in2]} + 1*65000_{[lb/}$

in2]*3.89[in2]) = **153.76**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	379.08	46.42	DL	0.12	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.81$[in] = **31.59**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 95.36$[kip]$/(0.5*5.08$[kip/in]$*1*18$[in]$) =$ **2.08** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.08/16$ [in] = **3.87**[kip/in] p. 9-5

Ratio **0.94**

Global critical strength ratio **0.94**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-14**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W21X44

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	8.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	Design
DL1	-8.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-25.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
25.00	DL	Design
-25.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	185.62	25.00	DL	0.13	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*10$[in] = **2.21**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.21$[in2]$)$ = **92.81**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 92.81$[kip] + 92.81[kip] = **185.62**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	25.00	DL	0.10	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	25.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	287.50	25.00	DL	0.09	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv}$ = **10.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + 1*65000[lb/in2]$*4$[in2], 0.6*50000[lb/in2]$*10.5$[in2] + 1*65000[lb/in2]$*4$[in2]$) =$ **287.5**[kip] — Eq. J4-5

Ratio **0.13**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	25.00	DL	0.09	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] — Eq. J4-1

Tension rupture	[Kip]	202.26	25.00	DL	0.12	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 10.4[in2] - 2*(0.5[in] + 1/8\ [in])*0.349[in] = \mathbf{9.96}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/10[in] = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 9.96[in2]*0.7 = \mathbf{6.97}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*6.97[in2] = \mathbf{202.26}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	258.95	25.00	DL	0.10	Eq. J4-1

$A_g = L_w*t_p = 17.3[in]*0.5[in] = \mathbf{8.65}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.65[in2] = \mathbf{258.95}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	154.27	25.00	DL1	0.16	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*18.69[in]/0.144[in])^2 = \mathbf{40405.56}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 40405.56[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/40405.56[lb/in2])}*50000[lb/in2] =$

$\mathbf{29787.43}[lb/in2]$ Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*29787.43[lb/in2]*8.65[in2] = \mathbf{154.27}[kip]$ Eq. E3-1

Ratio **0.16**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.06}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.06[in] + 10.35[in])*1.96 - 5[in] = \mathbf{23.28}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((23.28[in] + 5[in])^2 + (4.06[in] + 10.35[in])^2)^{1/2} = \mathbf{31.74}[in]$ p. 13-5

$H_b = \alpha*P/r = 23.28[in]*25[kip]/31.74[in] = \mathbf{18.34}[kip]$ p. 13-5

$H_c = e_c*P/r = 5[in]*25[kip]/31.74[in] = \mathbf{3.94}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35[in]*25[kip]/31.74[in] - 0[kip] = \mathbf{8.15}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.06[in]*25[kip]/31.74[in] + 0[kip] = \mathbf{3.2}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(8.15[kip]*(23.28[in] - 23.28[in])) + abs(0[kip]*23.28[in]) = \mathbf{1.81E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(3.94[kip]*(4.06[in] - 4.06[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{4.06}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (4.06[in] + 10.35[in])*1.96 - 5[in] = \mathbf{23.28}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((23.28[in] + 5[in])^2 + (4.06[in] + 10.35[in])^2)^{1/2} = \mathbf{31.74}[in]$ p. 13-5

$H_b = \alpha*P/r = 23.28[in]*-25[kip]/31.74[in] = \mathbf{-18.34}[kip]$ p. 13-5

$H_c = e_c*P/r = 5[in]*-25[kip]/31.74[in] = \mathbf{-3.94}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 10.35[in]*-25[kip]/31.74[in] - 0[kip] = \mathbf{-8.15}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 4.06[in]*-25[kip]/31.74[in] + 0[kip] = \mathbf{-3.2}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-8.15[kip]*(23.28[in] - 23.28[in])) + abs(0[kip]*23.28[in]) = **1.81E-15**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-3.94[kip]*(4.06[in] - 4.06[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	18.34	8.15	0.00	0.00	0.00	0.00	Design
DL1	-18.34	-8.15	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	674.47	8.15	DL	0.01	Eq. J4-1
A_g = L_p*t_p = 45.05[in]*0.5[in] = **22.53**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*22.53[in2] = **674.47**[kip]						Eq. J4-1
Shear yielding	[Kip]	450.54	18.34	DL	0.04	Eq. J4-3
A_g = L_p*t_p = 45.05[in]*0.5[in] = **22.53**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*22.53[in2] = **450.54**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	52117.07	DL	0.01	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 8.15[kip]/(0.5[in]*45.05[in]) = **361.92**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	117211.60	DL	0.04	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 18.34[kip]/(0.5[in]*45.05[in]) = **813.97**[lb/in2]						9
Weld capacity	[Kip]	377.83	25.08	DL	0.07	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.1[kip/in]*1*4*45.05[in]) = **377.83**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 8.15[kip]/45.05[in] = **0.181**[kip/in]						9
f_{uv} = H_b/l = 18.34[kip]/45.05[in] = **0.407**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 1.81E-15[kip*ft]/(45.05[in]^2/6) = **6.42E-17**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.181[kip/in] + 6.42E-17[kip/in])^2 + 0.407[kip/in]^2)$^{1/2}$ = **0.445**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.181[kip/in] - 6.42E-17[kip/in])^2 + 0.407[kip/in]^2)$^{1/2}$ + ((0.181[kip/in] + 6.42E-17[kip/in])^2 + 0.407[kip/in]^2)$^{1/2}$) = **0.445**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 45.05[in]*max(0.445[kip/in], 1.25*0.445[kip/in]) =
25.08[kip] 9

Beam

Weld block shear	[Kip]	340.86	18.34	DL	0.05	Eq. J4-5

$A_{gv} = l$*t_w = 45.05[in]*0.35[in] = **15.77**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (13[in2] - 0.35[in]*18.8[in])/2 = **3.21**[in2] 8

$A_{nv} = A_{gv}$ = **15.77**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.21**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*15.77[in2] + 1*65000[lb/in2]*3.21[in2], 0.6*50000[lb/in2]*15.77[in2] + 1*
65000[lb/in2]*3.21[in2]) = **340.86**[kip] Eq. J4-5

Web crippling	[Kip]	366.56	8.15	DL1	0.02	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **45.05**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)$*0.80*$t_w^2$*(1 + 3*($N/d$)*($t_w/t_f$)$^{1.5}$)*($E$*$F_{yw}$*$t_f/t_w$)$^{1/2}$ = 0.5*
0.80*0.35[in]^2*(1 + 3*(45.05[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.45[in]/0.35[in])$^{1/2}$ = **366.56**[kip] Eq. J10-4

Local web yielding	[Kip]	581.05	8.15	DL	0.01	Eq. J10-2

IsBeamReaction → **False**

$N = N$ = **45.05**[in] Sec. J10-2

IsMemberEnd → **False**

$(1/\Omega)R_n = (1/\Omega)$*(5*$k$ + N)*F_{yw}*t_w = 0.667*(5*0.95[in] + 45.05[in])*50000[lb/in2]*0.35[in] =
581.05[kip] Eq. J10-2

Ratio **0.07**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	3.20	3.94	0.00	0.00	0.00	Design
DL1	-3.20	-3.94	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	6.00	4.06	8.12	✔	p. 10-104
$L_{min} = T/2 = 8.12$[in]$/2 =$ **4.06**[in]						p. 10-104
$L_{max} = L =$ **8.12**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d = 8/3*1$[in] $=$ **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
$s_{max} = \min(24*t_p, 12$ [in]$) = \min(24*0.375$[in]$, 12$ [in]$) =$ **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	2.56	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] $+ 0$[in] $=$ **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
$L_{emin} = 2*d = 2*1$[in] $=$ **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
$w_{min} = (5/8)*t_p = (5/8)*0.375$[in] $=$ **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	33.75	5.07	DL	0.15	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (2>=10) and (2<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
$k_s = \max(1 - T_u/((1/\Omega)*D_u*T_b*N_b), 0.0) = \max(1 - 0$[kip]$/(0.667*1.13*64$[kip]$*1), 0.0) =$ **1**						Eq. J3-5
$(1/\Omega)R_n = (1/\Omega)*\mu*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64$[kip]$*1*1 =$ **16.87**[kip]						Eq. J3-4
$(1/\Omega)R_n = C*(1/\Omega)R_n*BoltFactor = 2*16.87$[kip]$*1 =$ **33.75**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	42.50	3.20	DL	0.08	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.375[in]*
65000[lb/in2]*1 = **42.5**[kip] Eq. J3-6

Shear yielding	[Kip]	45.00	3.20	DL	0.07	Eq. J4-3

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*2.25[in2] = **45**[kip] Eq. J4-3

Shear rupture	[Kip]	27.42	3.20	DL	0.12	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 6[in] - 2*1.13[in] = **3.75**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 3.75[in]*0.375[in] = **1.41**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*1.41[in2] = **27.42**[kip] Eq. J4-4

Block shear	[Kip]	38.09	3.20	DL	0.08	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (2 - 1)*3[in])*0.375[in] = **1.69**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (2 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **1.05**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.05[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*1.69[in2] + 1*65000[lb/
in2]*0.539[in2]) = **38.09**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	42.96	3.94	DL	0.09	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*2 = **42.96**[kip] Eq. J3-6

Tension yielding	[Kip]	67.37	3.94	DL	0.06	Eq. J4-1

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*F_y*A_g = 0.599*50000[lb/in2]*2.25[in2] = **67.37**[kip] Eq. J4-1

Tension rupture	[Kip]	45.70	3.94	DL	0.09	Eq. J4-2

A_g = L_p*t_p = 6[in]*0.375[in] = **2.25**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p = (6[in] - 2*1.13[in])*0.375[in] = \mathbf{1.41}$[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*2.25[in2], 1.41[in2]) = \mathbf{1.41}$[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*1.41[in2] = \mathbf{45.7}$[kip] Eq. J4-2

Tear out under axial load	[Kip]	43.88	3.94	DL	0.09	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 2>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = \mathbf{1.5}$[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = \mathbf{1.08}$[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.375[in] = \mathbf{0.703}$[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*0.703[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*0.703[in2]) = \mathbf{43.88}$[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	59.79	5.07	DL	0.08	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L = 0.5*4.98[kip/in]*1*4*6[in] = \mathbf{59.79}$[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	101.88	3.94	DL1	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N = \mathbf{3}$[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34[in]^2*(1 + 3*(3[in]/10[in])*(0.34[in]/0.56[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.56[in]/0.34[in])^{1/2} = \mathbf{101.88}$[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	76.78	3.20	DL	0.04	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.56[in] - 1.06[in]/2) = \mathbf{2.03}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*2.03[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(2 - 1))*0.5[in]*$
$65000[lb/in2]*1 = \mathbf{76.78}$[kip] Eq. J3-6

Shear yielding	[Kip]	81.16	3.20	DL	0.04	Eq. J4-3

$A_g = L_p*t_p = 8.12[in]*0.5[in] = \mathbf{4.06}$[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.06[in2] = \mathbf{81.16}$[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	76.78	3.94	DL	0.05	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.5[in] - 1.06[in]/2) = \mathbf{1.97}$[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}$[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*2 = **76.78**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	121.50	3.94	DL	0.03	Eq. J4-1

$A_g = L_p*t_p$ = 8.12[in]*0.5[in] = **4.06**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*4.06[in2] = **121.5**[kip] Eq. J4-1

Tension rupture	[Kip]	95.32	3.94	DL	0.04	Eq. J4-2

$A_g = L_p*t_p$ = 8.12[in]*0.5[in] = **4.06**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (8.12[in] - 2*1.13[in])*0.5[in] = **2.93**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*4.06[in2], 2.93[in2]) = **2.93**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)*F_u*A_e = 0.5*65000[lb/in2]*2.93[in2] = **95.32**[kip] Eq. J4-2

Tear out under axial load	[Kip]	67.97	3.94	DL	0.06	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 2>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(2 - 1)*0.5[in] = **0.938**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + $U_{bs}*F_u*A_{nt}$, 0.6*F_y*A_{gv} + $U_{bs}*F_u*A_{nt}$) = 0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*0.938[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*0.938[in2]) = **67.97**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	7.56	DL	0.03	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.56[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 5.07[kip]/(0.5*4.98[kip/in]*1*6[in]) = **0.339** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.339/16 [in] = **0.63**[kip/in] p. 9-5

Ratio **0.15**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 8[kip] + 0[kip] + 18.34[kip] = **26.34**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 20[kip] - 0[kip] + 8.15[kip] = **28.15**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = -8[kip] + 0[kip] + -18.34[kip] = **-26.34**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 20[kip] - 0[kip] + -8.15[kip] = **11.85**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	28.15	26.34	0.00	0.00	0.00	Design
DL1	11.85	-26.34	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	15.00	9.40	18.80	✔	p. 10-104
$L_{min} = T/2$ = 18.8[in]/2 = **9.4**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 20.7[in] - max(0.95[in], 0[in]) - max(0.95[in], 0[in]) = **18.8**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2$ + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d$ = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	8.40	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d$ = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.35[in], 12 [in]) = **8.4**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.35	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	84.37	38.55	DL	0.46	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (5>=10) and (5<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 5*16.87[kip]*1 = **84.37**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	170.02	28.15	DL	0.17	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(5 - 1))*0.5[in]*						
65000[lb/in2]*1 = **170.02**[kip]						Eq. J3-6
Shear yielding	[Kip]	150.00	28.15	DL	0.19	Eq. J4-3
A_g = L_p*t_p = 15[in]*0.5[in] = **7.5**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.5[in2] = **150**[kip]						Eq. J4-3
Shear rupture	[Kip]	91.41	28.15	DL	0.31	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 15[in] - 5*1.13[in] = **9.38**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 9.38[in]*0.5[in] = **4.69**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*4.69[in2] = **91.41**[kip]						Eq. J4-4
Block shear	[Kip]	105.63	28.15	DL	0.27	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (5 - 1)*3[in])*0.5[in] = **6.75**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (5 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **4.22**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*4.22[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*6.75[in2] + 1*65000[lb/in2]*0.719[in2]) = **105.63**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	143.20	26.34	DL	0.18	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*5 = **143.2**[kip] Eq. J3-6

Tension yielding	[Kip]	224.55	26.34	DL	0.12	Eq. J4-1

A_g = L_p*t_p = 15[in]*0.5[in] = **7.5**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*7.5[in2] = **224.55**[kip] Eq. J4-1

Tension rupture	[Kip]	152.34	26.34	DL	0.17	Eq. J4-2

A_g = L_p*t_p = 15[in]*0.5[in] = **7.5**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (15[in] - 5*1.13[in])*0.5[in] = **4.69**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*7.5[in2], 4.69[in2]) = **4.69**[in2] Sec. J4-1

(1/Ω)R_n = *(1/Ω)**F_u*A_e = 0.5*65000[lb/in2]*4.69[in2] = **152.34**[kip] Eq. J4-2

Tear out under axial load	[Kip]	149.91	26.34	DL	0.18	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 5>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.5[in] = **3.75**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*3.75[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*3.75[in2]) = **149.91**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	178.51	38.55	DL	0.22	Tables 8-4 .. 8-11

(1/Ω)R_n = *(1/Ω)**C*C_1*D*L = 0.5*4.76[kip/in]*1*5*15[in] = **178.51**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	193.16	26.34	DL1	0.14	Eq. J10-4

IsBeamReaction → **False**

N = N = **12**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.34[in]^2*(1 + 3*(12[in]/10[in])*(0.34[in]/0.56[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*$
$0.56[in]/0.34[in])^{1/2} = \mathbf{193.16}[kip]$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	133.09	28.15	DL	0.21	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.35[in] - 1.06[in]/2) = \mathbf{3.82}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.82[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(5 - 1))*0.35[in]*$
$65000[lb/in2]*1 = \mathbf{133.09}[kip]$ Eq. J3-6

Shear yielding	[Kip]	144.90	28.15	DL	0.19	Eq. J4-3

$A_g = L_p*t_p = 20.7[in]*0.35[in] = \mathbf{7.25}[in2]$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.25[in2] = \mathbf{144.9}[kip]$ Eq. J4-3

Bolt bearing under axial load	[Kip]	117.30	26.34	DL	0.22	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25[in] - 1.06[in]/2) = \mathbf{1.72}[in]$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) = \mathbf{1.94}[in]$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72[in], 2.4*1[in]) + \min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.35[in]*$
$65000[lb/in2]*5 = \mathbf{117.3}[kip]$ Eq. J3-6

Yielding strength due to axial load	[Kip]	389.22	26.34	DL	0.07	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*13[in2] = \mathbf{389.22}[kip]$ Eq. D2-1

Tension rupture	[Kip]	263.95	26.34	DL	0.10	Eq. J4-2

$IsBoltedConnection \rightarrow \mathbf{True}$

$L_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 13[in2] - 5*0.35[in]*1.13[in] = \mathbf{11.03}[in2]$ Sec. D3-2

$U = 1 - x/l = 1 - 0.791[in]/3[in] = \mathbf{0.736}$ Table D3.1

$A_e = U*A_n = 0.736*11.03[in2] = \mathbf{8.12}[in2]$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000[lb/in2]*8.12[in2] = \mathbf{263.95}[kip]$ Eq. J4-2

Tear out under axial load	[Kip]	108.35	26.34	DL	0.24	Eq. J4-5

$dh_h = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$dh_v = d_h + 1/16\ [in] = 1.06[in] + 1/16\ [in] = \mathbf{1.13}[in]$ Sec. D3-2

$n>1 \rightarrow 5>1 \rightarrow \mathbf{True}$

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25[in] + (1 - 1)*3[in])*0.35[in] = \mathbf{1.58}[in2]$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25[in] + (1 - 1)*3[in] - 1.13[in]*(1 -$
$0.5))*0.35[in] = \mathbf{1.18}[in2]$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(5 - 1)*0.35[in] = \mathbf{2.63}[in2]$ Sec. J4-3

$IsStressUniform \rightarrow \mathbf{True}$

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*1.18[in2] + 1*65000[lb/in2]*2.63[in2], 0.6*50000[lb/in2]*1.58[in2] + 1*65000[lb/$

in2]*2.63[in2]) = **108.35**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	262.08	24.05	DL	0.09	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.56$[in] = **21.84**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 38.55$[kip]$/(0.5*4.76$[kip/in]$*1*15$[in]$) =$ **1.08** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.08/16$ [in] = **2**[kip/in] p. 9-5

Ratio **0.46**

Global critical strength ratio **0.46**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-15**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X40

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	20.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00	Design
DL1	-20.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-40.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
40.00	DL	Design
-40.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	40.00	DL	0.27	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	162.03	40.00	DL	0.25	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.291$[in] = **4.66**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*4.66$[in2]$)$ = **162.03**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	40.00	DL	0.26	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	257.50	40.00	DL	0.16	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*$4$[in2]$)$ = **257.5**[kip] — Eq. J4-5

Ratio	**0.27**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	40.00	DL	0.17	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] — Eq. J4-1

Tension rupture	[Kip]	152.18	40.00	DL	0.26	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 8.76[in2] - 2*(0.5[in] + 1/8\ [in])*0.291[in] = \mathbf{8.4}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/8[in] = \mathbf{0.625}$ Table D3.1

$A_e = A_n*U = 8.4[in2]*0.625 = \mathbf{5.25}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*5.25[in2] = \mathbf{152.18}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	258.05	40.00	DL	0.16	Eq. J4-1

$A_g = L_w*t_p = 17.24[in]*0.5[in] = \mathbf{8.62}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.62[in2] = \mathbf{258.05}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	254.64	40.00	DL1	0.16	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*2.99[in]/0.144[in])^2 = \mathbf{1.57E+06}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.57E+06[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/1.57E+06[lb/in2])}*50000[lb/in2] =$

49339.44[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*49339.44[lb/in2]*8.62[in2] = \mathbf{254.64}[kip]$ Eq. E3-1

Ratio **0.26**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 8.95[in]*0.667 - 0.22[in] = \mathbf{5.75}[in]$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 10.87[in]*(0.667 + 10.87[in]/7.69[in]) = \mathbf{22.64}[in]$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.667)^2 + (10.87[in]/7.69[in])^2 = \mathbf{2.45}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (22.64[in]*0.667 + 5.75[in]*(10.87[in]/$
$7.69[in])^2)/2.45 = \mathbf{10.87}[in]$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (22.64[in] - 5.75[in]*0.667)/2.45 = \mathbf{7.69}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((10.87[in] + 0.22[in])^2 + (7.69[in] +$
$8.95[in])^2)^{1/2} = \mathbf{20}[in]$ p. 13-5

$H_b = \alpha*P/r = 10.87[in]*40[kip]/20[in] = \mathbf{21.75}[kip]$ p. 13-5

$H_c = e_c*P/r = 0.22[in]*40[kip]/20[in] = \mathbf{0.44}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*40[kip]/20[in] - 0[kip] = \mathbf{17.9}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 7.69[in]*40[kip]/20[in] + 0[kip] = \mathbf{15.37}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(17.9[kip]*(10.87[in] - 10.87[in])) +$
$abs(0[kip]*10.87[in]) = \mathbf{1.99E-15}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(0.44[kip]*(7.69[in] - 7.69[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$K = e_b*tan\theta - e_c = 8.95[in]*0.667 - 0.22[in] = \mathbf{5.75}[in]$ p. 13-10

$K' = \alpha_{bar}*(tan\theta + \alpha_{bar}/\beta_{bar}) = 10.87[in]*(0.667 + 10.87[in]/7.69[in]) = \mathbf{22.64}[in]$ p. 13-10

$D = (tan\theta)^2 + (\alpha_{bar}/\beta_{bar})^2 = (0.667)^2 + (10.87[in]/7.69[in])^2 = \mathbf{2.45}$ p. 13-10

$\alpha = (K'*tan\theta + K*(\alpha_{bar}/\beta_{bar})^2)/D = (22.64[in]*0.667 + 5.75[in]*(10.87[in]/$

$7.69_{[in]})^2)/2.45 = \mathbf{10.87}_{[in]}$ p. 13-10

$\beta = (K' - K*tan\theta)/D = (22.64_{[in]} - 5.75_{[in]}*0.667)/2.45 = \mathbf{7.69}_{[in]}$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((10.87_{[in]} + 0.22_{[in]})^2 + (7.69_{[in]} + 8.95_{[in]})^2)^{1/2} = \mathbf{20}_{[in]}$ p. 13-5

$H_b = \alpha*P/r = 10.87_{[in]}*\text{-}40_{[kip]}/20_{[in]} = \mathbf{\text{-}21.75}_{[kip]}$ p. 13-5

$H_c = e_c*P/r = 0.22_{[in]}*\text{-}40_{[kip]}/20_{[in]} = \mathbf{\text{-}0.44}_{[kip]}$ p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95_{[in]}*\text{-}40_{[kip]}/20_{[in]} - 0_{[kip]} = \mathbf{\text{-}17.9}_{[kip]}$ p. 13-5

$V_c = \beta*P/r + \Delta V = 7.69_{[in]}*\text{-}40_{[kip]}/20_{[in]} + 0_{[kip]} = \mathbf{\text{-}15.37}_{[kip]}$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(\text{-}17.9_{[kip]}*(10.87_{[in]} - 10.87_{[in]})) + abs(0_{[kip]}*10.87_{[in]}) = \mathbf{1.99E\text{-}15}_{[kip*ft]}$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(\text{-}0.44_{[kip]}*(7.69_{[in]} - 7.69_{[in]})) = \mathbf{0}_{[kip*ft]}$ p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	21.75	17.90	0.00	0.00	0.00	0.00	Design
DL1	-21.75	-17.90	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	310.61	17.90	DL	0.06	Eq. J4-1
$A_g = L_p*t_p = 20.75_{[in]}*0.5_{[in]} = \mathbf{10.37}_{[in2]}$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*10.37_{[in2]} = \mathbf{310.61}_{[kip]}$						Eq. J4-1
Shear yielding	[Kip]	207.48	21.75	DL	0.10	Eq. J4-3
$A_g = L_p*t_p = 20.75_{[in]}*0.5_{[in]} = \mathbf{10.37}_{[in2]}$						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*10.37_{[in2]} = \mathbf{207.48}_{[kip]}$						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	248522.20	DL	0.06	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y = 0.599*50000_{[lb/in2]} = \mathbf{29940.12}_{[lb/in2]}$						J4-1
$f_{ua} = V_b/(t_p*l) = 17.9_{[kip]}/(0.5_{[in]}*20.75_{[in]}) = \mathbf{1725.85}_{[lb/in2]}$						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	301953.40	DL	0.10	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y = 0.667*0.6*50000_{[lb/in2]} = \mathbf{20000}_{[lb/in2]}$						J4-1
$f_{uv} = H_b/(t_p*l) = 21.75_{[kip]}/(0.5_{[in]}*20.75_{[in]}) = \mathbf{2096.9}_{[lb/in2]}$						9
Weld capacity	[Kip]	193.07	35.22	DL	0.18	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L) = 2 * (0.5*2.33_{[kip/in]}*1*4*20.75_{[in]}) = \mathbf{193.07}_{[kip]}$						Tables 8-4 .. 8-11

$f_{ua} = V_b/l$ = 17.9[kip]/20.75[in] = **0.863**[kip/in] 9

$f_{uv} = H_b/l$ = 21.75[kip]/20.75[in] = **1.05**[kip/in] 9

$f_{ub} = M_b/(l^2/6)$ = 1.99E-15[kip*ft]/(20.75[in]^2/6) = **3.32E-16**[kip/in] 9

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0.863[kip/in] + 3.32E-16[kip/in])^2 + 1.05[kip/in]^2)$^{1/2}$ = **1.36**[kip/in] 9

$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0.863[kip/in] - 3.32E-16[kip/in])^2 + 1.05[kip/in]^2)$^{1/2}$ + ((0.863[kip/in] + 3.32E-16[kip/in])^2 + 1.05[kip/in]^2)$^{1/2}$) = **1.36**[kip/in] 9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 20.75[in]*max(1.36[kip/in], 1.25*1.36[kip/in]) = **35.22**[kip] 9

Beam

Weld block shear	[Kip]	207.65	21.75	DL	0.10	Eq. J4-5

$A_{gv} = l*t_w$ = 20.75[in]*0.315[in] = **6.54**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$ = (11.8[in2] - 0.315[in]*16.05[in])/2 = **3.37**[in2] 8

$A_{nv} = A_{gv}$ = **6.54**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.37**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*6.54[in2] + 1*65000[lb/in2]*3.37[in2], 0.6*50000[lb/in2]*6.54[in2] + 1*65000[lb/in2]*3.37[in2]) = **207.65**[kip] Eq. J4-5

Web crippling	[Kip]	161.42	17.90	DL1	0.11	Eq. J10-4

IsBeamReaction → **False**

$N = N$ = **20.75**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.315[in]^2*(1 + 3*(20.75[in]/17.9[in])*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])$^{1/2}$ = **161.42**[kip] Eq. J10-4

Local web yielding	[Kip]	242.19	17.90	DL	0.07	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **20.75**[in] Sec. J10-2

IsMemberEnd → **True**

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w$ = 0.667*(2.5*0.927[in] + 20.75[in])*50000[lb/in2]*0.315[in] = **242.19**[kip] Eq. J10-3

Ratio **0.18**

Lower right gusset interface - column

Angles

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	15.37	0.44	Design
DL1	-15.37	-0.44	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle (Gusset side)						
Weld size	[1/16in]	4	3	4	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} =$ **0.0156**						table J2.4
t_p<1/4 [in] → 0.313[in]<1/4 [in] → **False**						
$w_{max} = t_p$ - 1/16 [in] = 0.313[in] - 1/16 [in] = **0.0208**						Sec. J2.2b
Angle (Column side)						
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.50	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.313[in], 12 [in]) = **7.5**[in]						Sec. J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Gusset side)						
Weld capacity	[Kip]	106.26	15.38	DL	0.14	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*C*C_1*D*L) = 2 * (0.5*2.95[kip/in]*1*4*9[in]) = **106.26**[kip]						Tables 8-4 .. 8-11
Shear yielding	[Kip]	81.00	15.37	DL	0.19	Eq. J4-3
$A_g = L_p$*t_p = 9[in]*0.313[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.81[in2]) = **81**[kip]						Eq. J4-3
Leg tensile yielding	[Kip]	121.26	0.44	DL	0.00	Eq. J4-1
$A_g = L_p$*t_p = 9[in]*0.313[in] = **2.81**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*2.81[in2]) = **121.26**[kip]						Eq. J4-1

Angle (Column side)

Bolts shear	[Kip]	101.09	15.37	DL	0.15	Tables (7-1..14)

k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0.44[kip]/(0.667*1.13*64[kip]*6), 0.0) = **0.998** Eq. J3-5

(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*0.998 = **16.85**[kip] Eq. J3-4

(1/Ω)R_n = 2 * (C*(1/Ω)R_n) = 2 * (3*16.85[kip]) = **101.09**[kip] Tables (7-1..14)

Bolt bearing under shear load	[Kip]	105.35	15.37	DL	0.15	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = 2 * ((1/Ω)*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(3/(1*3))*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(3 - 1))*0.313[in]*58000[lb/in2]*1) = **105.35**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	81.00	15.37	DL	0.19	Eq. J4-3

A_g = L_p*t_p = 9[in]*0.313[in] = **2.81**[in2] Sec. D3-1

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*2.81[in2]) = **81**[kip] Eq. J4-3

Shear rupture	[Kip]	61.17	15.37	DL	0.25	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 9[in] - 3*1.13[in] = **5.63**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 5.63[in]*0.313[in] = **1.76**[in2] Sec. J4-2

(1/Ω)R_n = 2 * ((1/Ω)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*1.76[in2]) = **61.17**[kip] Eq. J4-4

Block shear	[Kip]	67.62	15.37	DL	0.23	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*1.13[in])*0.313[in] = **0.293**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (3 - 1)*3[in])*0.313[in] = **2.34**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (3 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.313[in] = **1.46**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = 2 * ((1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*min(0.6*58000[lb/in2]*1.46[in2] + 1*58000[lb/in2]*0.293[in2], 0.6*36000[lb/in2]*2.34[in2] + 1*58000[lb/in2]*0.293[in2])) = **67.62**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	13.67	0.44	DL	0.03	p. 9-10

f_v = F/(A_b*N_{bolts}) = 15.37[kip]/(0.785[in2]*6) = **3264.09**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((1/Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*3264.09[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **1.13E+05**[lb/in2] Eq. J3-3

(1/Ω)R_n = (1/Ω)*F'_{nt}*A_b = 0.5*1.13E+05[lb/in2]*0.785[in2] = **44.16**[kip] Eq. J3-2

$f_v = F/(A_b*N_{bolts})$ = 15.37[kip]/(0.785[in2]*6) = **3264.09**[lb/in2] Sec. J3.7

F'_{nt} = min(max(1.3*F_{nt} - F_{nt}*f_v/((*1/*Ω)*F_{nv}), 0.0), F_{nt}) = min(max(1.3*1.13E+05[lb/in2] - 1.13E+05[lb/in2]*3264.09[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **1.13E+05**[lb/in2] Eq. J3-3

*(1/*Ω)R_n = *(1/*Ω)*F'_{nt}*A_b = 0.5*1.13E+05[lb/in2]*0.785[in2] = **44.16**[kip] Eq. J3-2

a' = Min(a + d/2, 1.25*b + d/2) = Min(1.5[in] + 1[in]/2, 1.25*2.34[in] + 1[in]/2) = **2**[in] p. 9-12

b' = b - d/2 = 2.34[in] - 1[in]/2 = **1.84**[in] p. 9-12

ρ = b'/a' = 1.84[in]/2[in] = **0.922** p. 9-12

δ = 1 - d'/p = 1 - 1.06[in]/3[in] = **0.646** p. 9-11

t_c = ((3.33*B*b')/((*1/*Ω)*p*F_u))$^{0.5}$ = ((3.33*44.16[kip]*1.84[in])/(0.5*3[in]*58000[lb/in2]))$^{0.5}$ = **1.77**[in] p. 9-12

α′ = (1/(δ*(1 + ρ)))*((t_c/t_p)^2 - 1) = (1/(0.646*(1 + 0.922)))*((1.77[in]/0.313[in])^2 - 1) = **24.9** p. 9-13

Q = (t_p/t_c)^2*(1 + δ) = (0.313[in]/1.77[in])^2*(1 + 0.646) = **0.0516** p. 9-13

T_{avail} = 6 * (B*Q) = 6 * (44.16[kip]*0.0516) = **13.67**[kip] p. 9-10

Gusset

Welds rupture	[Kip/ft]	234.00	25.79	DL	0.11	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.5[in] = **19.5**[kip/in] p. 9-5

D_{min} = P/((*1/*Ω)*C*C_1*L) = 7.69[kip]/(0.5*2.95[kip/in]*1*9[in]) = **0.579** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 2 * (0.6*F_{EXX}*(2)$^{1/2}$/2*D_{min}/16 [in]) = 2 * (0.6*70000[lb/in2]*(2)$^{1/2}$/2*0.579/16 [in]) = **2.15**[kip/in] p. 9-5

Shear yielding	[Kip]	153.70	15.37	DL	0.10	Eq. J4-3

A_g = L_p*t_p = 15.37[in]*0.5[in] = **7.69**[in2] Sec. D3-1

*(1/*Ω)R_n = *(1/*Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.69[in2] = **153.7**[kip] Eq. J4-3

Tear out under axial load	[Kip]	198.75	0.44	DL	0.00	Eq. J4-5

A_{gv} = 2.0*(b - c)*t_p = 2.0*(4[in] - 0.5[in])*0.5[in] = **3.5**[in2] Sec. J4-3

A_{nv} = A_{gv} = **3.5**[in2] Sec. J4-3

A_{nt} = L*t_p = 9[in]*0.5[in] = **4.5**[in2] Sec. J4-3

*(1/*Ω)R_n = *(1/*Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*3.5[in2] + 1*65000[lb/in2]*4.5[in2], 0.6*50000[lb/in2]*3.5[in2] + 1*65000[lb/in2]*4.5[in2]) = **198.75**[kip] Eq. J4-5

Column

Bolt bearing under shear load	[Kip]	201.63	15.37	DL	0.08	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.20E+31[in] - 1.06[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

*(1/*Ω)R_n = 2 * ((*1/*Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))* t_p*F_u*n_c) = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])* (3 - 1))*0.44[in]*65000[lb/in2]*1) = **201.63**[kip] Eq. J3-6

Ratio **0.25**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = 20$[kip] + 0[kip] + 21.75[kip] = **41.75**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 25$[kip] - 0[kip] + 17.9[kip] = **42.9**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot} = -20$[kip] + 0[kip] + -21.75[kip] = **-41.75**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot} = 25$[kip] - 0[kip] + -17.9[kip] = **7.1**[kip]

Right beam interface - column

Angles

DEMANDS

Description	Ru [Kip]	Pu [Kip]	Load type
DL	42.90	41.75	Design
DL1	7.10	-41.75	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	12.00	8.02	16.05	✔	p. 10-8
$L_{min} = T/2 = 16.05$[in]$/2 =$ **8.02**[in]						p. 10-8
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 17.9$[in] $- \max(0.927$[in], 0[in]$) -$ $\max(0.927$[in], 0[in]$) =$ **16.05**[in]						p. 10-8
Angle (Beam side)						
Weld size	[1/16in]	4	3	7	✔	table J2.4, Sec. J2.2b
$w_{min} = w_{min} =$ **0.0156**						table J2.4
t_p<1/4 [in] → 0.5[in]<1/4 [in] → **False**						
$w_{max} = t_p$ - 1/16 [in] = 0.5[in] - 1/16 [in] = **0.0365**						Sec. J2.2b
Angle (Column side)						
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	1.41	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.25$[in] + 0[in] = **1.25**[in]						Tables J3.4,

						J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67		10.56 ✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.44[in], 12 [in]) = **10.56**[in]						Sec. J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Weld capacity	[Kip]	147.01	59.87	DL	0.41	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*C*C_1*D*L) = 2 * (0.5*3.06[kip/in]*1*4*12[in]) = **147.01**[kip]						Tables 8-4 .. 8-11
Shear yielding	[Kip]	172.80	42.90	DL	0.25	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*6[in2]) = **172.8**[kip]						Eq. J4-3
Leg tensile yielding	[Kip]	258.68	41.75	DL	0.16	Eq. J4-1
A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*F_y*A_g) = 2 * (0.599*36000[lb/in2]*6[in2]) = **258.68**[kip]						Eq. J4-1
Angle (Column side)						
Bolts shear	[Kip]	120.38	42.90	DL	0.36	Tables (7-1..14)
k_s = max(1 - T_u/($(1/\Omega)$*D_u*T_b*N_b), 0.0) = max(1 - 41.75[kip]/(0.667*1.13*64[kip]*8), 0.0) = **0.892**						Eq. J3-5
$(1/\Omega)R_n$ = $(1/\Omega)$*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*0.892 = **15.05**[kip]						Eq. J3-4
$(1/\Omega)R_n$ = 2 * (C*$(1/\Omega)R_n$) = 2 * (4*15.05[kip]) = **120.38**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	235.99	42.90	DL	0.18	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c) = 2 * (0.5*(4/(1*4))*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*58000[lb/in2]*1) = **235.99**[kip]						p. 7-18, Sec. J3.10
Shear yielding	[Kip]	172.80	42.90	DL	0.25	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2]						Sec. D3-1
$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_y*A_g) = 2 * (0.667*0.60*36000[lb/in2]*6[in2]) = **172.8**[kip]						Eq. J4-3

Shear rupture	[Kip]	130.50	42.90	DL	0.33	Eq. J4-4

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$L_e = L - n*L_h$ = 12[in] - 4*1.13[in] = **7.5**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$ = 7.5[in]*0.5[in] = **3.75**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*3.75$[in2]$) =$ **130.5**[kip] Eq. J4-4

Block shear	[Kip]	137.91	42.90	DL	0.31	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (1.41[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.13[in])*0.5[in] = **0.423**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.5[in] + (4 - 1)*3[in])*0.5[in] = **5.25**[in2] Sec. J4-3

$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.5[in] + (4 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **3.28**[in2] Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = 2 * ((1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})) = 2 * (0.5*\min(0.6*58000$[lb/in2]$*3.28$[in2]$ + 1*58000$[lb/in2]$*0.423$[in2]$, 0.6*36000$[lb/in2]$* 5.25$[in2]$ + 1*58000$[lb/in2]$*0.423$[in2]$)) =$ **137.91**[kip] Eq. J4-5

Resulting tension capacity due prying action	[Kip]	46.67	41.75	DL	0.89	p. 9-10

$f_v = F/(A_b*N_{bolts})$ = 42.9[kip]/(0.785[in2]*8) = **6831.9**[lb/in2] Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*1.13E+05$[lb/in2] - 1.13E+05[lb/in2]*6831.9[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **1.13E+05**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*1.13E+05[lb/in2]*0.785[in2] = **44.16**[kip] Eq. J3-2

$f_v = F/(A_b*N_{bolts})$ = 42.9[kip]/(0.785[in2]*8) = **6831.9**[lb/in2] Sec. J3.7

$F'_{nt} = \min(\max(1.3*F_{nt} - F_{nt}*f_v/((1/\Omega)*F_{nv}), 0.0), F_{nt}) = \min(\max(1.3*1.13E+05$[lb/in2] - 1.13E+05[lb/in2]*6831.9[lb/in2]/(0.5*60000[lb/in2]), 0.0), 1.13E+05[lb/in2]) = **1.13E+05**[lb/in2] Eq. J3-3

$(1/\Omega)R_n = (1/\Omega)*F'_{nt}*A_b$ = 0.5*1.13E+05[lb/in2]*0.785[in2] = **44.16**[kip] Eq. J3-2

$a' = \text{Min}(a + d/2, 1.25*b + d/2) = \text{Min}(1.41$[in] + 1[in]/2, 1.25*2.34[in] + 1[in]/2) = **1.91**[in] p. 9-12

$b' = b - d/2$ = 2.34[in] - 1[in]/2 = **1.84**[in] p. 9-12

$\rho = b'/a'$ = 1.84[in]/1.91[in] = **0.966** p. 9-12

$\delta = 1 - d'/p$ = 1 - 1.06[in]/3[in] = **0.646** p. 9-11

$t_c = ((3.33*B*b')/((1/\Omega)*p*F_u))^{0.5} = ((3.33*44.16$[kip]$*1.84$[in]$)/(0.5*3$[in]$*58000$[lb/in2]$))^{0.5} =$ **1.76**[in] p. 9-12

$\alpha' = (1/(\delta*(1 + \rho)))*((t_c/t_p)^2 - 1) = (1/(0.646*(1 + 0.966)))*((1.76$[in]$/0.5$[in]$)^2 - 1) =$ **9.02** p. 9-13

$Q = (t_p/t_c)^2*(1 + \delta) = (0.5$[in]$/1.76$[in]$)^2*(1 + 0.646) =$ **0.132** p. 9-13

$T_{avail} = 8 * (B*Q) = 8 * (44.16$[kip]$*0.132) =$ **46.67**[kip] p. 9-10

Beam

Welds rupture	[Kip/ft]	147.42	72.57	DL	0.49	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.315[in] = **12.29**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 29.93$[kip]$/(0.5*3.06$[kip/in]$*1*12$[in]$) =$ **1.63** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 2 * (0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in]$) = 2 * (0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.63/16$ [in]$) =$

6.05[kip/in] p. 9-5

Shear yielding	[Kip]	112.77	42.90	DL	0.38	Eq. J4-3

$A_g = L_p*t_p$ = 17.9[in]*0.315[in] = **5.64**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*5.64[in2] = **112.77**[kip] Eq. J4-3

Tear out under axial load	[Kip]	155.93	41.75	DL	0.27	Eq. J4-5

$A_{gv} = 2.0*(b - c)*t_p$ = 2.0*(4[in] - 0.5[in])*0.315[in] = **2.21**[in2] Sec. J4-3

$A_{nv} = A_{gv}$ = **2.21**[in2] Sec. J4-3

$A_{nt} = L*t_p$ = 12[in]*0.315[in] = **3.78**[in2] Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*2.21[in2] + 1*65000[lb/in2]*3.78[in2], 0.6*50000[lb/in2]*2.21[in2] + 1*65000[lb/in2]*3.78[in2]) = **155.93**[kip] Eq. J4-5

Column

Bolt bearing under shear load	[Kip]	268.13	42.90	DL	0.16	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 1.20E+31[in] - 1.06[in]/2) = **1.20E+31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = 2 * ((1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*$
$t_p*F_u*n_c)$ = 2 * (0.5*(min(1.2*1.20E+31[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*
(4 - 1))*0.44[in]*65000[lb/in2]*1) = **268.13**[kip] Eq. J3-6

Ratio **0.89**

Global critical strength ratio **0.89**

NOTATION

a: Plate depth

A_b: Nominal bolt area

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

a': Distance for prying action

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α': Value that either maximizes the bolt available tensile strength for a given thickness or minimizes the thickness required for a given bolt available tensile strength

α_{bar}: Centroid of the gusset to beam connection

B: Available tensile strength per bolt

b: Plate, connector or member width

B: Available strength of all bolts

b': Distance for prying action

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

b: Distance from bolt centerline to the face/centerline of tee stem/angle leg.

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

c: Setback

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

d': Width of the hole along the length of the fitting

δ: Ratio of the net area at bolt line to gross area at face of the stem or leg of angle

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F: Required shear force for combined tension and shear

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_{nt}: Nominal tensile stress

F_{nv}: Nominal shear stress

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

f_v: Required shear stress

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

F'_{nt}:Nominal tensile stress modified to include the effects of shear stress

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

N_{bolts}: Number of bolts

n_c: Number of bolt columns

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

p: Tributary length per pair of bolts, which should preferably not exceed the gage between the pair of bolts

Q: Prying action coefficient

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

ρ: Prying distances ratio

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_{avail}: Available tensile strength per bolt including effects of prying action

T_b: Minimum fastener pretension

t_c: Flange or angle thickness required to develop the available strength of the bolt with no prying action

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{max}: Maximum weld size required

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

Current Date: 2016-05-25 1:13 PM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-16**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X40

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	10.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00	Design
DL1	-10.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-40.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
40.00	DL	Design
-40.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	40.00	DL	0.27	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	162.03	40.00	DL	0.25	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.291$[in] = **4.66**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*4.66$[in2]$)$ = **162.03**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	40.00	DL	0.26	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	257.50	40.00	DL	0.16	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*$4$[in2]$)$ = **257.5**[kip] — Eq. J4-5

Ratio	**0.27**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	40.00	DL	0.17	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] — Eq. J4-1

Tension rupture	[Kip]	152.18	40.00	DL	0.26	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 8.76[in2] - 2*(0.5[in] + 1/8\ [in])*0.291[in] = \mathbf{8.4}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/8[in] = \mathbf{0.625}$ Table D3.1

$A_e = A_n*U = 8.4[in2]*0.625 = \mathbf{5.25}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*5.25[in2] = \mathbf{152.18}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	258.05	40.00	DL	0.16	Eq. J4-1

$A_g = L_w*t_p = 17.24[in]*0.5[in] = \mathbf{8.62}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.62[in2] = \mathbf{258.05}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	213.52	40.00	DL1	0.19	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*11.3[in]/0.144[in])^2 = \mathbf{1.10E+05}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.10E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/1.10E+05[lb/in2])}*50000[lb/in2] =$

41371.35[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*41371.35[lb/in2]*8.62[in2] = \mathbf{213.52}[kip]$ Eq. E3-1

Ratio **0.26**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{12.34}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (12.34[in] + 8.95[in])*0.667 - 6.05[in] = \mathbf{8.15}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((8.15[in] + 6.05[in])^2 + (12.34[in] +$

$8.95[in])^2)^{1/2} = \mathbf{25.59}[in]$ p. 13-5

$H_b = \alpha*P/r = 8.15[in]*40[kip]/25.59[in] = \mathbf{12.74}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.05[in]*40[kip]/25.59[in] = \mathbf{9.46}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*40[kip]/25.59[in] - 0[kip] = \mathbf{13.99}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 12.34[in]*40[kip]/25.59[in] + 0[kip] = \mathbf{19.29}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(13.99[kip]*(8.15[in] - 8.15[in])) +$

$abs(0[kip]*8.15[in]) = \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.46[kip]*(12.34[in] - 12.34[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{12.34}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (12.34[in] + 8.95[in])*0.667 - 6.05[in] = \mathbf{8.15}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((8.15[in] + 6.05[in])^2 + (12.34[in] +$

$8.95[in])^2)^{1/2} = \mathbf{25.59}[in]$ p. 13-5

$H_b = \alpha*P/r = 8.15[in]*-40[kip]/25.59[in] = \mathbf{-12.74}[kip]$ p. 13-5

$H_c = e_c*P/r = 6.05[in]*-40[kip]/25.59[in] = \mathbf{-9.46}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*-40[kip]/25.59[in] - 0[kip] = \mathbf{-13.99}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 12.34[in]*-40[kip]/25.59[in] + 0[kip] = \mathbf{-19.29}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-13.99[kip]*(8.15[in] - 8.15[in])) + abs(0[kip]*8.15[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-9.46[kip]*(12.34[in] - 12.34[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	12.74	13.99	0.00	0.00	0.00	0.00	Design
DL1	-12.74	-13.99	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	221.53	13.99	DL	0.06	Eq. J4-1
A_g = L_p*t_p = 14.8[in]*0.5[in] = **7.4**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*7.4[in2] = **221.53**[kip]						Eq. J4-1
Shear yielding	[Kip]	147.98	12.74	DL	0.09	Eq. J4-3
A_g = L_p*t_p = 14.8[in]*0.5[in] = **7.4**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.4[in2] = **147.98**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	272250.40	DL	0.06	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 13.99[kip]/(0.5[in]*14.8[in]) = **1890.63**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	247890.70	DL	0.09	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 12.74[kip]/(0.5[in]*14.8[in]) = **1721.46**[lb/in2]						9
Weld capacity	[Kip]	144.80	23.65	DL	0.16	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.45[kip/in]*1*4*14.8[in]) = **144.8**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 13.99[kip]/14.8[in] = **0.945**[kip/in]						9
f_{uv} = H_b/l = 12.74[kip]/14.8[in] = **0.861**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 0[kip*ft]/(14.8[in]^2/6) = **0**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.945[kip/in] + 0[kip/in])^2 + 0.861[kip/in]^2)$^{1/2}$ = **1.28**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5* (((0.945[kip/in] - 0[kip/in])^2 + 0.861[kip/in]^2)$^{1/2}$ + ((0.945[kip/in] + 0[kip/in])^2 + 0.861[kip/in]^2)$^{1/2}$) = **1.28**[kip/in]						9

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve}) = 14.8[in]*\max(1.28[kip/in], 1.25*1.28[kip/in]) = \mathbf{23.65}[kip]$ 9

Beam

Weld block shear	[Kip]	179.54	12.74	DL	0.07	Eq. J4-5

$A_{gv} = l*t_w = 14.8[in]*0.315[in] = \mathbf{4.66}[in2]$ Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2 = (11.8[in2] - 0.315[in]*16.05[in])/2 = \mathbf{3.37}[in2]$ 8

$A_{nv} = A_{gv} = \mathbf{4.66}[in2]$ Sec. J4.3

$A_{nt} = A_{gt} = \mathbf{3.37}[in2]$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000[lb/in2]*4.66[in2] + 1*65000[lb/in2]*3.37[in2], 0.6*50000[lb/in2]*4.66[in2] + 1*65000[lb/in2]*3.37[in2]) = \mathbf{179.54}[kip]$ Eq. J4-5

Web crippling	[Kip]	75.40	13.99	DL1	0.19	Eq. J10-5b

$IsBeamReaction \rightarrow \mathbf{False}$

$N = N = \mathbf{14.8}[in]$ Sec. J10-2

$N/d <= 0.2 \rightarrow 14.8[in]/17.9[in] <= 0.2 \rightarrow \mathbf{False}$

$(1/\Omega)R_n = (1/\Omega)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} =$
$0.5*0.40*0.315[in]^2*(1 + (4*14.8[in]/17.9[in] - 0.2)*(0.315[in]/0.525[in])^{1.5})*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])^{1/2} = \mathbf{75.4}[kip]$ Eq. J10-5b

Local web yielding	[Kip]	179.72	13.99	DL	0.08	Eq. J10-3

$IsBeamReaction \rightarrow \mathbf{False}$

$N = N = \mathbf{14.8}[in]$ Sec. J10-2

$IsMemberEnd \rightarrow \mathbf{True}$

$(1/\Omega)R_n = (1/\Omega)*(2.5*k + N)*F_{yw}*t_w = 0.667*(2.5*0.927[in] + 14.8[in])*50000[lb/in2]*0.315[in] = \mathbf{179.72}[kip]$ Eq. J10-3

Ratio **0.19**

Lower right gusset interface - column

Single plate

DEMANDS

Description	Beam Ru [Kip]	Beam Pu [Kip]	Column Pu [Kip]	Column Mu22 [Kip*ft]	Column Mu33 [Kip*ft]	Load type
DL	19.29	9.46	0.00	0.00	0.00	Design
DL1	-19.29	-9.46	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References

Shear plate

Length	[in]	12.50	12.34	24.68	✔	p. 10-104
L_{min} = T/2 = 24.68[in]/2 = **12.34**[in]						p. 10-104
L_{max} = L = **24.68**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	7.84	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	21.48	DL	0.32	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 4*16.87[kip]*1 = **67.5**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	102.83	19.29	DL	0.19	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.375[in]*
65000[lb/in2]*1 = **102.83**[kip] Eq. J3-6

Shear yielding	[Kip]	93.75	19.29	DL	0.21	Eq. J4-3

A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.69[in2] = **93.75**[kip] Eq. J4-3

Shear rupture	[Kip]	58.50	19.29	DL	0.33	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 12.5[in] - 4*1.13[in] = **8**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.375[in] = **3**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3[in2] = **58.5**[kip] Eq. J4-4

Block shear	[Kip]	67.34	19.29	DL	0.29	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (4 - 1)*3[in])*0.375[in] = **4.03**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **2.55**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*2.55[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*4.03[in2] + 1*65000[lb/
in2]*0.539[in2]) = **67.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	85.92	9.46	DL	0.11	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*4 = **85.92**[kip] Eq. J3-6

Tension yielding	[Kip]	140.34	9.46	DL	0.07	Eq. J4-1

A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*4.69[in2] = **140.34**[kip] Eq. J4-1

Tension rupture	[Kip]	97.50	9.46	DL	0.10	Eq. J4-2

A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (12.5[in] - 4*1.13[in])*0.375[in] = **3**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*4.69$[in2], 3[in2]) = **3**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3[in2] = **97.5**[kip] Eq. J4-2

Tear out under axial load	[Kip]	89.58	9.46	DL	0.11	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = **1.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = **1.08**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(4 - 1)*0.375[in] = **2.11**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*2.11[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*2.11[in2]) = **89.58**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	106.36	21.48	DL	0.20	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.25[kip/in]*1*4*12.5[in] = **106.36**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	150.77	9.46	DL1	0.06	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N$ = **9**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.345[in]^2*(1 + 3*(9[in]/12.1[in])*(0.345[in]/0.575[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.575[in]/0.345[in])$^{1/2}$ = **150.77**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	152.34	19.29	DL	0.13	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 7.84[in] - 1.06[in]/2) = **7.31**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$ = 0.5*(min(1.2*7.31[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*65000[lb/in2]*1 = **152.34**[kip] Eq. J3-6

Shear yielding	[Kip]	246.82	19.29	DL	0.08	Eq. J4-3

$A_g = L_p*t_p$ = 24.68[in]*0.5[in] = **12.34**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*12.34[in2] = **246.82**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	153.56	9.46	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 2.5[in] - 1.06[in]/2) = **1.97**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*4 = **153.56**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	369.48	9.46	DL	0.03	Eq. J4-1

$A_g = L_p*t_p$ = 24.68[in]*0.5[in] = **12.34**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*12.34[in2] = **369.48**[kip] Eq. J4-1

Tension rupture	[Kip]	327.95	9.46	DL	0.03	Eq. J4-2

$A_g = L_p*t_p$ = 24.68[in]*0.5[in] = **12.34**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (24.68[in] - 4*1.13[in])*0.5[in] = **10.09**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*12.34[in2], 10.09[in2]) = **10.09**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*10.09[in2] = **327.95**[kip] Eq. J4-2

Tear out under axial load	[Kip]	128.91	9.46	DL	0.07	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*2.81[in2]) = **128.91**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	269.10	18.00	DL	0.07	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.575[in] = **22.43**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 21.48[kip]/(0.5*4.25[kip/in]*1*12.5[in]) = **0.808** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.808/16 [in] = **1.5**[kip/in] p. 9-5

Ratio **0.33**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 10[kip] + 0[kip] + 12.74[kip] = **22.74**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 20[kip] - 0[kip] + 13.99[kip] = **33.99**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = -10[kip] + 0[kip] + -12.74[kip] = **-22.74**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 20[kip] - 0[kip] + -13.99[kip] = **6.01**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	33.99	22.74	0.00	0.00	0.00	Design
DL1	6.01	-22.74	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	12.00	8.02	16.05	✔	p. 10-104
$L_{min} = T/2$ = 16.05[in]/2 = **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.9[in] - max(0.927[in], 0[in]) - max(0.927[in], 0[in]) = **16.05**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2$ + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d$ = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d$ = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.315[in], 12 [in]) = **7.56**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00		--	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5		--	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	67.50	40.89	DL	0.61	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 4*16.87[kip]*1 = **67.5**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	132.23	33.99	DL	0.26	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*						
65000[lb/in2]*1 = **132.23**[kip]						Eq. J3-6
Shear yielding	[Kip]	120.00	33.99	DL	0.28	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6[in2] = **120**[kip]						Eq. J4-3
Shear rupture	[Kip]	73.13	33.99	DL	0.46	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 12[in] - 4*1.13[in] = **7.5**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 7.5[in]*0.5[in] = **3.75**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.75[in2] = **73.13**[kip]						Eq. J4-4
Block shear	[Kip]	87.34	33.99	DL	0.39	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.5[in] = **5.25**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **3.28**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*0.719[in2]) = **87.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	114.56	22.74	DL	0.20	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **114.56**[kip] Eq. J3-6

Tension yielding	[Kip]	179.64	22.74	DL	0.13	Eq. J4-1

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*6[in2] = **179.64**[kip] Eq. J4-1

Tension rupture	[Kip]	121.88	22.74	DL	0.19	Eq. J4-2

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (12[in] - 4*1.13[in])*0.5[in] = **3.75**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*6[in2], 3.75[in2]) = **3.75**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*3.75[in2] = **121.88**[kip] Eq. J4-2

Tear out under axial load	[Kip]	119.44	22.74	DL	0.19	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 -
0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*2.81[in2]) = **119.44**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	134.46	40.89	DL	0.30	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*4.48[kip/in]*1*5*12[in] = **134.46**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	150.77	22.74	DL1	0.15	Eq. J10-4

IsBeamReaction → **False**

N = N = **9**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.345\text{[in]}^2*(1 + 3*(9\text{[in]}/12.1\text{[in]})*(0.345\text{[in]}/0.575\text{[in]})^{1.5})*(2.90E+07\text{[lb/in2]}*50000\text{[lb/in2]}*$
$0.575\text{[in]}/0.345\text{[in]})^{1/2} = \mathbf{150.77}\text{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	95.98	33.99	DL	0.35	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45\text{[in]} - 1.06\text{[in]}/2) = \mathbf{3.92}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.92\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(4 - 1))*0.315\text{[in]}*$
$65000\text{[lb/in2]}*1 = \mathbf{95.98}\text{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	112.77	33.99	DL	0.30	Eq. J4-3

$A_g = L_p*t_p = 17.9\text{[in]}*0.315\text{[in]} = \mathbf{5.64}\text{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000\text{[lb/in2]}*5.64\text{[in2]} = \mathbf{112.77}\text{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	84.46	22.74	DL	0.27	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25\text{[in]} - 1.06\text{[in]}/2) = \mathbf{1.72}\text{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3\text{[in]} - 1.06\text{[in]}) = \mathbf{1.94}\text{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72\text{[in]}, 2.4*1\text{[in]}) + \min(1.2*1.94\text{[in]}, 2.4*1\text{[in]})*(1 - 1))*0.315\text{[in]}*$
$65000\text{[lb/in2]}*4 = \mathbf{84.46}\text{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	353.29	22.74	DL	0.06	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000\text{[lb/in2]}*11.8\text{[in2]} = \mathbf{353.29}\text{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	241.37	22.74	DL	0.09	Eq. J4-2

IsBoltedConnection → **True**

$L_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 11.8\text{[in2]} - 4*0.315\text{[in]}*1.13\text{[in]} = \mathbf{10.38}\text{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.854\text{[in]}/3\text{[in]} = \mathbf{0.715}$ Table D3.1

$A_e = U*A_n = 0.715*10.38\text{[in2]} = \mathbf{7.43}\text{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000\text{[lb/in2]}*7.43\text{[in2]} = \mathbf{241.37}\text{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	78.32	22.74	DL	0.29	Eq. J4-5

$dh_h = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\text{ [in]} = 1.06\text{[in]} + 1/16\text{ [in]} = \mathbf{1.13}\text{[in]}$ Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]})*0.315\text{[in]} = \mathbf{1.42}\text{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25\text{[in]} + (1 - 1)*3\text{[in]} - 1.13\text{[in]}*(1 -$
$0.5))*0.315\text{[in]} = \mathbf{1.06}\text{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3\text{[in]} - 1.13\text{[in]})*(4 - 1)*0.315\text{[in]} = \mathbf{1.77}\text{[in2]}$ Sec. J4-3

IsStressUniform → **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000\text{[lb/in2]}*1.06\text{[in2]} + 1*65000\text{[lb/in2]}*1.77\text{[in2]}, 0.6*50000\text{[lb/in2]}*1.42\text{[in2]} + 1*65000\text{[lb/}$

in2]*1.77[in2]) = **78.32**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	269.10	33.87	DL	0.13	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.575$[in] = **22.43**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 40.89$[kip]$/(0.5*4.48$[kip/in]$*1*12$[in]$) =$ **1.52** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*1.52/16$ [in] = **2.82**[kip/in] p. 9-5

Ratio **0.61**

Global critical strength ratio **0.61**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-03 Vertical HSS Beam Column Gusset Connection\VB-03.cnx\

Steel connections

Results

Connection name : **CBB_DA**
Connection ID : **VB-03-17**

Family: Column - Beams - Braces (CBB)

Type: Gusset

Description: W18X40

Design code: AISC 360-05 ASD

DEMANDS

	Right beam			Left beam			Column		Pu				
Description	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Mu33**	**Pu**	**Vu**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	20.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	Design
DL1	-20.00	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-36.00	Design

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
36.00	DL	Design
-36.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	36.00	DL	0.24	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] — Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] — Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] — Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] — Eq. J2-6

Maximum weld force that brace can develop	[Kip]	162.03	36.00	DL	0.22	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.291$[in] = **4.66**[in2] — Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*4.66$[in2]$)$ = **162.03**[kip] — Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	36.00	DL	0.23	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] — Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] — Eq. J4-4

Block shear on gusset	[Kip]	257.50	36.00	DL	0.14	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] — Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] — Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] — Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] — Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*$4$[in2]$)$ = **257.5**[kip] — Eq. J4-5

Ratio **0.24**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	36.00	DL	0.15	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] — Eq. J4-1

Tension rupture	[Kip]	152.18	36.00	DL	0.24	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 8.76[in2] - 2*(0.5[in] + 1/8\ [in])*0.291[in] = \mathbf{8.4}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/8[in] = \mathbf{0.625}$ Table D3.1

$A_e = A_n*U = 8.4[in2]*0.625 = \mathbf{5.25}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*5.25[in2] = \mathbf{152.18}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	258.05	36.00	DL	0.14	Eq. J4-1

$A_g = L_w*t_p = 17.24[in]*0.5[in] = \mathbf{8.62}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*8.62[in2] = \mathbf{258.05}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	214.34	36.00	DL1	0.17	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*11.19[in]/0.144[in])^2 = \mathbf{1.13E+05}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 1.13E+05[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/1.13E+05[lb/in2])}*50000[lb/in2] =$

41530.63[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*41530.63[lb/in2]*8.62[in2] = \mathbf{214.34}[kip]$ Eq. E3-1

Ratio **0.24**

Calculation of the brace interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{12.44}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (12.44[in] + 8.95[in])*0.7 - 7[in] = \mathbf{7.98}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((7.98[in] + 7[in])^2 + (12.44[in] + 8.95[in])^2)^{1/2} = \mathbf{26.11}[in]$ p. 13-5

$H_b = \alpha*P/r = 7.98[in]*36[kip]/26.11[in] = \mathbf{11}[kip]$ p. 13-5

$H_c = e_c*P/r = 7[in]*36[kip]/26.11[in] = \mathbf{9.65}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*36[kip]/26.11[in] - 0[kip] = \mathbf{12.34}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 12.44[in]*36[kip]/26.11[in] + 0[kip] = \mathbf{17.15}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha) = abs(12.34[kip]*(7.98[in] - 7.98[in])) + abs(0[kip]*7.98[in]) = \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar})) = abs(9.65[kip]*(12.44[in] - 12.44[in])) = \mathbf{0}[kip*ft]$ p. 13-10

Load condition :DL1

General case DG29 p. 24-33

$\beta = \beta_{bar} = \mathbf{12.44}[in]$ p. 13-10

$\alpha = (\beta + e_b)*tan\theta - e_c = (12.44[in] + 8.95[in])*0.7 - 7[in] = \mathbf{7.98}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2} = ((7.98[in] + 7[in])^2 + (12.44[in] + 8.95[in])^2)^{1/2} = \mathbf{26.11}[in]$ p. 13-5

$H_b = \alpha*P/r = 7.98[in]*-36[kip]/26.11[in] = \mathbf{-11}[kip]$ p. 13-5

$H_c = e_c*P/r = 7[in]*-36[kip]/26.11[in] = \mathbf{-9.65}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V = 8.95[in]*-36[kip]/26.11[in] - 0[kip] = \mathbf{-12.34}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V = 12.44[in]*-36[kip]/26.11[in] + 0[kip] = \mathbf{-17.15}[kip]$ p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α) = abs(-12.34[kip]*(7.98[in] - 7.98[in])) + abs(0[kip]*7.98[in]) = **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar})) = abs(-9.65[kip]*(12.44[in] - 12.44[in])) = **0**[kip*ft] p. 13-10

Lower right gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	11.00	12.34	0.00	0.00	0.00	0.00	Design
DL1	-11.00	-12.34	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	216.40	12.34	DL	0.06	Eq. J4-1
A_g = L_p*t_p = 14.46[in]*0.5[in] = **7.23**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*F_y*A_g = 0.599*50000[lb/in2]*7.23[in2] = **216.4**[kip]						Eq. J4-1
Shear yielding	[Kip]	144.56	11.00	DL	0.08	Eq. J4-3
A_g = L_p*t_p = 14.46[in]*0.5[in] = **7.23**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*7.23[in2] = **144.56**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	245823.90	DL	0.06	J4-1
(1/Ω)F_n = *(1/Ω)*F_y = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
f_{ua} = V_b/(t_p*l) = 12.34[kip]/(0.5[in]*14.46[in]) = **1707.11**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	219121.40	DL	0.08	J4-1
(1/Ω)F_n = *(1/Ω)*0.6*F_y = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
f_{uv} = H_b/(t_p*l) = 11[kip]/(0.5[in]*14.46[in]) = **1521.68**[lb/in2]						9
Weld capacity	[Kip]	141.94	20.66	DL	0.15	Tables 8-4 .. 8-11
(1/Ω)R_n = 2 * (*(1/Ω)*C*C_1*D*L) = 2 * (0.5*2.45[kip/in]*1*4*14.46[in]) = **141.94**[kip]						Tables 8-4 .. 8-11
f_{ua} = V_b/l = 12.34[kip]/14.46[in] = **0.854**[kip/in]						9
f_{uv} = H_b/l = 11[kip]/14.46[in] = **0.761**[kip/in]						9
f_{ub} = M_b/(l^2/6) = 0[kip*ft]/(14.46[in]^2/6) = **0**[kip/in]						9
f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$ = ((0.854[kip/in] + 0[kip/in])^2 + 0.761[kip/in]^2)$^{1/2}$ = **1.14**[kip/in]						9
f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)$^{1/2}$ + ((f_{ua} + f_{ub})^2 + f_{uv}^2)$^{1/2}$) = 0.5*(((0.854[kip/in] - 0[kip/in])^2 + 0.761[kip/in]^2)$^{1/2}$ + ((0.854[kip/in] + 0[kip/in])^2 + 0.761[kip/in]^2)$^{1/2}$) = **1.14**[kip/in]						9

$f_{uWeld} = l$*max(f_{uPeak}, 1.25*f_{uAve}) = 14.46[in]*max(1.14[kip/in], 1.25*1.14[kip/in]) = **20.66**[kip] 9

Beam

Weld block shear	[Kip]	177.92	11.00	DL	0.06	Eq. J4-5

$A_{gv} = l$*t_w = 14.46[in]*0.315[in] = **4.55**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w$*$T)/2$ = (11.8[in2] - 0.315[in]*16.05[in])/2 = **3.37**[in2] 8

$A_{nv} = A_{gv}$ = **4.55**[in2] Sec. J4.3

$A_{nt} = A_{gt}$ = **3.37**[in2] Sec. J4.3

(1/Ω)R_n = *(1/Ω)*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*4.55[in2] + 1*65000[lb/in2]*3.37[in2], 0.6*50000[lb/in2]*4.55[in2] + 1*65000[lb/in2]*3.37[in2]) = **177.92**[kip] Eq. J4-5

Web crippling	[Kip]	74.30	12.34	DL1	0.17	Eq. J10-5b

IsBeamReaction → **False**

$N = N$ = **14.46**[in] Sec. J10-2

N/d<=0.2 → 14.46[in]/17.9[in]<=0.2 → **False**

(1/Ω)R_n = *(1/Ω)*0.40*t_w^2*(1 + (4*N/d - 0.2)*(t_w/t_f)$^{1.5}$)*(E*F_{yw}*t_f/t_w)$^{1/2}$ =
0.5*0.40*0.315[in]^2*(1 + (4*14.46[in]/17.9[in] - 0.2)*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])$^{1/2}$ = **74.3**[kip] Eq. J10-5b

Local web yielding	[Kip]	176.12	12.34	DL	0.07	Eq. J10-3

IsBeamReaction → **False**

$N = N$ = **14.46**[in] Sec. J10-2

IsMemberEnd → **True**

(1/Ω)R_n = *(1/Ω)*(2.5*k + N)*F_{yw}*t_w = 0.667*(2.5*0.927[in] + 14.46[in])*50000[lb/in2]*0.315[in] = **176.12**[kip] Eq. J10-3

Ratio **0.17**

Lower right gusset interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	17.15	9.65	0.00	0.00	0.00	Design
DL1	-17.15	-9.65	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**

Shear plate

Length	[in]	12.50	12.44	24.88	✔	p. 10-104
L_{min} = T/2 = 24.88[in]/2 = **12.44**[in]						p. 10-104
L_{max} = L = **24.88**[in]						
Thickness	[in]	0.38	--	0.56	✔	p. 10-102
t_{pmax} = d/2 + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	9.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.375[in], 12 [in]) = **9**[in]						Sec. J3.5

Beam

Vertical edge distance	[in]	7.94	1.25	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	4	4	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.375[in] = **0.0195**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	19.68	DL	0.29	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((1/Ω)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = (1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C*(1/Ω)R_n*BoltFactor = 4*16.87[kip]*1 = **67.5**[kip]						Tables (7-1..14)

Bolt bearing under shear load	[Kip]	102.83	17.15	DL	0.17	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.375[in]*
65000[lb/in2]*1 = **102.83**[kip] Eq. J3-6

Shear yielding	[Kip]	93.75	17.15	DL	0.18	Eq. J4-3

A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*4.69[in2] = **93.75**[kip] Eq. J4-3

Shear rupture	[Kip]	58.50	17.15	DL	0.29	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 12.5[in] - 4*1.13[in] = **8**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 8[in]*0.375[in] = **3**[in2] Sec. J4-2

(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3[in2] = **58.5**[kip] Eq. J4-4

Block shear	[Kip]	67.34	17.15	DL	0.25	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*
1.13[in])*0.375[in] = **0.539**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (4 - 1)*3[in])*0.375[in] = **4.03**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (4 - 1)*(3[in] - 1.13[in]) -
1.13[in]/2)*0.375[in] = **2.55**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

(1/Ω)R_n = *(1/Ω)**min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*2.55[in2] + 1*65000[lb/in2]*0.539[in2], 0.6*50000[lb/in2]*4.03[in2] + 1*65000[lb/
in2]*0.539[in2]) = **67.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	85.92	9.65	DL	0.11	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.375[in]*
65000[lb/in2]*4 = **85.92**[kip] Eq. J3-6

Tension yielding	[Kip]	140.34	9.65	DL	0.07	Eq. J4-1

A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

(1/Ω)R_n = *(1/Ω)**F_y*A_g = 0.599*50000[lb/in2]*4.69[in2] = **140.34**[kip] Eq. J4-1

Tension rupture	[Kip]	97.50	9.65	DL	0.10	Eq. J4-2

A_g = L_p*t_p = 12.5[in]*0.375[in] = **4.69**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (12.5[in] - 4*1.13[in])*0.375[in] = **3**[in2] Sec. D3-2

$A_e = \min(0.85*A_g, A_n) = \min(0.85*4.69$[in2], 3[in2]) = **3**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*3[in2] = **97.5**[kip] Eq. J4-2

Tear out under axial load	[Kip]	89.58	9.65	DL	0.11	Eq. J4-5

$dh_h = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h + 1/16$ [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p$ = 2*(2[in] + (1 - 1)*3[in])*0.375[in] = **1.5**[in2] Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p$ = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.375[in] = **1.08**[in2] Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p$ = (3[in] - 1.13[in])*(4 - 1)*0.375[in] = **2.11**[in2] Sec. J4-3

IsStressUniform $\rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =
0.5*min(0.6*65000[lb/in2]*1.08[in2] + 1*65000[lb/in2]*2.11[in2], 0.6*50000[lb/in2]*1.5[in2] + 1*65000[lb/in2]*2.11[in2]) = **89.58**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	108.74	19.68	DL	0.18	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*4.35[kip/in]*1*4*12.5[in] = **108.74**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	229.90	9.65	DL1	0.04	Eq. J10-4

IsBeamReaction $\rightarrow$ **False**

$N = N$ = **9**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*
0.80*0.44[in]^2*(1 + 3*(9[in]/14[in])*(0.44[in]/0.71[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*
0.71[in]/0.44[in])$^{1/2}$ = **229.9**[kip] Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	152.34	17.15	DL	0.11	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 7.94[in] - 1.06[in]/2) = **7.41**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
F_u*n_c = 0.5*(min(1.2*7.41[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*
65000[lb/in2]*1 = **152.34**[kip] Eq. J3-6

Shear yielding	[Kip]	248.81	17.15	DL	0.07	Eq. J4-3

$A_g = L_p*t_p$ = 24.88[in]*0.5[in] = **12.44**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*12.44[in2] = **248.81**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	153.56	9.65	DL	0.06	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$ = Max(0.0, 2.5[in] - 1.06[in]/2) = **1.97**[in] Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$ = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$

F_u*n_c = 0.5*(min(1.2*1.97[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]* 65000[lb/in2]*4 = **153.56**[kip] Eq. J3-6

Yielding strength due to axial load	[Kip]	372.47	9.65	DL	0.03	Eq. J4-1

$A_g = L_p*t_p$ = 24.88[in]*0.5[in] = **12.44**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*12.44[in2] = **372.47**[kip] Eq. J4-1

Tension rupture	[Kip]	331.19	9.65	DL	0.03	Eq. J4-2

$A_g = L_p*t_p$ = 24.88[in]*0.5[in] = **12.44**[in2] Sec. D3-1

IsBoltedConnection → **True**

$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$A_n = (l - n*L_h)*t_p$ = (24.88[in] - 4*1.13[in])*0.5[in] = **10.19**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*12.44[in2], 10.19[in2]) = **10.19**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*65000[lb/in2]*10.19[in2] = **331.19**[kip] Eq. J4-2

Tear out under axial load	[Kip]	128.91	9.65	DL	0.07	Eq. J4-5

$dh_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.5[in] + (1 - 1)*3[in])*0.5[in] = **2.5**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.5[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.94**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*1.94[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2.5[in2] + 1*65000[lb/in2]*2.81[in2]) = **128.91**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	332.28	16.12	DL	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 19.68[kip]/(0.5*4.35[kip/in]*1*12.5[in]) = **0.724** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*0.724/16 [in] = **1.34**[kip/in] p. 9-5

Ratio **0.29**

Calculation of the brace interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = 20[kip] + 0[kip] + 11[kip] = **31**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 35[kip] - 0[kip] + 12.34[kip] = **47.34**[kip]

Load condition :DL1

$H_{BeamToColumn} = H_{Beam} + H_{Top} + H_{Bot}$ = -20[kip] + 0[kip] + -11[kip] = **-31**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$ = 35[kip] - 0[kip] + -12.34[kip] = **22.66**[kip]

Right beam interface - column

Single plate

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	47.34	31.00	0.00	0.00	0.00	Design
DL1	22.66	-31.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	12.00	8.02	16.05	✔	p. 10-104
$L_{min} = T/2$ = 16.05[in]/2 = **8.02**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 17.9[in] - max(0.927[in], 0[in]) - max(0.927[in], 0[in]) = **16.05**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2$ + 1/16 [in] = 1[in]/2 + 1/16 [in] = **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
$L_{emin} = 2*d$ = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	7.56	✔	Sec. J3.3, Sec. J3.5
$s_{min} = 8/3*d$ = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.315[in], 12 [in]) = **7.56**[in]						Sec. J3.5
Beam						
Vertical edge distance	[in]	4.45	1.25	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$ = 1.25[in] + 0[in] = **1.25**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.25	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	67.50	56.58	DL	0.84	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (4>=10) and (4<=12) and (True) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(1/Ω)R_n = *(1/Ω)**μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*1*64[kip]*1*1 = **16.87**[kip]						Eq. J3-4
(1/Ω)R_n = C**(1/Ω)*R_n**BoltFactor* = 4*16.87[kip]*1 = **67.5**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	132.23	47.34	DL	0.36	Eq. J3-6
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.5[in] - 1.06[in]/2) = **0.969**[in]						Sec. J4.10
$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in]						Sec. J4.10
(1/Ω)R_n = *(1/Ω)**(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*						
F_u*n_c = 0.5*(min(1.2*0.969[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(4 - 1))*0.5[in]*						
65000[lb/in2]*1 = **132.23**[kip]						Eq. J3-6
Shear yielding	[Kip]	120.00	47.34	DL	0.39	Eq. J4-3
A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2]						Sec. D3-1
(1/Ω)R_n = *(1/Ω)**0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*6[in2] = **120**[kip]						Eq. J4-3
Shear rupture	[Kip]	73.13	47.34	DL	0.65	Eq. J4-4
L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
L_e = L - n*L_h = 12[in] - 4*1.13[in] = **7.5**[in]						DG4 Eq. 3-13
A_{nv} = L_e*t_p = 7.5[in]*0.5[in] = **3.75**[in2]						Sec. J4-2
(1/Ω)R_n = *(1/Ω)**0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*3.75[in2] = **73.13**[kip]						Eq. J4-4
Block shear	[Kip]	87.34	47.34	DL	0.54	Eq. J4-5
dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
A_{nt} = (L_{eh} + (n_c - 1)**spa* - (n_c - 0.5)*dh_h)*t_p = (2[in] + (1 - 1)*3[in] - (1 - 0.5)*						
1.13[in])*0.5[in] = **0.719**[in2]						Sec. J4-3
A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.5[in] + (4 - 1)*3[in])*0.5[in] = **5.25**[in2]						Sec. J4-3
A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.5[in] + (4 - 1)*(3[in] - 1.13[in]) -						
1.13[in]/2)*0.5[in] = **3.28**[in2]						Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*3.28[in2] + 1*65000[lb/in2]*0.719[in2], 0.6*50000[lb/in2]*5.25[in2] + 1*65000[lb/in2]*0.719[in2]) = **87.34**[kip] Eq. J4-5

Bolt bearing under axial load	[Kip]	114.56	31.00	DL	0.27	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 2[in] - 1.06[in]/2) = **1.47**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)$*(min($k_1$*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*
F_u*n_c = 0.5*(min(1.2*1.47[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(1 - 1))*0.5[in]*
65000[lb/in2]*4 = **114.56**[kip] Eq. J3-6

Tension yielding	[Kip]	179.64	31.00	DL	0.17	Eq. J4-1

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)$*$F_y$*$A_g$ = 0.599*50000[lb/in2]*6[in2] = **179.64**[kip] Eq. J4-1

Tension rupture	[Kip]	121.88	31.00	DL	0.25	Eq. J4-2

A_g = L_p*t_p = 12[in]*0.5[in] = **6**[in2] Sec. D3-1

IsBoltedConnection → **True**

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_n = (l - n*L_h)*t_p = (12[in] - 4*1.13[in])*0.5[in] = **3.75**[in2] Sec. D3-2

A_e = min(0.85*A_g, A_n) = min(0.85*6[in2], 3.75[in2]) = **3.75**[in2] Sec. J4-1

$(1/\Omega)R_n = (1/\Omega)$*$F_u$*$A_e$ = 0.5*65000[lb/in2]*3.75[in2] = **121.88**[kip] Eq. J4-2

Tear out under axial load	[Kip]	119.44	31.00	DL	0.26	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

n>1 → 4>1 → **True**

A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2[in] + (1 - 1)*3[in])*0.5[in] = **2**[in2] Sec. J4-3

A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2[in] + (1 - 1)*3[in] - 1.13[in]*(1 - 0.5))*0.5[in] = **1.44**[in2] Sec. J4-3

A_{nt} = (s - dh_v)*(n - 1)*t_p = (3[in] - 1.13[in])*(4 - 1)*0.5[in] = **2.81**[in2] Sec. J4-3

IsStressUniform → **True**

U_{bs} = 1 Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*1.44[in2] + 1*65000[lb/in2]*2.81[in2], 0.6*50000[lb/in2]*2[in2] + 1*65000[lb/in2]*2.81[in2]) = **119.44**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	133.95	56.58	DL	0.42	Tables 8-4 .. 8-11

$(1/\Omega)R_n = (1/\Omega)$*$C$*$C_1$*$D$*$L$ = 0.5*4.46[kip/in]*1*5*12[in] = **133.95**[kip] Tables 8-4 .. 8-11

Web crippling	[Kip]	229.90	31.00	DL1	0.13	Eq. J10-4

IsBeamReaction → **False**

N = N = **9**[in] Sec. J10-2

$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2} = 0.5*$
$0.80*0.44_{[in]}{}^2*(1 + 3*(9_{[in]}/14_{[in]})*(0.44_{[in]}/0.71_{[in]})^{1.5})*(2.90E+07_{[lb/in2]}*50000_{[lb/in2]}*$
$0.71_{[in]}/0.44_{[in]})^{1/2} = \mathbf{229.9}_{[kip]}$ Eq. J10-4

Beam

Bolt bearing under shear load	[Kip]	95.98	47.34	DL	0.49	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45_{[in]} - 1.06_{[in]}/2) = \mathbf{3.92}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 1.06_{[in]}) = \mathbf{1.94}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*3.92_{[in]}, 2.4*1_{[in]}) + \min(1.2*1.94_{[in]}, 2.4*1_{[in]})*(4 - 1))*0.315_{[in]}*$
$65000_{[lb/in2]}*1 = \mathbf{95.98}_{[kip]}$ Eq. J3-6

Shear yielding	[Kip]	112.77	47.34	DL	0.42	Eq. J4-3

$A_g = L_p*t_p = 17.9_{[in]}*0.315_{[in]} = \mathbf{5.64}_{[in2]}$ Sec. D3-1

$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g = 0.667*0.60*50000_{[lb/in2]}*5.64_{[in2]} = \mathbf{112.77}_{[kip]}$ Eq. J4-3

Bolt bearing under axial load	[Kip]	84.46	31.00	DL	0.37	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 2.25_{[in]} - 1.06_{[in]}/2) = \mathbf{1.72}_{[in]}$ Sec. J4.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3_{[in]} - 1.06_{[in]}) = \mathbf{1.94}_{[in]}$ Sec. J4.10

$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$
$F_u*n_c = 0.5*(\min(1.2*1.72_{[in]}, 2.4*1_{[in]}) + \min(1.2*1.94_{[in]}, 2.4*1_{[in]})*(1 - 1))*0.315_{[in]}*$
$65000_{[lb/in2]}*4 = \mathbf{84.46}_{[kip]}$ Eq. J3-6

Yielding strength due to axial load	[Kip]	353.29	31.00	DL	0.09	Eq. D2-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*11.8_{[in2]} = \mathbf{353.29}_{[kip]}$ Eq. D2-1

Tension rupture	[Kip]	241.37	31.00	DL	0.13	Eq. J4-2

$IsBoltedConnection \rightarrow$ **True**

$L_h = d_h + 1/16\ _{[in]} = 1.06_{[in]} + 1/16\ _{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$A_n = A_g - n_h*t_p*L_h = 11.8_{[in2]} - 4*0.315_{[in]}*1.13_{[in]} = \mathbf{10.38}_{[in2]}$ Sec. D3-2

$U = 1 - x/l = 1 - 0.854_{[in]}/3_{[in]} = \mathbf{0.715}$ Table D3.1

$A_e = U*A_n = 0.715*10.38_{[in2]} = \mathbf{7.43}_{[in2]}$ Sec. D3-3

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*65000_{[lb/in2]}*7.43_{[in2]} = \mathbf{241.37}_{[kip]}$ Eq. J4-2

Tear out under axial load	[Kip]	78.32	31.00	DL	0.40	Eq. J4-5

$dh_h = d_h + 1/16\ _{[in]} = 1.06_{[in]} + 1/16\ _{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$dh_v = d_h + 1/16\ _{[in]} = 1.06_{[in]} + 1/16\ _{[in]} = \mathbf{1.13}_{[in]}$ Sec. D3-2

$n>1 \rightarrow 4>1 \rightarrow$ **True**

$A_{gv} = 2*(L + (n_c - 1)*g)*t_p = 2*(2.25_{[in]} + (1 - 1)*3_{[in]})*0.315_{[in]} = \mathbf{1.42}_{[in2]}$ Sec. J4-3

$A_{nv} = 2*(L + (n_c - 1)*g - dh_h*(n_c - 0.5))*t_p = 2*(2.25_{[in]} + (1 - 1)*3_{[in]} - 1.13_{[in]}*(1 -$
$0.5))*0.315_{[in]} = \mathbf{1.06}_{[in2]}$ Sec. J4-3

$A_{nt} = (s - dh_v)*(n - 1)*t_p = (3_{[in]} - 1.13_{[in]})*(4 - 1)*0.315_{[in]} = \mathbf{1.77}_{[in2]}$ Sec. J4-3

$IsStressUniform \rightarrow$ **True**

$U_{bs} = 1$ Sec. J4-3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000_{[lb/in2]}*1.06_{[in2]} + 1*65000_{[lb/in2]}*1.77_{[in2]}, 0.6*50000_{[lb/in2]}*1.42_{[in2]} + 1*65000_{[lb/}$

in2]*1.77[in2]) = **78.32**[kip] Eq. J4-5

Support

Welds rupture	[Kip/ft]	332.28	47.05	DL	0.14	p. 9-5

$R_n = 0.6*F_u*t_p = 0.6*65000$[lb/in2]$*0.71$[in] = **27.69**[kip/in] p. 9-5

$D_{min} = P/((1/\Omega)*C*C_1*L) = 56.58$[kip]$/(0.5*4.46$[kip/in]$*1*12$[in]$) =$ **2.11** tables 8-4..11

HasWeldsOnBothSides → **False**

$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] $= 0.6*70000$[lb/in2]$*(2)^{1/2}/2*2.11/16$ [in] = **3.92**[kip/in] p. 9-5

Ratio **0.84**

Global critical strength ratio **0.84**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gt}: Gross area subject to tension

A_{gv}: Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

A_w: Effective area of the weld

α: Distance from the face of the column flange or web to the centroid of the gusset to beam connection

α_{bar}: Centroid of the gusset to beam connection

b: Plate, connector or member width

$(1/\Omega)R_n$: Available shear strength per bolt

N: Bearing length

β: Distance from the face of the beam flange to the centroid of the gusset to column connection

β_{bar}: Centroid of the gusset to column connection

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

D: Uniform force method factor

d_w: Distance between weld and the end of the plate

ΔV: Arbitrary shear

d: Beam depth

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

E: Elastic modulus

e_b: One half the depth of the beam

e_c: One half the depth of the column

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

g: Transversal gage between bolts

H_b: Required shear force on the beam to gusset connection

H_{Beam}: Beam horizontal force

$H_{BeamToColumn}$: Beam to column interrface total horizontal force

H_{Bot}: Bottom horizontal component of the gusset forces

H_c: Required axial force on the column to gusset connection

h_{sc}: Hole factor

H_{Top}: Top horizontal component of the gusset forces

HasWeldsOnBothSides: Has welds on both sides

IsBeamReaction: Is beam reaction

IsBoltedConnection: Is bolted connection

IsCorrosionConsidered: Is corrosion considered

IsMemberEnd: Is member end

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

K: Effective length factor

k_1: Bearing factor

k_2: Bearing factor

k: Distance from outer face of flange to the web toe of fillet

k: Outside corner radius

k_s: Slip resistance factor

K: Uniform force method factor

K': Uniform force method factor

l: Length

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_h: Weld length on heel

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M_b: Required moment on the beam to gusset connection

M_c: Required moment on the column to gusset connection

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N: Bearing length

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

n_h: Holes number

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

R_n: Nominal strength

R_u: Required strength

r: Uniform force method parameter

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

t_w: Web thickness

$tan\theta$: Tangent of the brace with the vertical angle

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V_{Beam}: Beam vertical force

$V_{BeamToColumn}$: Beam to column interrface total vertical force

V_{Bot}: Bottom vertical component of the gusset forces

V_c: Required shear force on the column to gusset connection

V_{Top}: Top vertical component of the gusset forces

w_{min}: Minimum weld size required

x: Connection eccentricity

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

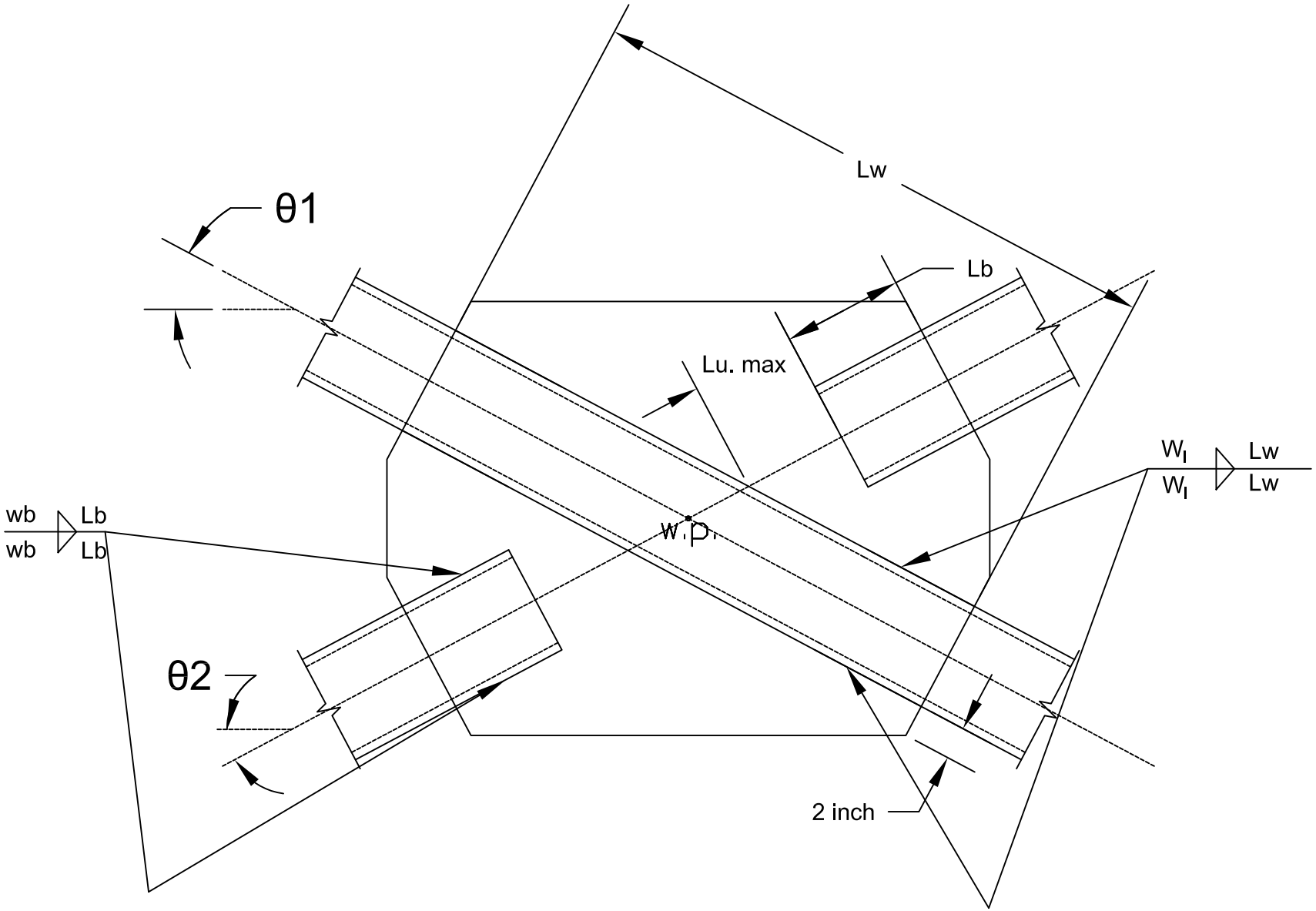
{8} Dowswell, B., 2003, Connection Design For Steel Structures, Structural Design Solutions, LLC. Chapter 13, p. 14

VB-04 Vertical HSS X-Brace Connection

Connection ID	HSS brace	Brace Slope Angles			Gusset Plate to Continous HSS			Gusset Plate To HSS Interface		
		"θ_1" (Deg)	"θ_2" (Deg)	Axial Loading (kips) "±A"	A572 Gr. 50 Gusset Pl Thk. (inch)	Weld Length Lw (inch)	Weld Size WL (inch)	Weld Size "W_b"	Weld Length "L_b"*	Maximum Distance to HSS
VB-04-1	(4)HSS8x8x5/8	28	28	±100	5/8"	41.5	5/16"	5/16"	8"	7.4"
VB-04-2	(4)HSS8x8x1/2	26	26	±60	5/8"	43	5/16"	1/4"	8"	7.9"
VB-04-3	(4)HSS8x8x3/8	27	27	±25	5/8"	42	5/16"	1/4"	8"	7.6"

*Stress relieve hole length not included

VB-04 HSS X Brace-Brace Connection



Current Date: 2016-05-25 10:56 AM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-04 Vertical X Brace Connection\VB-04.cnx\

Steel connections

Results

Connection name : **VXB**

Connection ID : **VB-04-1**

Family: VXB (VXB)

Type: Gusset

Design code: AISC 360-05 ASD

DEMANDS

	Pu				
Description	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip]	
DL	-100.00	100.00	-100.00	100.00	Design
DL1	100.00	-100.00	-100.00	-100.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
-100.00	DL	Design
100.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Brace - Directly welded Connection						

Total weld design strength	[Kip]	148.49	100.00	DL	0.67	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	323.50	100.00	DL	0.31	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.581$[in] = **9.3**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$)$ = **323.5**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	100.00	DL	0.64	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] Eq. J4-4

Block shear on gusset	[Kip]	257.50	100.00	DL1	0.39	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2]$) =$ **257.5**[kip] Eq. J4-5

Ratio **0.67**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	451.74	100.00	DL1	0.22	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*16.4$[in2] = **451.74**[kip] Eq. J4-1

Tension rupture	[Kip]	284.09	100.00	DL1	0.35	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 16.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.581$[in] = **15.67**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/8$[in] = **0.625** Table D3.1

$A_e = A_n * U$ = 15.67[in2]*0.625 = **9.8**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e$ = 0.5*58000[lb/in2]*9.8[in2] = **284.09**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	209.50	100.00	DL1	0.48	Eq. J4-1

$A_g = L_w * t_p$ = 13.99[in]*0.5[in] = **7**[in2]

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g$ = 0.599*50000[lb/in2]*7[in2] = **209.5**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	123.82	100.00	DL	0.81	Eq. E3-1

$F_e = \pi^2 * E/(K*L/r)^2 = \pi^2 * 2.90E+07$[lb/in2]$/(1*12.24$[in]$/0.144$[in]$)^2$ = **39796.5**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 39796.5$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)} * F_y = 0.658^{(1*50000}$[lb/in2]$/39796.5$[lb/in2]$)*50000$[lb/in2] =

29552.25[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega) * F_{cr} * A_g$ = 0.599*29552.25[lb/in2]*7[in2] = **123.82**[kip] Eq. E3-1

Ratio **0.81**

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
100.00	DL	Design
-100.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	100.00	DL	0.67	Eq. J2-4, Eq. J2-6

$F_w = 0.6 * F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2 * D/16$ [in]$* L = (2)^{1/2}/2 * 5/16$ [in]$* 8$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega) * F_w * A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6 * F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2 * D/16$ [in]$* L = (2)^{1/2}/2 * 5/16$ [in]$* 8$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega) * F_w * A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 74.25[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	323.50	100.00	DL	0.31	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e * t_p$ = 16[in]*0.581[in] = **9.3**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$) =$ **323.5**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	100.00	DL	0.64	Eq. J4-4

$L_e = L_t + L_h = 8$[in] $+ 8$[in] $=$ **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] $=$ **8**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] $=$ **156**[kip] Eq. J4-4

Block shear on gusset	[Kip]	257.50	100.00	DL	0.39	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in]$, 8$[in]$) =$ **8**[in]

$L = L_{max} + d_w = 8$[in] $+ 0.5$[in] $=$ **8.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] $=$ **8.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] $=$ **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] $+ 1*65000$[lb/in2]$*4$[in2]$, 0.6*50000$[lb/in2]$*8.5$[in2] $+ 1*65000$[lb/in2]$*$
4[in2]$) =$ **257.5**[kip] Eq. J4-5

Ratio **0.67**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	451.74	100.00	DL	0.22	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*16.4$[in2] $=$ **451.74**[kip] Eq. J4-1

Tension rupture	[Kip]	284.09	100.00	DL	0.35	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 16.4$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.581$[in] $=$ **15.67**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/8$[in] $=$ **0.625** Table D3.1

$A_e = A_n*U = 15.67$[in2]$*0.625 =$ **9.8**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.8$[in2] $=$ **284.09**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	209.50	100.00	DL	0.48	Eq. J4-1

$A_g = L_w*t_p = 13.99$[in]$*0.5$[in] $=$ **7**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*7$[in2] $=$ **209.5**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	123.82	100.00	DL1	0.81	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(1*12.24$[in]$/0.144$[in]$)^2 =$ **39796.5**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 39796.5$[lb/in2]$>= 0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/39796.5$[lb/in2]$)*50000$[lb/in2] $=$
29552.25[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*29552.25[lb/in2]*7[in2] = **123.82**[kip] Eq. E3-1

Ratio **0.81**

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-100.00	DL	Design
-100.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	100.00	DL	0.67	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}/2*5/16$ [in]*8[in] = **1.77**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*1.77[in2]) = **74.25**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}/2*5/16$ [in]*8[in] = **1.77**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]*1.77[in2]) = **74.25**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 74.25[kip] + 74.25[kip] = **148.49**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.50	100.00	DL	0.31	Eq. J4-4
$L_e = L_t + L_h$ = 8[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p$ = 16[in]*0.581[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]*9.3[in2]) = **323.5**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	156.00	100.00	DL	0.64	Eq. J4-4
$L_e = L_t + L_h$ = 8[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p$ = 16[in]*0.5[in] = **8**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*8[in2] = **156**[kip]						Eq. J4-4

Ratio **0.67**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Buckling on the Whitmore section	[Kip]	123.82	100.00	DL	0.81	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(1*12.24$[in]$/0.144$[in]$)^2 =$ **39796.5**[lb/in2]						Eq. E3-4
$F_e >= 0.44*Q*F_y \rightarrow 39796.5$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/39796.5$[lb/in2]$)*50000$[lb/in2] = **29552.25**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*29552.25$[lb/in2]$*7$[in2] = **123.82**[kip]						Eq. E3-1
Ratio	**0.81**					

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
100.00	DL	Design
-100.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	100.00	DL	0.67	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$) =$ **74.25**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*8$[in] = **1.77**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$) =$ **74.25**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	323.50	100.00	DL	0.31	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.581$[in] = **9.3**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*9.3$[in2]$) =$ **323.5**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	156.00	100.00	DL	0.64	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e * t_p = 16$[in]*0.5[in] = **8**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]*8[in2] = **156**[kip] Eq. J4-4

Block shear on gusset	[Kip]	257.50	100.00	DL	0.39	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]) = **8**[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]*0.5[in] = **8.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} = $ **8.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]*0.5[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]*8.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*8.5[in2] + 1*65000[lb/in2]*
4[in2]) = **257.5**[kip] Eq. J4-5

Ratio **0.67**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	451.74	100.00	DL	0.22	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]*16.4[in2] = **451.74**[kip] Eq. J4-1

Tension rupture	[Kip]	284.09	100.00	DL	0.35	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in])*$t = 16.4$[in2] - 2*(0.5[in] + 1/8 [in])*0.581[in] = **15.67**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]/8[in] = **0.625** Table D3.1

$A_e = A_n*U = 15.67$[in2]*0.625 = **9.8**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]*9.8[in2] = **284.09**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	209.50	100.00	DL	0.48	Eq. J4-1

$A_g = L_w*t_p = 13.99$[in]*0.5[in] = **7**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]*7[in2] = **209.5**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	123.82	100.00	DL1	0.81	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]/(1*12.24[in]/0.144[in])^2 = **39796.5**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 39796.5$[lb/in2]>=0.44*1*50000[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/39796.5}$[lb/in2]$^{)}$*50000[lb/in2] =
29552.25[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*29552.25$[lb/in2]*7[in2] = **123.82**[kip] Eq. E3-1

Ratio **0.81**

Global critical strength ratio **0.81**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

$cos\theta$: Cosine of the brace with the horizontal angle

d_w: Distance between weld and the end of the plate

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

H: Brace axial force horizontal component

H_{Left}: Left brace axial force horizontal component

H_{Right}: Right brace axial force horizontal component

K: Effective length factor

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M: Bending required

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

$sin\theta$: Sine of the brace with the horizontal angle

t: Design wall thickness of HSS member

t_p: Plate thickness

U: Shear lag factor

U_{bs}: Stress index

V: Brace axial force vertical component

V_{Left}: Left vertical component of the gusset forces

V_{Right}: Right vertical component of the gusset forces

x: Connection eccentricity

x_{Left}: Distance from the gusset center to the left vertical force

x_{Right}: Distance from the gusset center to the right vertical force

Current Date: 2016-05-25 10:57 AM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-04 Vertical X Brace Connection\VB-04.cnx\

Steel connections

Results

Connection name : **VXB**
Connection ID : **VB-04-2**

Family: VXB (VXB)

Type: Gusset

Design code: AISC 360-05 ASD

DEMANDS

	Pu				
Description	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip]	
DL	60.00	-60.00	60.00	-60.00	Design
DL1	-60.00	60.00	-60.00	60.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
60.00	DL	Design
-60.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	118.79	60.00	DL	0.51	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4$[kip] + 59.4[kip] = **118.79**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	258.91	60.00	DL	0.23	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.465$[in] = **7.44**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*7.44$[in2]$)$ = **258.91**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	60.00	DL	0.38	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip] Eq. J4-4

Block shear on gusset	[Kip]	257.50	60.00	DL	0.23	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*8.5$[in2] + 1$*65000$[lb/in2]$*4$[in2]$) =$ **257.5**[kip] Eq. J4-5

Ratio **0.51**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	60.00	DL	0.16	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	234.15	60.00	DL	0.26	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/8$[in] = **0.625** Table D3.1

$A_e = A_n * U$ = 12.92[in2]*0.625 = **8.07**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e$ = 0.5*58000[lb/in2]*8.07[in2] = **234.15**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	207.25	60.00	DL	0.29	Eq. J4-1

$A_g = L_w * t_p$ = 13.84[in]*0.5[in] = **6.92**[in2]

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g$ = 0.599*50000[lb/in2]*6.92[in2] = **207.25**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	114.58	60.00	DL1	0.52	Eq. E3-1

$F_e = \pi^2 * E/(K*L/r)^2 = \pi^2 * 2.90E+07$[lb/in2]$/(1*12.99$[in]$/0.144$[in]$)^2$ = **35310.7**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 35310.7$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)} * F_y = 0.658^{(1*50000}$[lb/in2]$^{/35310.7}$[lb/in2]$^{)} * 50000$[lb/in2] =

27642.52[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega) * F_{cr} * A_g$ = 0.599*27642.52[lb/in2]*6.92[in2] = **114.58**[kip] Eq. E3-1

Ratio **0.52**

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-60.00	DL	Design
60.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	118.79	60.00	DL	0.51	Eq. J2-4, Eq. J2-6

$F_w = 0.6 * F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2 * D/16$ [in]$* L = (2)^{1/2}/2 * 4/16$ [in]$* 8$[in] = **1.41**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega) * F_w * A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip] Eq. J2-4

$F_w = 0.6 * F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2 * D/16$ [in]$* L = (2)^{1/2}/2 * 4/16$ [in]$* 8$[in] = **1.41**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega) * F_w * A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 59.4[kip] + 59.4[kip] = **118.79**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	258.91	60.00	DL	0.23	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e * t_p$ = 16[in]*0.465[in] = **7.44**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*7.44$[in2]$) =$ **258.91**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	156.00	60.00	DL	0.38	Eq. J4-4

$L_e = L_t + L_h = 8$[in] $+ 8$[in] $=$ **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] $=$ **8**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] $=$ **156**[kip] Eq. J4-4

Block shear on gusset	[Kip]	257.50	60.00	DL1	0.23	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in]$, 8$[in]$) =$ **8**[in]

$L = L_{max} + d_w = 8$[in] $+ 0.5$[in] $=$ **8.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] $=$ **8.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **8.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] $=$ **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] $+ 1*65000$[lb/in2]$*4$[in2]$, 0.6*50000$[lb/in2]$*8.5$[in2] $+ 1*65000$[lb/in2]$*$
4[in2]$) =$ **257.5**[kip] Eq. J4-5

Ratio **0.51**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	60.00	DL1	0.16	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] $=$ **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	234.15	60.00	DL1	0.26	Eq. J4-2

$A_n = A_g - 2*(t_p +$ 1/8 [in]$)*t = 13.5$[in2] $- 2*(0.5$[in] $+$ 1/8 [in]$)*0.465$[in] $=$ **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/8$[in] $=$ **0.625** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.625 =$ **8.07**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*8.07$[in2] $=$ **234.15**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	207.25	60.00	DL1	0.29	Eq. J4-1

$A_g = L_w*t_p = 13.84$[in]$*0.5$[in] $=$ **6.92**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*6.92$[in2] $=$ **207.25**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	114.58	60.00	DL	0.52	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(1*12.99$[in]$/0.144$[in]$)^2 =$ **35310.7**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 35310.7$[lb/in2]$>= 0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/35310.7}$[lb/in2]$^{)}*50000$[lb/in2] $=$
27642.52[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*27642.52$[lb/in2]$*6.92$[in2] = **114.58**[kip] Eq. E3-1

Ratio **0.52**

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
60.00	DL	Design
-60.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	118.79	60.00	DL	0.51	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4$[kip] + 59.4[kip] = **118.79**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	258.91	60.00	DL	0.23	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.465$[in] = **7.44**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*7.44$[in2]$)$ = **258.91**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	156.00	60.00	DL	0.38	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	257.50	60.00	DL	0.23	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]						
$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **8.5**[in2]						Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] $=$ **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] $+ 1*65000$[lb/in2]$*4$[in2]$, 0.6*50000$[lb/in2]$*8.5$[in2] $+ 1*65000$[lb/in2]$*$
4[in2]$) =$ **257.5**[kip] Eq. J4-5

Ratio **0.51**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	371.86	60.00	DL	0.16	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] $=$ **371.86**[kip]						Eq. J4-1
Tension rupture	[Kip]	234.15	60.00	DL	0.26	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] $=$ **12.92**[in2]						Sec. D3.2
$U = 1 - x/l = 1 - 3$[in]$/8$[in] $=$ **0.625**						Table D3.1
$A_e = A_n*U = 12.92$[in2]$*0.625 =$ **8.07**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*8.07$[in2] $=$ **234.15**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	207.25	60.00	DL	0.29	Eq. J4-1
$A_g = L_w*t_p = 13.84$[in]$*0.5$[in] $=$ **6.92**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*6.92$[in2] $=$ **207.25**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	114.58	60.00	DL1	0.52	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(1*12.99$[in]$/0.144$[in]$)^2 =$ **35310.7**[lb/in2]						Eq. E3-4
$F_e >= 0.44*Q*F_y \rightarrow 35310.7$[lb/in2]$>= 0.44*1*50000$[lb/in2] $\rightarrow$ **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/35310.7}$[lb/in2]$^{)}*50000$[lb/in2] $=$ **27642.52**[lb/in2]						Eq. E7-2
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*27642.52$[lb/in2]$*6.92$[in2] $=$ **114.58**[kip]						Eq. E3-1

Ratio **0.52**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	Description	Load type
[Kip]		
-60.00	DL	Design

60.00 DL1 Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	118.79	60.00	DL	0.51	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4$[kip] + 59.4[kip] = **118.79**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	258.91	60.00	DL	0.23	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.465$[in] = **7.44**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*7.44$[in2]$)$ = **258.91**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	156.00	60.00	DL	0.38	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.5$[in] = **8**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*8$[in2] = **156**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	257.50	60.00	DL1	0.23	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) =$ **8**[in]						
$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.5$[in] = **8.5**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **8.5**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$ $0.5*\min(0.6*65000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$, 0.6*50000$[lb/in2]$*8.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **257.5**[kip]						Eq. J4-5
Ratio	**0.51**					

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	60.00	DL1	0.16	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	234.15	60.00	DL1	0.26	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/8$[in] = **0.625** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.625 =$ **8.07**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*8.07$[in2] = **234.15**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	207.25	60.00	DL1	0.29	Eq. J4-1

$A_g = L_w*t_p = 13.84$[in]$*0.5$[in] = **6.92**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*6.92$[in2] = **207.25**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	114.58	60.00	DL	0.52	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(1*12.99$[in]$/0.144$[in]$)^2 =$ **35310.7**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 35310.7$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/35310.7$[lb/in2]$)*50000$[lb/in2] =

27642.52[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*27642.52$[lb/in2]$*6.92$[in2] = **114.58**[kip] Eq. E3-1

Ratio **0.52**

Global critical strength ratio **0.52**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

d_w: Distance between weld and the end of the plate

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

K: Effective length factor

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

t: Design wall thickness of HSS member

t_p: Plate thickness

U: Shear lag factor

U_{bs}: Stress index

x: Connection eccentricity

Current Date: 2016-05-25 11:03 AM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-04 Vertical X Brace Connection\VB-04.cnx\

Steel connections

Results

Connection name : **VXB**

Connection ID : **VB-04-3**

Family: VXB (VXB)

Type: Gusset

Design code: AISC 360-05 ASD

DEMANDS

	Pu				
Description	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip]	
DL	25.00	-25.00	25.00	-25.00	Design
DL1	-25.00	25.00	-25.00	25.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
25.00	DL	Design
-25.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	118.79	25.00	DL	0.21	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4$[kip] + 59.4[kip] = **118.79**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	194.32	25.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.349$[in] = **5.58**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.58$[in2]$)$ = **194.32**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	117.00	25.00	DL	0.21	Eq. J4-4

$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]

$A_{nv} = L_e*t_p = 16$[in]$*0.375$[in] = **6**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*6$[in2] = **117**[kip] Eq. J4-4

Block shear on gusset	[Kip]	193.13	25.00	DL	0.13	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]

$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.375$[in] = **6.38**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **6.38**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.375$[in] = **3**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*6.38$[in2] + $1*65000$[lb/in2]$*3$[in2], $0.6*50000$[lb/in2]$*6.38$[in2] + $1*65000$[lb/in2]$*3$[in2]$)$ = **193.13**[kip] Eq. J4-5

Ratio **0.21**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	25.00	DL	0.09	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	182.17	25.00	DL	0.14	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] - $2*(0.375$[in] + 1/8 [in]$)*0.349$[in] = **10.05**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/8$[in] = **0.625** Table D3.1

$A_e = A_n * U = 10.05[in2] * 0.625 = \mathbf{6.28}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000[lb/in2] * 6.28[in2] = \mathbf{182.17}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	155.93	25.00	DL	0.16	Eq. J4-1

$A_g = L_w * t_p = 13.89[in] * 0.375[in] = \mathbf{5.21}[in2]$

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 50000[lb/in2] * 5.21[in2] = \mathbf{155.93}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	58.30	25.00	DL1	0.43	Eq. E3-1

$F_e = \pi^2 * E/(K * L/r)^2 = \pi^2 * 2.90E+07[lb/in2]/(1 * 12.54[in]/0.108[in])^2 = \mathbf{21316.79}[lb/in2]$ Eq. E3-4

$F_e >= 0.44 * Q * F_y \rightarrow 21316.79[lb/in2] >= 0.44 * 1 * 50000[lb/in2] \rightarrow$ **False**

$F_{cr} = 0.877 * F_e = 0.877 * 21316.79[lb/in2] = \mathbf{18694.83}[lb/in2]$ Eq. E7-3

$(1/\Omega)P_n = (1/\Omega) * F_{cr} * A_g = 0.599 * 18694.83[lb/in2] * 5.21[in2] = \mathbf{58.3}[kip]$ Eq. E3-1

Ratio **0.43**

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-25.00	DL	Design
25.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	118.79	25.00	DL	0.21	Eq. J2-4, Eq. J2-6

$F_w = 0.6 * F_{EXX} = 0.6 * 70000[lb/in2] = \mathbf{42000}[lb/in2]$ Sec. J2.4

$A_w = (2)^{1/2}/2 * D/16\ [in] * L = (2)^{1/2}/2 * 4/16\ [in] * 8[in] = \mathbf{1.41}[in2]$ Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega) * F_w * A_w) = 2 * (0.5 * 42000[lb/in2] * 1.41[in2]) = \mathbf{59.4}[kip]$ Eq. J2-4

$F_w = 0.6 * F_{EXX} = 0.6 * 70000[lb/in2] = \mathbf{42000}[lb/in2]$ Sec. J2.4

$A_w = (2)^{1/2}/2 * D/16\ [in] * L = (2)^{1/2}/2 * 4/16\ [in] * 8[in] = \mathbf{1.41}[in2]$ Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega) * F_w * A_w) = 2 * (0.5 * 42000[lb/in2] * 1.41[in2]) = \mathbf{59.4}[kip]$ Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4[kip] + 59.4[kip] = \mathbf{118.79}[kip]$ Eq. J2-6

Maximum weld force that brace can develop	[Kip]	194.32	25.00	DL	0.13	Eq. J4-4

$L_e = L_t + L_h = 8[in] + 8[in] = \mathbf{16}[in]$

$A_{nv} = L_e * t_p = 16[in] * 0.349[in] = \mathbf{5.58}[in2]$ Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega) * 0.60 * F_u * A_{nv}) = 2 * (0.5 * 0.60 * 58000[lb/in2] * 5.58[in2]) = \mathbf{194.32}[kip]$ Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	117.00	25.00	DL	0.21	Eq. J4-4

$L_e = L_t + L_h = 8\text{[in]} + 8\text{[in]} = \mathbf{16}\text{[in]}$

$A_{nv} = L_e * t_p = 16\text{[in]} * 0.375\text{[in]} = \mathbf{6}\text{[in2]}$ Sec. J4-2

$(1/\Omega)R_n = (1/\Omega) * 0.60 * F_u * A_{nv} = 0.5 * 0.60 * 65000\text{[lb/in2]} * 6\text{[in2]} = \mathbf{117}\text{[kip]}$ Eq. J4-4

Block shear on gusset	[Kip]	193.13	25.00	DL1	0.13	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(8\text{[in]}, 8\text{[in]}) = \mathbf{8}\text{[in]}$

$L = L_{max} + d_w = 8\text{[in]} + 0.5\text{[in]} = \mathbf{8.5}\text{[in]}$ Sec. J4.3

$A_{gv} = 2 * L * t_p = 2 * 8.5\text{[in]} * 0.375\text{[in]} = \mathbf{6.38}\text{[in2]}$ Sec. J4.3

$A_{nv} = A_{gv} = \mathbf{6.38}\text{[in2]}$ Sec. J4.3

$A_{nt} = b * t_p = 8\text{[in]} * 0.375\text{[in]} = \mathbf{3}\text{[in2]}$ Sec. J4.3

$(1/\Omega)R_n = (1/\Omega) * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt},\ 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt}) =$

$0.5 * \min(0.6 * 65000\text{[lb/in2]} * 6.38\text{[in2]} + 1 * 65000\text{[lb/in2]} * 3\text{[in2]},\ 0.6 * 50000\text{[lb/in2]} * 6.38\text{[in2]} + 1 * 65000\text{[lb/in2]} * 3\text{[in2]}) = \mathbf{193.13}\text{[kip]}$ Eq. J4-5

Ratio **0.21**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	25.00	DL1	0.09	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 46000\text{[lb/in2]} * 10.4\text{[in2]} = \mathbf{286.47}\text{[kip]}$ Eq. J4-1

Tension rupture	[Kip]	182.17	25.00	DL1	0.14	Eq. J4-2

$A_n = A_g - 2 * (t_p + 1/8\ \text{[in]}) * t = 10.4\text{[in2]} - 2 * (0.375\text{[in]} + 1/8\ \text{[in]}) * 0.349\text{[in]} = \mathbf{10.05}\text{[in2]}$ Sec. D3.2

$U = 1 - x/l = 1 - 3\text{[in]}/8\text{[in]} = \mathbf{0.625}$ Table D3.1

$A_e = A_n * U = 10.05\text{[in2]} * 0.625 = \mathbf{6.28}\text{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega) * F_u * A_e = 0.5 * 58000\text{[lb/in2]} * 6.28\text{[in2]} = \mathbf{182.17}\text{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	155.93	25.00	DL1	0.16	Eq. J4-1

$A_g = L_w * t_p = 13.89\text{[in]} * 0.375\text{[in]} = \mathbf{5.21}\text{[in2]}$

$(1/\Omega)R_n = (1/\Omega) * F_y * A_g = 0.599 * 50000\text{[lb/in2]} * 5.21\text{[in2]} = \mathbf{155.93}\text{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	58.30	25.00	DL	0.43	Eq. E3-1

$F_e = \pi^2 * E/(K * L/r)^2 = \pi^2 * 2.90\text{E+}07\text{[lb/in2]}/(1 * 12.54\text{[in]}/0.108\text{[in]})^2 = \mathbf{21316.79}\text{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44 * Q * F_y \rightarrow 21316.79\text{[lb/in2]} >= 0.44 * 1 * 50000\text{[lb/in2]} \rightarrow \mathbf{False}$

$F_{cr} = 0.877 * F_e = 0.877 * 21316.79\text{[lb/in2]} = \mathbf{18694.83}\text{[lb/in2]}$ Eq. E7-3

$(1/\Omega)P_n = (1/\Omega) * F_{cr} * A_g = 0.599 * 18694.83\text{[lb/in2]} * 5.21\text{[in2]} = \mathbf{58.3}\text{[kip]}$ Eq. E3-1

Ratio	0.43

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
25.00	DL	Design
-25.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	118.79	25.00	DL	0.21	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4$[kip] + 59.4[kip] = **118.79**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	194.32	25.00	DL	0.13	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.349$[in] = **5.58**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.58$[in2]$)$ = **194.32**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	117.00	25.00	DL	0.21	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.375$[in] = **6**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*6$[in2] = **117**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	193.13	25.00	DL	0.13	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$) = **8**$[in]						
$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.375$[in] = **6.38**[in2]						Sec. J4.3
$A_{nv} = A_{gv} =$ **6.38**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.375$[in] = **3**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$						

0.5*min(0.6*65000[lb/in2]*6.38[in2] + 1*65000[lb/in2]*3[in2], 0.6*50000[lb/in2]*6.38[in2] + 1*65000[lb/in2]*3[in2]) = **193.13**[kip] Eq. J4-5

Ratio **0.21**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	286.47	25.00	DL	0.09	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*10.4[in2] = **286.47**[kip]						Eq. J4-1
Tension rupture	[Kip]	182.17	25.00	DL	0.14	Eq. J4-2
$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t$ = 10.4[in2] - 2*(0.375[in] + 1/8 [in])*0.349[in] = **10.05**[in2]						Sec. D3.2
$U = 1 - x/l$ = 1 - 3[in]/8[in] = **0.625**						Table D3.1
$A_e = A_n*U$ = 10.05[in2]*0.625 = **6.28**[in2]						Eq. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*6.28[in2] = **182.17**[kip]						Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	155.93	25.00	DL	0.16	Eq. J4-1
$A_g = L_w*t_p$ = 13.89[in]*0.375[in] = **5.21**[in2]						
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*5.21[in2] = **155.93**[kip]						Eq. J4-1
Buckling on the Whitmore section	[Kip]	58.30	25.00	DL1	0.43	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(1*12.54[in]/0.108[in])^2 = **21316.79**[lb/in2]						Eq. E3-4
F_e>=0.44*$Q*F_y$ → 21316.79[lb/in2]>=0.44*1*50000[lb/in2] → **False**						
$F_{cr} = 0.877*F_e$ = 0.877*21316.79[lb/in2] = **18694.83**[lb/in2]						Eq. E7-3
$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*18694.83[lb/in2]*5.21[in2] = **58.3**[kip]						Eq. E3-1

Ratio **0.43**

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-25.00	DL	Design
25.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	118.79	25.00	DL	0.21	Eq. J2-4, Eq. J2-6
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2]						Sec. J2.4
$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*8$[in] = **1.41**[in2]						Sec. J2.4
$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.41$[in2]$)$ = **59.4**[kip]						Eq. J2-4
$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 59.4$[kip] + 59.4[kip] = **118.79**[kip]						Eq. J2-6
Maximum weld force that brace can develop	[Kip]	194.32	25.00	DL	0.13	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.349$[in] = **5.58**[in2]						Sec. J4-2
$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.58$[in2]$)$ = **194.32**[kip]						Eq. J4-4
Gusset						
Maximum weld force that gusset can develop	[Kip]	117.00	25.00	DL	0.21	Eq. J4-4
$L_e = L_t + L_h = 8$[in] + 8[in] = **16**[in]						
$A_{nv} = L_e*t_p = 16$[in]$*0.375$[in] = **6**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*6$[in2] = **117**[kip]						Eq. J4-4
Block shear on gusset	[Kip]	193.13	25.00	DL1	0.13	Eq. J4-5
$L_{max} = \max(L_t, L_h) = \max(8$[in], 8[in]$)$ = **8**[in]						
$L = L_{max} + d_w = 8$[in] + 0.5[in] = **8.5**[in]						Sec. J4.3
$A_{gv} = 2*L*t_p = 2*8.5$[in]$*0.375$[in] = **6.38**[in2]						Sec. J4.3
$A_{nv} = A_{gv}$ = **6.38**[in2]						Sec. J4.3
$A_{nt} = b*t_p = 8$[in]$*0.375$[in] = **3**[in2]						Sec. J4.3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = $0.5*\min(0.6*65000$[lb/in2]$*6.38$[in2] + $1*65000$[lb/in2]$*3$[in2], $0.6*50000$[lb/in2]$*6.38$[in2] + $1*65000$[lb/in2]$*3$[in2]$)$ = **193.13**[kip]						Eq. J4-5
Ratio	**0.21**					

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	286.47	25.00	DL1	0.09	Eq. J4-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip]						Eq. J4-1

Tension rupture	[Kip]	182.17	25.00	DL1	0.14	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8\ [in])*t = 10.4[in2] - 2*(0.375[in] + 1/8\ [in])*0.349[in] = \mathbf{10.05}[in2]$ Sec. D3.2

$U = 1 - x/l = 1 - 3[in]/8[in] = \mathbf{0.625}$ Table D3.1

$A_e = A_n*U = 10.05[in2]*0.625 = \mathbf{6.28}[in2]$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000[lb/in2]*6.28[in2] = \mathbf{182.17}[kip]$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	155.93	25.00	DL1	0.16	Eq. J4-1

$A_g = L_w*t_p = 13.89[in]*0.375[in] = \mathbf{5.21}[in2]$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000[lb/in2]*5.21[in2] = \mathbf{155.93}[kip]$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	58.30	25.00	DL	0.43	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(1*12.54[in]/0.108[in])^2 = \mathbf{21316.79}[lb/in2]$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 21316.79[lb/in2] >= 0.44*1*50000[lb/in2] \rightarrow$ **False**

$F_{cr} = 0.877*F_e = 0.877*21316.79[lb/in2] = \mathbf{18694.83}[lb/in2]$ Eq. E7-3

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*18694.83[lb/in2]*5.21[in2] = \mathbf{58.3}[kip]$ Eq. E3-1

Ratio **0.43**

Global critical strength ratio **0.43**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

d_w: Distance between weld and the end of the plate

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

K: Effective length factor

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

t: Design wall thickness of HSS member

t_p: Plate thickness

U: Shear lag factor

U_{bs}: Stress index

x: Connection eccentricity

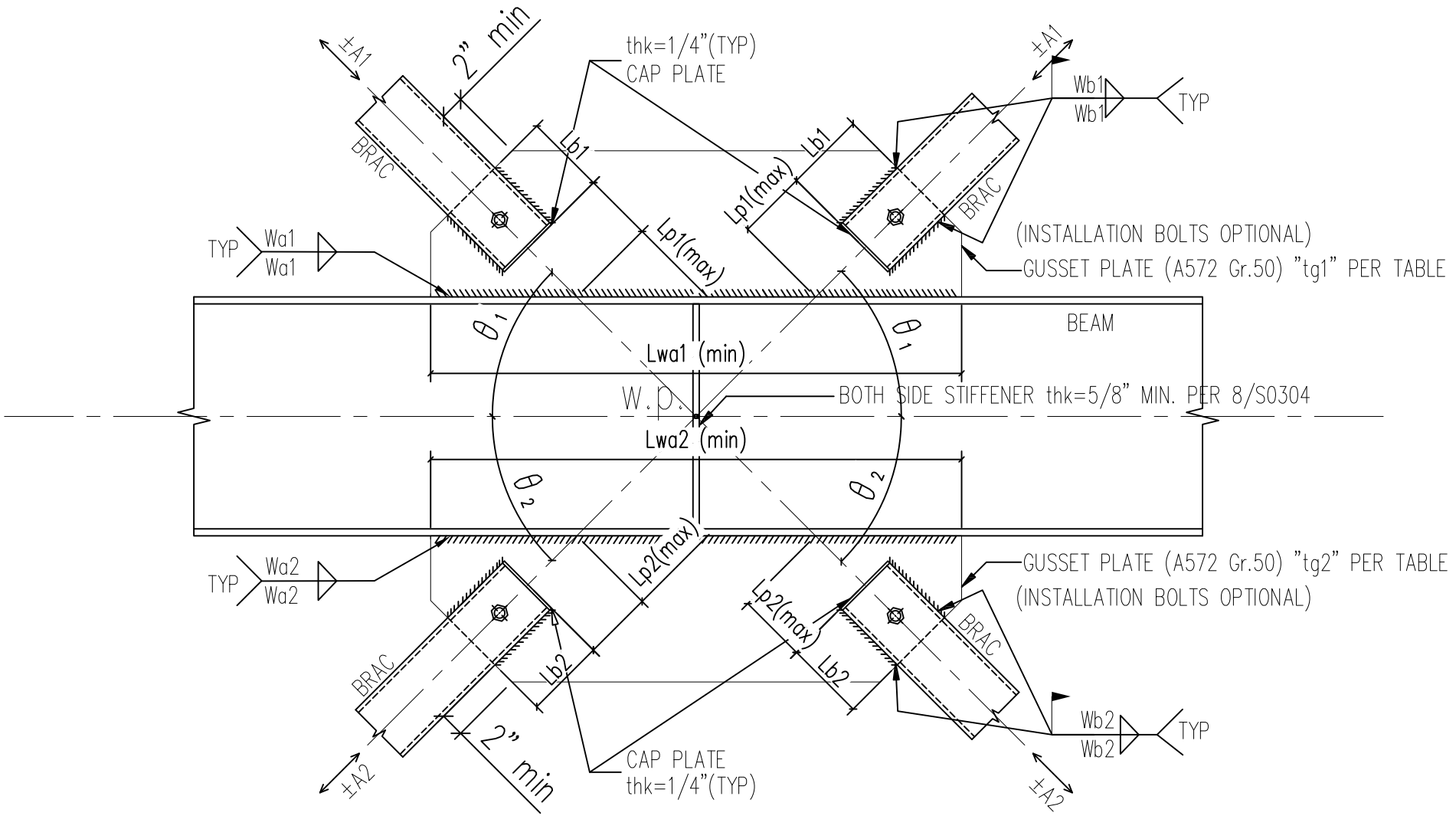
VB-05 HSS Chevron Brace Connection

Connection ID	Beam Size	HSS Size	Brace Slope Angles				UP Gusset Plate To Beam Interface			LOW Gusset Plate To Beam Interface			UP Gusset Plate To HSS Interface			LOW Gusset Plate To HSS Interface		
			"θ_1"	"θ_2"	Axial Loading (kips) "±A1"	Axial Loading (kips) "±A2"	Gusset Plate (A572 Gr.50) Thickness (inch) "t_{g1}"	Weld Size (inch) "W_{a1}"	Weld length (inch) "L_{wa1}" min.	Gusset Plate (A572 Gr.50) Thickness (inch) "t_{g2}"	Weld Size (inch) "W_{a2}"	Weld length (inch) "L_{wa2}" min.	Weld Size (inch) "W_{b1}"	Weld Length (inch) "L_{b1}"	Maximum Distance to Beam (inch) "L_{p1}"	Weld Size (inch) "W_{b2}"	Weld Length (inch) "L_{b2}"	Maximum Distance to Beam (inch) "L_{p2}"
VB-05-1	W21x44	(4)HSS8x8x1/2	55.0	52.0	±152	±152	1/2"	5/16"	45.37	1/2"	5/16"	48.61	5/16"	12"	5.4	5/16"	12"	5.77
VB-05-2	W18x40	(4)HSS8x8x5/16 (3/8)	56.3	55.0	±40	±102	1/2"	1/4"	39.69	1/2"	1/4"	40.88	1/4"	10"	5.13	1/4"	10"	5.28
VB-05-3	W21x44	(4)HSS8x8x1/2	53.7	52.0	±186	±186	1/2"	3/8"	46.85	1/2"	3/8"	48.71	5/16"	12"	5.63	5/16"	12"	5.85
VB-05-4	W18x40	(4)HSS8x8x5/16 (3/8)	55.1	53.7	±36	±112	1/2"	1/4"	40.78	1/2"	1/4"	42.09	1/4"	10"	5.27	1/4"	10"	5.43

*stress relieve hole length not included

VB-05

HSS Chevron Brace Connection



Current Date: 2016-05-25 10:38 AM

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File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-05 Chevron Brace Connection\VB-05.cnx\

Steel connections

Results

Connection name : **CVR**

Connection ID : **VB-05-1**

Family: Chevron - Braces (CVR)

Type: Gusset

Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Beam			Pu				
Description	**Pu**	**Vu**	**Mu33**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	0.00	0.00	152.00	-152.00	152.00	-152.00	Design
DL1	0.00	0.00	0.00	-152.00	152.00	-152.00	152.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
152.00	DL	Design
-152.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	222.74	152.00	DL	0.68	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	152.00	DL	0.39	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	152.00	DL	0.65	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	152.00	DL	0.48	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) = **12**$[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.68**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	152.00	DL	0.41	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	152.00	DL	0.54	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/12$[in] = **0.75** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.75 =$ **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.69$[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	312.75	152.00	DL	0.49	Eq. J4-1

$A_g = L_w*t_p = 20.89$[in]$*0.5$[in] = **10.45**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*10.45$[in2] = **312.75**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	312.24	152.00	DL1	0.49	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.62$[in]$/0.144$[in]$)^2 =$ **4.47E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 4.47E+05$[lb/in2]$>= 0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/4.47E+05}$[lb/in2]$^{)}*50000$[lb/in2] =

47714.57[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47714.57$[lb/in2]$*10.93$[in2] = **312.24**[kip] Eq. E3-1

Ratio **0.54**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = 152$[kip]$*0.574 =$ **87.18**[kip]

$V = P*sin\theta = 152$[kip]$*0.819 =$ **124.51**[kip]

Load condition :DL1

$H = P*cos\theta = -152$[kip]$*0.574 =$ **-87.18**[kip]

$V = P*sin\theta = -152$[kip]$*0.819 =$ **-124.51**[kip]

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-152.00	DL	Design
152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	152.00	DL	0.68	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	152.00	DL	0.39	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	152.00	DL	0.65	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	152.00	DL1	0.48	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) = **12**$[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.68**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	152.00	DL1	0.41	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	152.00	DL1	0.54	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/12$[in] = **0.75** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.75 =$ **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.69$[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	312.75	152.00	DL1	0.49	Eq. J4-1

$A_g = L_w * t_p$ = 20.89[in]*0.5[in] = **10.45**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.45[in2] = **312.75**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	312.24	152.00	DL	0.49	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.62$[in]$/0.144$[in]$)^2$ = **4.47E+05**[lb/in2] Eq. E3-4

F_e>=0.44*$Q*F_y$ → 4.47E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/4.47E+05$[lb/in2]$)$*50000[lb/in2] =

47714.57[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47714.57[lb/in2]*10.93[in2] = **312.24**[kip] Eq. E3-1

Ratio **0.54**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = -152[kip]*0.574 = **-87.18**[kip]

$V = P*sin\theta$ = -152[kip]*0.819 = **-124.51**[kip]

Load condition :DL1

$H = P*cos\theta$ = 152[kip]*0.574 = **87.18**[kip]

$V = P*sin\theta$ = 152[kip]*0.819 = **124.51**[kip]

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
152.00	DL	Design
-152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	152.00	DL	0.68	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]*12[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	152.00	DL	0.39	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	152.00	DL	0.65	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	152.00	DL	0.48	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$)$ = **12**[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.68**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	152.00	DL	0.41	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	152.00	DL	0.54	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/12$[in] = **0.75** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.75$ = **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.69$[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	311.26	152.00	DL	0.49	Eq. J4-1

$A_g = L_w * t_p$ = 20.79[in]*0.5[in] = **10.4**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.4[in2] = **311.26**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	309.89	152.00	DL1	0.49	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*6.05[in]/0.144[in])^2 = **3.85E+05**[lb/in2] Eq. E3-4

F_e>=0.44*$Q*F_y \rightarrow$ 3.85E+05[lb/in2]>=0.44*1*50000[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = 0.658$^{(1*50000}$[lb/in2]$^{/3.85E+05}$[lb/in2]$^{)}$*50000[lb/in2] =

47355.94[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47355.94[lb/in2]*10.93[in2] = **309.89**[kip] Eq. E3-1

Ratio **0.54**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = 152[kip]*0.616 = **93.58**[kip]

$V = P*sin\theta$ = 152[kip]*0.788 = **119.78**[kip]

Load condition :DL1

$H = P*cos\theta$ = -152[kip]*0.616 = **-93.58**[kip]

$V = P*sin\theta$ = -152[kip]*0.788 = **-119.78**[kip]

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-152.00	DL	Design
152.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	152.00	DL	0.68	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}$/2*5/16 [in]*12[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*2.65[in2]) = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}$/2*5/16 [in]*12[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*2.65[in2]) = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 111.37[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	152.00	DL	0.39	Eq. J4-4

$L_e = L_t + L_h$ = 12[in] + 12[in] = **24**[in]

$A_{nv} = L_e * t_p$ = 24[in]*0.465[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*11.16[in2]) = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	152.00	DL	0.65	Eq. J4-4

$L_e = L_t + L_h$ = 12[in] + 12[in] = **24**[in]

$A_{nv} = L_e * t_p$ = 24[in]*0.5[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u$*$A_{nv}$ = 0.5*0.60*65000[lb/in2]*12[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	152.00	DL1	0.48	Eq. J4-5

L_{max} = max(L_t, L_h) = max(12[in], 12[in]) = **12**[in]

$L = L_{max} + d_w$ = 12[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p$ = 2*12.5[in]*0.5[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p$ = 8[in]*0.5[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*12.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*12.5[in2] + 1*65000[lb/in2]*4[in2]) = **317.5**[kip] Eq. J4-5

Ratio **0.68**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	152.00	DL1	0.41	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	152.00	DL1	0.54	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t$ = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l$ = 1 - 3[in]/12[in] = **0.75** Table D3.1

$A_e = A_n*U$ = 12.92[in2]*0.75 = **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.69[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	311.26	152.00	DL1	0.49	Eq. J4-1

$A_g = L_w*t_p$ = 20.79[in]*0.5[in] = **10.4**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.4[in2] = **311.26**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	309.89	152.00	DL	0.49	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*6.05$[in]$/0.144$[in]$)^2 =$ **3.85E+05**[lb/in2] Eq. E3-4

F_e>=$0.44*Q*F_y \rightarrow 3.85E+05$[lb/in2]>=$0.44*1*50000$[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/3.85E+05}$[lb/in2]$^{)}*50000$[lb/in2] =

47355.94[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47355.94$[lb/in2]$*10.93$[in2] = **309.89**[kip] Eq. E3-1

Ratio **0.54**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = -152$[kip]$*0.616 =$ **-93.58**[kip]

$V = P*sin\theta = -152$[kip]$*0.788 =$ **-119.78**[kip]

Load condition :DL1

$H = P*cos\theta = 152$[kip]$*0.616 =$ **93.58**[kip]

$V = P*sin\theta = 152$[kip]$*0.788 =$ **119.78**[kip]

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left} = 87.18$[kip] - -87.18[kip] = **174.37**[kip]

$V = V_{Right} + V_{Left} = 124.51$[kip] + -124.51[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = 124.51$[kip]$*7.25$[in] - -124.51[kip]$*7.25$[in] = **150.39**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left} =$ -87.18[kip] - 87.18[kip] = **-174.37**[kip]

$V = V_{Right} + V_{Left} =$ -124.51[kip] + 124.51[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} =$ -124.51[kip]$*7.25$[in] - 124.51[kip]$*7.25$[in] = **-150.39**[kip*ft]

Upper gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	174.37	0.00	150.39	0.00	0.00	0.00	Design
DL1	-174.37	0.00	-150.39	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	679.21	238.66	DL	0.35	Eq. J4-1
$A_g = L_p*t_p$ = 45.37[in]*0.5[in] = **22.69**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*22.69[in2] = **679.21**[kip]						Eq. J4-1
Shear yielding	[Kip]	453.71	174.37	DL	0.38	Eq. J4-3
$A_g = L_p*t_p$ = 45.37[in]*0.5[in] = **22.69**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*22.69[in2] = **453.71**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*45.37[in]) = **0**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	1106815.00	DL	0.38	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 174.37[kip]/(0.5[in]*45.37[in]) = **7686.21**[lb/in2]						9
Weld capacity	[Kip]	422.09	369.46	DL	0.88	Tables 8-4 .. 8-11
$(1/\Omega)R_n$ = 2 * $((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*5*45.37[in]) = **422.09**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/45.37[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = 174.37[kip]/45.37[in] = **3.84**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 150.39[kip*ft]/(45.37[in]^2/6) = **5.26**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 5.26[kip/in])^2 + 3.84[kip/in]^2)$^{1/2}$ = **6.51**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5* (((0[kip/in] - 5.26[kip/in])^2 + 3.84[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 5.26[kip/in])^2 + 3.84[kip/in]^2)$^{1/2}$) = **6.51**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 45.37[in]*max(6.51[kip/in], 1.25*6.51[kip/in]) = **369.46**[kip]						9
Beam						
Web crippling	[Kip]	217.79	59.66	DL	0.27	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **22.69**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5* 0.80*0.35[in]^2*(1 + 3*(22.69[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]* 0.45[in]/0.35[in])$^{1/2}$ = **217.79**[kip]						Eq. J10-4
Local web yielding	[Kip]	320.08	59.66	DL	0.19	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **22.69**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.95[in] + 22.69[in])*50000[lb/in2]*0.35[in] =						

320.08[kip] Eq. J10-2

Ratio **0.88**

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left}$ = -93.58[kip] - 93.58[kip] = **-187.16**[kip]

$V = V_{Right} + V_{Left}$ = -119.78[kip] + 119.78[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = -119.78[kip]*8.09[in] - 119.78[kip]*8.09[in] = **-161.43**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left}$ = 93.58[kip] - -93.58[kip] = **187.16**[kip]

$V = V_{Right} + V_{Left}$ = 119.78[kip] + -119.78[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = 119.78[kip]*8.09[in] - -119.78[kip]*8.09[in] = **161.43**[kip*ft]

Lower gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-187.16	0.00	-161.43	0.00	0.00	0.00	Design
DL1	187.16	0.00	161.43	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	727.73	239.09	DL	0.33	Eq. J4-1
$A_g = L_p*t_p$ = 48.61[in]*0.5[in] = **24.31**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*24.31[in2] = **727.73**[kip]						Eq. J4-1
Shear yielding	[Kip]	486.12	187.16	DL	0.39	Eq. J4-3
$A_g = L_p*t_p$ = 48.61[in]*0.5[in] = **24.31**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*24.31[in2] = **486.12**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*48.61[in]) = **0**[lb/in2]						9

Gusset edge shear stress	[Lb/ft2]	2880000.00	1108819.00	DL	0.39	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -187.16[kip]/(0.5[in]*48.61[in]) = **-7700.13**[lb/in2]						9
Weld capacity	[Kip]	452.28	379.54	DL	0.84	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*5*48.61[in]) = **452.28**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/48.61[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = -187.16[kip]/48.61[in] = **-3.85**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -161.43[kip*ft]/(48.61[in]^2/6) = **-4.92**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 4.92[kip/in])^2 + 3.85[kip/in]^2)$^{1/2}$ = **6.25**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 4.92[kip/in])^2 + 3.85[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 4.92[kip/in])^2 + 3.85[kip/in]^2)$^{1/2}$) = **6.25**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 48.61[in]*max(6.25[kip/in], 1.25*6.25[kip/in]) = **379.54**[kip]						9

Beam

Web crippling	[Kip]	228.56	59.77	DL	0.26	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **24.31**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.35[in]^2*(1 + 3*(24.31[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **228.56**[kip]						Eq. J10-4
Local web yielding	[Kip]	338.99	59.77	DL	0.18	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **24.31**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.95[in] + 24.31[in])*50000[lb/in2]*0.35[in] = **338.99**[kip]						Eq. J10-2

Ratio **0.84**

Global critical strength ratio **0.88**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

N: Bearing length

C_1: Electrode strength coefficient

C: Weld group coefficient

$cos\theta$: Cosine of the brace with the horizontal angle

d_w: Distance between weld and the end of the plate

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H: Brace axial force horizontal component

H_{Left}: Left brace axial force horizontal component

H_{Right}: Right brace axial force horizontal component

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M: Bending required

M_b: Required moment on the beam to gusset connection

N: Bearing length

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

$sin\theta$: Sine of the brace with the horizontal angle

t_p: Thickness of the connected material

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V: Brace axial force vertical component

V_{Left}: Left vertical component of the gusset forces

V_{Right}: Right vertical component of the gusset forces

x: Connection eccentricity

x_{Left}: Distance from the gusset center to the left vertical force

x_{Right}: Distance from the gusset center to the right vertical force

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 10:41 AM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-05 Chevron Brace Connection\VB-05.cnx\

Steel connections

Results

Connection name : **CVR**

Connection ID : **VB-05-2**

Family: Chevron - Braces (CVR)

Type: Gusset

Description: W18x40

Design code: AISC 360-05 ASD

DEMANDS

	Beam			Pu				
Description	**Pu**	**Vu**	**Mu33**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	0.00	0.00	40.00	-40.00	102.00	-102.00	Design
DL1	0.00	0.00	0.00	-40.00	40.00	-102.00	102.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
40.00	DL	Design
-40.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	40.00	DL	0.27	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	202.54	40.00	DL	0.20	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.291$[in] = **5.82**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.82$[in2]$)$ = **202.54**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	40.00	DL	0.21	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	40.00	DL	0.14	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.27**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	40.00	DL	0.17	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] Eq. J4-1

Tension rupture	[Kip]	170.44	40.00	DL	0.23	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 8.76$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.291$[in] = **8.4**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 8.4_{[in2]}*0.7 = \mathbf{5.88}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*5.88_{[in2]} = \mathbf{170.44}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	281.13	40.00	DL	0.14	Eq. J4-1

$A_g = L_w*t_p = 18.78_{[in]}*0.5_{[in]} = \mathbf{9.39}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*9.39_{[in2]} = \mathbf{281.13}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	280.84	40.00	DL1	0.14	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*5.26_{[in]}/0.144_{[in]})^2 = \mathbf{5.10E+05}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 5.10E+05_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/5.10E+05_{[lb/in2]})}*50000_{[lb/in2]} =$

47987.91[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47987.91_{[lb/in2]}*9.77_{[in2]} = \mathbf{280.84}_{[kip]}$ Eq. E3-1

Ratio **0.23**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = 40_{[kip]}*0.555 = \mathbf{22.19}_{[kip]}$

$V = P*sin\theta = 40_{[kip]}*0.832 = \mathbf{33.28}_{[kip]}$

Load condition :DL1

$H = P*cos\theta = -40_{[kip]}*0.555 = \mathbf{-22.19}_{[kip]}$

$V = P*sin\theta = -40_{[kip]}*0.832 = \mathbf{-33.28}_{[kip]}$

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-40.00	DL	Design
40.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	40.00	DL	0.27	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	202.54	40.00	DL	0.20	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.291$[in] = **5.82**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.82$[in2]$)$ = **202.54**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	40.00	DL	0.21	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	40.00	DL1	0.14	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.27**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	40.00	DL1	0.17	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] Eq. J4-1

Tension rupture	[Kip]	170.44	40.00	DL1	0.23	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 8.76$[in2] - 2*(0.5[in] + 1/8 [in])*0.291[in] = **8.4**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/10$[in] = **0.7** Table D3.1

$A_e = A_n*U = 8.4$[in2]$*0.7 =$ **5.88**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*5.88$[in2] = **170.44**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	281.13	40.00	DL1	0.14	Eq. J4-1

$A_g = L_w * t_p$ = 18.78[in]*0.5[in] = **9.39**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.39[in2] = **281.13**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	280.84	40.00	DL	0.14	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*5.26[in]/0.144[in])^2 = **5.10E+05**[lb/in2] Eq. E3-4

F_e>=0.44*Q*F_y → 5.10E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = $0.658^{(1*50000}$[lb/in2]$^{/5.10E+05}$[lb/in2]$^{)}$*50000[lb/in2] =

47987.91[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47987.91[lb/in2]*9.77[in2] = **280.84**[kip] Eq. E3-1

Ratio **0.23**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = -40[kip]*0.555 = **-22.19**[kip]

$V = P*sin\theta$ = -40[kip]*0.832 = **-33.28**[kip]

Load condition :DL1

$H = P*cos\theta$ = 40[kip]*0.555 = **22.19**[kip]

$V = P*sin\theta$ = 40[kip]*0.832 = **33.28**[kip]

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
102.00	DL	Design
-102.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	102.00	DL	0.69	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}$/2*4/16 [in]*10[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)*F_w*A_w$) = 2 * (0.5*42000[lb/in2]*1.77[in2]) = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	102.00	DL	0.42	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	102.00	DL	0.52	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	102.00	DL	0.35	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} = $ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$) =$ **287.5**[kip] Eq. J4-5

Ratio **0.69**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	102.00	DL	0.36	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	102.00	DL	0.50	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] - 2*(0.5[in] + 1/8 [in])*0.349[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/10$[in] = **0.7** Table D3.1

$A_e = A_n*U = 9.96$[in2]$*0.7 = $ **6.97**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*6.97$[in2] = **202.26**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	280.26	102.00	DL	0.36	Eq. J4-1

$A_g = L_w * t_p$ = 18.72[in]*0.5[in] = **9.36**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.36[in2] = **280.26**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	280.10	102.00	DL1	0.36	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.43$[in]$/0.144$[in]$)^2$ = **4.78E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow$ 4.78E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/4.78E+05}$[lb/in2]$^{)}$*50000[lb/in2] =

47860.29[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47860.29[lb/in2]*9.77[in2] = **280.1**[kip] Eq. E3-1

Ratio **0.50**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = 102[kip]*0.574 = **58.5**[kip]

$V = P*sin\theta$ = 102[kip]*0.819 = **83.55**[kip]

Load condition :DL1

$H = P*cos\theta$ = -102[kip]*0.574 = **-58.5**[kip]

$V = P*sin\theta$ = -102[kip]*0.819 = **-83.55**[kip]

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-102.00	DL	Design
102.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	102.00	DL	0.69	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]*10[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]*10[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 74.25[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	102.00	DL	0.42	Eq. J4-4

$L_e = L_t + L_h$ = 10[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p$ = 20[in]*0.349[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*6.98[in2]) = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	102.00	DL	0.52	Eq. J4-4

$L_e = L_t + L_h$ = 10[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p$ = 20[in]*0.5[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u$*$A_{nv}$ = 0.5*0.60*65000[lb/in2]*10[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	102.00	DL1	0.35	Eq. J4-5

L_{max} = max(L_t, L_h) = max(10[in], 10[in]) = **10**[in]

$L = L_{max} + d_w$ = 10[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p$ = 2*10.5[in]*0.5[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p$ = 8[in]*0.5[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2]) = **287.5**[kip] Eq. J4-5

Ratio **0.69**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	102.00	DL1	0.36	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*10.4[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	102.00	DL1	0.50	Eq. J4-2

$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 10.4[in2] - 2*(0.5[in] + 1/8 [in])*0.349[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l$ = 1 - 3[in]/10[in] = **0.7** Table D3.1

$A_e = A_n*U$ = 9.96[in2]*0.7 = **6.97**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*6.97[in2] = **202.26**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	280.26	102.00	DL1	0.36	Eq. J4-1

$A_g = L_w*t_p$ = 18.72[in]*0.5[in] = **9.36**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.36[in2] = **280.26**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	280.10	102.00	DL	0.36	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.43$[in]$/0.144$[in]$)^2 =$ **4.78E+05**[lb/in2] Eq. E3-4

F_e>=$0.44*Q*F_y \rightarrow 4.78E+05$[lb/in2]>=$0.44*1*50000$[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/4.78E+05$[lb/in2]$)*50000$[lb/in2] =

47860.29[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47860.29$[lb/in2]$*9.77$[in2] = **280.1**[kip] Eq. E3-1

Ratio **0.50**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = -102$[kip]$*0.574 =$ **-58.5**[kip]

$V = P*sin\theta = -102$[kip]$*0.819 =$ **-83.55**[kip]

Load condition :DL1

$H = P*cos\theta = 102$[kip]$*0.574 =$ **58.5**[kip]

$V = P*sin\theta = 102$[kip]$*0.819 =$ **83.55**[kip]

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left} = 22.19$[kip] - -22.19[kip] = **44.39**[kip]

$V = V_{Right} + V_{Left} = 33.28$[kip] + -33.28[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = 33.28$[kip]$*5.97$[in] - -33.28[kip]$*5.97$[in] = **33.11**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left} = -22.19$[kip] - 22.19[kip] = **-44.39**[kip]

$V = V_{Right} + V_{Left} = -33.28$[kip] + 33.28[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = -33.28$[kip]$*5.97$[in] - 33.28[kip]$*5.97$[in] = **-33.11**[kip*ft]

Upper gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	44.39	0.00	33.11	0.00	0.00	0.00	Design
DL1	-44.39	0.00	-33.11	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	594.12	60.06	DL	0.10	Eq. J4-1
$A_g = L_p*t_p$ = 39.69[in]*0.5[in] = **19.84**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*19.84[in2] = **594.12**[kip]						Eq. J4-1
Shear yielding	[Kip]	396.87	44.39	DL	0.11	Eq. J4-3
$A_g = L_p*t_p$ = 39.69[in]*0.5[in] = **19.84**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*19.84[in2] = **396.87**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*39.69[in]) = **0**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	322110.00	DL	0.11	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 44.39[kip]/(0.5[in]*39.69[in]) = **2236.88**[lb/in2]						9
Weld capacity	[Kip]	295.37	93.35	DL	0.32	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*4*39.69[in]) = **295.37**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/39.69[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = 44.39[kip]/39.69[in] = **1.12**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 33.11[kip*ft]/(39.69[in]^2/6) = **1.51**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 1.51[kip/in])^2 + 1.12[kip/in]^2)$^{1/2}$ = **1.88**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 1.51[kip/in])^2 + 1.12[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 1.51[kip/in])^2 + 1.12[kip/in]^2)$^{1/2}$) = **1.88**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 39.69[in]*max(1.88[kip/in], 1.25*1.88[kip/in]) = **93.35**[kip]						9
Beam						
Web crippling	[Kip]	157.07	15.02	DL	0.10	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **19.84**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.315[in]^2*(1 + 3*(19.84[in]/17.9[in])*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])$^{1/2}$ = **157.07**[kip]						Eq. J10-4
Local web yielding	[Kip]	257.02	15.02	DL	0.06	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **19.84**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.927[in] + 19.84[in])*50000[lb/in2]*0.315[in] = **257.02**[kip]						Eq. J10-2

Ratio	**0.32**

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left}$ = -58.5[kip] - 58.5[kip] = **-117.01**[kip]

$V = V_{Right} + V_{Left}$ = -83.55[kip] + 83.55[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = -83.55[kip]*6.27[in] - 83.55[kip]*6.27[in] = **-87.27**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left}$ = 58.5[kip] - -58.5[kip] = **117.01**[kip]

$V = V_{Right} + V_{Left}$ = 83.55[kip] + -83.55[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = 83.55[kip]*6.27[in] - -83.55[kip]*6.27[in] = **87.27**[kip*ft]

Lower gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-117.01	0.00	-87.27	0.00	0.00	0.00	Design
DL1	117.01	0.00	87.27	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	611.92	153.72	DL	0.25	Eq. J4-1
$A_g = L_p*t_p$ = 40.88[in]*0.5[in] = **20.44**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*20.44[in2] = **611.92**[kip]						Eq. J4-1
Shear yielding	[Kip]	408.76	117.01	DL	0.29	Eq. J4-3
$A_g = L_p*t_p$ = 40.88[in]*0.5[in] = **20.44**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*20.44[in2] = **408.76**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*40.88[in]) = **0**[lb/in2]						9

Gusset edge shear stress	[Lb/ft2]	2880000.00	824405.90	DL	0.29	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -117.01[kip]/(0.5[in]*40.88[in]) = **-5725.04**[lb/in2]						9
Weld capacity	[Kip]	304.24	241.48	DL	0.79	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*4*40.88[in]) = **304.24**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/40.88[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = -117.01[kip]/40.88[in] = **-2.86**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -87.27[kip*ft]/(40.88[in]^2/6) = **-3.76**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 3.76[kip/in])^2 + 2.86[kip/in]^2)$^{1/2}$ = **4.73**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 3.76[kip/in])^2 + 2.86[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 3.76[kip/in])^2 + 2.86[kip/in]^2)$^{1/2}$) = **4.73**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 40.88[in]*max(4.73[kip/in], 1.25*4.73[kip/in]) = **241.48**[kip]						9

Beam

Web crippling	[Kip]	159.93	38.43	DL	0.24	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **20.44**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.315[in]^2*(1 + 3*(20.44[in]/17.9[in])*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])$^{1/2}$ = **159.93**[kip]						Eq. J10-4
Local web yielding	[Kip]	263.27	38.43	DL	0.15	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **20.44**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.927[in] + 20.44[in])*50000[lb/in2]*0.315[in] = **263.27**[kip]						Eq. J10-2

Ratio **0.79**

Global critical strength ratio **0.79**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

N: Bearing length

C_1: Electrode strength coefficient

C: Weld group coefficient

$cos\theta$: Cosine of the brace with the horizontal angle

d_w: Distance between weld and the end of the plate

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H: Brace axial force horizontal component

H_{Left}: Left brace axial force horizontal component

H_{Right}: Right brace axial force horizontal component

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M: Bending required

M_b: Required moment on the beam to gusset connection

N: Bearing length

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

$sin\theta$: Sine of the brace with the horizontal angle

t_p: Thickness of the connected material

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V: Brace axial force vertical component

V_{Left}: Left vertical component of the gusset forces

V_{Right}: Right vertical component of the gusset forces

x: Connection eccentricity

x_{Left}: Distance from the gusset center to the left vertical force

x_{Right}: Distance from the gusset center to the right vertical force

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 10:42 AM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-05 Chevron Brace Connection\VB-05.cnx\

Steel connections

Results

Connection name : **CVR**

Connection ID : **VB-05-3**

Family: Chevron - Braces (CVR)

Type: Gusset

Description: W21x44

Design code: AISC 360-05 ASD

DEMANDS

	Beam			Pu				
Description	**Pu**	**Vu**	**Mu33**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	0.00	0.00	186.00	-186.00	186.00	-186.00	Design
DL1	0.00	0.00	0.00	-186.00	186.00	-186.00	186.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
186.00	DL	Design
-186.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	222.74	186.00	DL	0.84	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	186.00	DL	0.48	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	186.00	DL	0.79	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	186.00	DL	0.59	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) = **12**$[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.84**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	186.00	DL	0.50	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	186.00	DL	0.66	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.465$[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/12$[in] = **0.75** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.75 =$ **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.69$[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	312.55	186.00	DL	0.60	Eq. J4-1

$A_g = L_w*t_p = 20.88$[in]$*0.5$[in] = **10.44**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000$[lb/in2]$*10.44$[in2] = **312.55**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	310.89	186.00	DL1	0.60	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.87$[in]$/0.144$[in]$)^2 =$ **4.09E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 4.09E+05$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/4.09E+05$[lb/in2]$)*50000$[lb/in2] =

47508.81[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47508.81$[lb/in2]$*10.93$[in2] = **310.89**[kip] Eq. E3-1

Ratio **0.66**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = 186$[kip]$*0.592 =$ **110.11**[kip]

$V = P*sin\theta = 186$[kip]$*0.806 =$ **149.9**[kip]

Load condition :DL1

$H = P*cos\theta = -186$[kip]$*0.592 =$ **-110.11**[kip]

$V = P*sin\theta = -186$[kip]$*0.806 =$ **-149.9**[kip]

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-186.00	DL	Design
186.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	186.00	DL	0.84	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	186.00	DL	0.48	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	186.00	DL	0.79	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	186.00	DL1	0.59	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$) = **12**$[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.84**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	186.00	DL1	0.50	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	186.00	DL1	0.66	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/12$[in] = **0.75** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.75 =$ **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.69$[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	312.55	186.00	DL1	0.60	Eq. J4-1

$A_g = L_w * t_p$ = 20.88[in]*0.5[in] = **10.44**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.44[in2] = **312.55**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	310.89	186.00	DL	0.60	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2$*2.90E+07[lb/in2]/(0.65*5.87[in]/0.144[in])^2 = **4.09E+05**[lb/in2] Eq. E3-4

F_e>=0.44*$Q*F_y$ → 4.09E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$ = $0.658^{(1*50000[lb/in2]/4.09E+05[lb/in2])}$*50000[lb/in2] =

47508.81[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47508.81[lb/in2]*10.93[in2] = **310.89**[kip] Eq. E3-1

Ratio **0.66**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = -186[kip]*0.592 = **-110.11**[kip]

$V = P*sin\theta$ = -186[kip]*0.806 = **-149.9**[kip]

Load condition :DL1

$H = P*cos\theta$ = 186[kip]*0.592 = **110.11**[kip]

$V = P*sin\theta$ = 186[kip]*0.806 = **149.9**[kip]

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
186.00	DL	Design
-186.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	186.00	DL	0.84	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}$/2*5/16 [in]*12[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)*F_w*A_w$) = 2 * (0.5*42000[lb/in2]*2.65[in2]) = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*5/16$ [in]$*12$[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*2.65$[in2]$)$ = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 111.37$[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	186.00	DL	0.48	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.465$[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*11.16$[in2]$)$ = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	186.00	DL	0.79	Eq. J4-4

$L_e = L_t + L_h = 12$[in] + 12[in] = **24**[in]

$A_{nv} = L_e*t_p = 24$[in]$*0.5$[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*12$[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	186.00	DL	0.59	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(12$[in], 12[in]$)$ = **12**[in]

$L = L_{max} + d_w = 12$[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*12.5$[in]$*0.5$[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ =

$0.5*\min(0.6*65000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*12.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **317.5**[kip] Eq. J4-5

Ratio **0.84**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	186.00	DL	0.50	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*13.5$[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	186.00	DL	0.66	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 13.5$[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/12$[in] = **0.75** Table D3.1

$A_e = A_n*U = 12.92$[in2]$*0.75$ = **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*9.69$[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	311.71	186.00	DL	0.60	Eq. J4-1

$A_g = L_w * t_p$ = 20.82[in]*0.5[in] = **10.41**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.41[in2] = **311.71**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	309.49	186.00	DL1	0.60	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*6.12[in]/0.144[in])^2$ = **3.76E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow$ 3.76E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/3.76E+05[lb/in2])}*50000[lb/in2]$ =

47295.19[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47295.19[lb/in2]*10.93[in2] = **309.49**[kip] Eq. E3-1

Ratio **0.66**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = 186[kip]*0.616 = **114.51**[kip]

$V = P*sin\theta$ = 186[kip]*0.788 = **146.57**[kip]

Load condition :DL1

$H = P*cos\theta$ = -186[kip]*0.616 = **-114.51**[kip]

$V = P*sin\theta$ = -186[kip]*0.788 = **-146.57**[kip]

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	Description	Load type
[Kip]		
-186.00	DL	Design
186.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	222.74	186.00	DL	0.84	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}/2*5/16$ [in]*12[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*2.65[in2]) = **111.37**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}/2*5/16$ [in]*12[in] = **2.65**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*2.65[in2]) = **111.37**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 111.37[kip] + 111.37[kip] = **222.74**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	388.37	186.00	DL	0.48	Eq. J4-4

$L_e = L_t + L_h$ = 12[in] + 12[in] = **24**[in]

$A_{nv} = L_e * t_p$ = 24[in]*0.465[in] = **11.16**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*11.16[in2]) = **388.37**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	234.00	186.00	DL	0.79	Eq. J4-4

$L_e = L_t + L_h$ = 12[in] + 12[in] = **24**[in]

$A_{nv} = L_e * t_p$ = 24[in]*0.5[in] = **12**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u$*$A_{nv}$ = 0.5*0.60*65000[lb/in2]*12[in2] = **234**[kip] Eq. J4-4

Block shear on gusset	[Kip]	317.50	186.00	DL1	0.59	Eq. J4-5

L_{max} = max(L_t, L_h) = max(12[in], 12[in]) = **12**[in]

$L = L_{max} + d_w$ = 12[in] + 0.5[in] = **12.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p$ = 2*12.5[in]*0.5[in] = **12.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **12.5**[in2] Sec. J4.3

$A_{nt} = b*t_p$ = 8[in]*0.5[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*12.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*12.5[in2] + 1*65000[lb/in2]*4[in2]) = **317.5**[kip] Eq. J4-5

Ratio **0.84**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	371.86	186.00	DL1	0.50	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*13.5[in2] = **371.86**[kip] Eq. J4-1

Tension rupture	[Kip]	280.98	186.00	DL1	0.66	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t$ = 13.5[in2] - 2*(0.5[in] + 1/8 [in])*0.465[in] = **12.92**[in2] Sec. D3.2

$U = 1 - x/l$ = 1 - 3[in]/12[in] = **0.75** Table D3.1

$A_e = A_n*U$ = 12.92[in2]*0.75 = **9.69**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*9.69[in2] = **280.98**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	311.71	186.00	DL1	0.60	Eq. J4-1

$A_g = L_w*t_p$ = 20.82[in]*0.5[in] = **10.41**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*10.41[in2] = **311.71**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	309.49	186.00	DL	0.60	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*6.12$[in]$/0.144$[in]$)^2 =$ **3.76E+05**[lb/in2] Eq. E3-4

F_e>=$0.44*Q*F_y \rightarrow 3.76E+05$[lb/in2]>=$0.44*1*50000$[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$^{/3.76E+05}$[lb/in2]$^{)}*50000$[lb/in2] =

47295.19[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47295.19$[lb/in2]$*10.93$[in2] = **309.49**[kip] Eq. E3-1

Ratio **0.66**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = -186$[kip]$*0.616 =$ **-114.51**[kip]

$V = P*sin\theta = -186$[kip]$*0.788 =$ **-146.57**[kip]

Load condition :DL1

$H = P*cos\theta = 186$[kip]$*0.616 =$ **114.51**[kip]

$V = P*sin\theta = 186$[kip]$*0.788 =$ **146.57**[kip]

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left} = 110.11$[kip] - -110.11[kip] = **220.23**[kip]

$V = V_{Right} + V_{Left} = 149.9$[kip] + -149.9[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = 149.9$[kip]$*7.6$[in] - -149.9[kip]$*7.6$[in] = **189.95**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left} = -110.11$[kip] - 110.11[kip] = **-220.23**[kip]

$V = V_{Right} + V_{Left} = -149.9$[kip] + 149.9[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = -149.9$[kip]$*7.6$[in] - 149.9[kip]$*7.6$[in] = **-189.95**[kip*ft]

Upper gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	220.23	0.00	189.95	0.00	0.00	0.00	Design
DL1	-220.23	0.00	-189.95	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	701.36	291.91	DL	0.42	Eq. J4-1
$A_g = L_p*t_p$ = 46.85[in]*0.5[in] = **23.43**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*23.43[in2] = **701.36**[kip]						Eq. J4-1
Shear yielding	[Kip]	468.51	220.23	DL	0.47	Eq. J4-3
$A_g = L_p*t_p$ = 46.85[in]*0.5[in] = **23.43**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*23.43[in2] = **468.51**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*46.85[in]) = **0**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	1353790.00	DL	0.47	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 220.23[kip]/(0.5[in]*46.85[in]) = **9401.32**[lb/in2]						9
Weld capacity	[Kip]	523.05	457.08	DL	0.87	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*6*46.85[in]) = **523.05**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/46.85[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = 220.23[kip]/46.85[in] = **4.7**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 189.95[kip*ft]/(46.85[in]^2/6) = **6.23**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 6.23[kip/in])^2 + 4.7[kip/in]^2)$^{1/2}$ = **7.8**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 6.23[kip/in])^2 + 4.7[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 6.23[kip/in])^2 + 4.7[kip/in]^2)$^{1/2}$) = **7.8**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 46.85[in]*max(7.8[kip/in], 1.25*7.8[kip/in]) = **457.08**[kip]						9
Beam						
Web crippling	[Kip]	222.71	72.98	DL	0.33	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **23.43**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.35[in]^2*(1 + 3*(23.43[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **222.71**[kip]						Eq. J10-4
Local web yielding	[Kip]	328.71	72.98	DL	0.22	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **23.43**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.95[in] + 23.43[in])*50000[lb/in2]*0.35[in] = **328.71**[kip]						Eq. J10-2

Ratio	**0.87**

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left}$ = -114.51[kip] - 114.51[kip] = **-229.03**[kip]

$V = V_{Right} + V_{Left}$ = -146.57[kip] + 146.57[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = -146.57[kip]*8.09[in] - 146.57[kip]*8.09[in] = **-197.53**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left}$ = 114.51[kip] - -114.51[kip] = **229.03**[kip]

$V = V_{Right} + V_{Left}$ = 146.57[kip] + -146.57[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = 146.57[kip]*8.09[in] - -146.57[kip]*8.09[in] = **197.53**[kip*ft]

Lower gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-229.03	0.00	-197.53	0.00	0.00	0.00	Design
DL1	229.03	0.00	197.53	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	729.19	291.98	DL	0.40	Eq. J4-1
$A_g = L_p*t_p$ = 48.71[in]*0.5[in] = **24.36**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*24.36[in2] = **729.19**[kip]						Eq. J4-1
Shear yielding	[Kip]	487.10	229.03	DL	0.47	Eq. J4-3
$A_g = L_p*t_p$ = 48.71[in]*0.5[in] = **24.36**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*24.36[in2] = **487.1**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*48.71[in]) = **0**[lb/in2]						9

Gusset edge shear stress	[Lb/ft2]	2880000.00	1354124.00	DL	0.47	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -229.03[kip]/(0.5[in]*48.71[in]) = **-9403.64**[lb/in2]						9
Weld capacity	[Kip]	543.83	463.86	DL	0.85	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*6*48.71[in]) = **543.83**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/48.71[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = -229.03[kip]/48.71[in] = **-4.7**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -197.53[kip*ft]/(48.71[in]^2/6) = **-5.99**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 5.99[kip/in])^2 + 4.7[kip/in]^2)$^{1/2}$ = **7.62**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 5.99[kip/in])^2 + 4.7[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 5.99[kip/in])^2 + 4.7[kip/in^2])$^{1/2}$) = **7.62**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 48.71[in]*max(7.62[kip/in], 1.25*7.62[kip/in]) = **463.86**[kip]						9

Beam

Web crippling	[Kip]	228.89	73.00	DL	0.32	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **24.36**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.35[in]^2*(1 + 3*(24.36[in]/20.7[in])*(0.35[in]/0.45[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.45[in]/0.35[in])$^{1/2}$ = **228.89**[kip]						Eq. J10-4
Local web yielding	[Kip]	339.56	73.00	DL	0.21	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **24.36**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.95[in] + 24.36[in])*50000[lb/in2]*0.35[in] = **339.56**[kip]						Eq. J10-2

Ratio **0.85**

Global critical strength ratio **0.87**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

N: Bearing length

C_1: Electrode strength coefficient

C: Weld group coefficient

$cos\theta$: Cosine of the brace with the horizontal angle

d_w: Distance between weld and the end of the plate

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H: Brace axial force horizontal component

H_{Left}: Left brace axial force horizontal component

H_{Right}: Right brace axial force horizontal component

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M: Bending required

M_b: Required moment on the beam to gusset connection

N: Bearing length

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

$\sin\theta$: Sine of the brace with the horizontal angle

t_p: Thickness of the connected material

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V: Brace axial force vertical component

V_{Left}: Left vertical component of the gusset forces

V_{Right}: Right vertical component of the gusset forces

x: Connection eccentricity

x_{Left}: Distance from the gusset center to the left vertical force

x_{Right}: Distance from the gusset center to the right vertical force

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Current Date: 2016-05-25 10:50 AM

Units system: English

File name: \\192.168.2.102\Design\Webster Connection Design Folder\Reports and Calculations\VB-05 Chevron Brace Connection\VB-05.cnx\

Steel connections

Results

Connection name : **CVR**

Connection ID : **VB-05-4**

Family: Chevron - Braces (CVR)

Type: Gusset

Description: W18x40

Design code: AISC 360-05 ASD

DEMANDS

	Beam			Pu				
Description	**Pu**	**Vu**	**Mu33**	**Brace1**	**Brace2**	**Brace3**	**Brace4**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip]	[Kip]	[Kip]	
DL	0.00	0.00	0.00	36.00	-36.00	112.00	-112.00	Design
DL1	0.00	0.00	0.00	-36.00	36.00	-112.00	112.00	Design

Interface between Gusset - Top right brace

Connection: Directly welded

DEMANDS

Pu	**Description**	**Load type**
[Kip]		
36.00	DL	Design
-36.00	DL1	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**

Brace - Directly welded Connection

Total weld design strength	[Kip]	148.49	36.00	DL	0.24	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	202.54	36.00	DL	0.18	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.291$[in] = **5.82**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.82$[in2]$)$ = **202.54**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	36.00	DL	0.18	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	36.00	DL	0.13	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.24**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	36.00	DL	0.15	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] Eq. J4-1

Tension rupture	[Kip]	170.44	36.00	DL	0.21	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 8.76$[in2] $- 2*(0.5$[in] $+ 1/8$ [in]$)*0.291$[in] = **8.4**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3_{[in]}/10_{[in]} = \mathbf{0.7}$ Table D3.1

$A_e = A_n*U = 8.4_{[in2]}*0.7 = \mathbf{5.88}_{[in2]}$ Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000_{[lb/in2]}*5.88_{[in2]} = \mathbf{170.44}_{[kip]}$ Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	280.33	36.00	DL	0.13	Eq. J4-1

$A_g = L_w*t_p = 18.73_{[in]}*0.5_{[in]} = \mathbf{9.36}_{[in2]}$

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*50000_{[lb/in2]}*9.36_{[in2]} = \mathbf{280.33}_{[kip]}$ Eq. J4-1

Buckling on the Whitmore section	[Kip]	280.16	36.00	DL1	0.13	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07_{[lb/in2]}/(0.65*5.42_{[in]}/0.144_{[in]})^2 = \mathbf{4.81E+05}_{[lb/in2]}$ Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 4.81E+05_{[lb/in2]} >= 0.44*1*50000_{[lb/in2]} \rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000_{[lb/in2]}/4.81E+05_{[lb/in2]})}*50000_{[lb/in2]} =$

47870.41[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47870.41_{[lb/in2]}*9.77_{[in2]} = \mathbf{280.16}_{[kip]}$ Eq. E3-1

Ratio **0.21**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = 36_{[kip]}*0.572 = \mathbf{20.6}_{[kip]}$

$V = P*sin\theta = 36_{[kip]}*0.82 = \mathbf{29.53}_{[kip]}$

Load condition :DL1

$H = P*cos\theta = -36_{[kip]}*0.572 = \mathbf{-20.6}_{[kip]}$

$V = P*sin\theta = -36_{[kip]}*0.82 = \mathbf{-29.53}_{[kip]}$

Interface between Gusset - Top left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
-36.00	DL	Design
36.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	36.00	DL	0.24	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	202.54	36.00	DL	0.18	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.291$[in] = **5.82**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*5.82$[in2]$)$ = **202.54**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	36.00	DL	0.18	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	36.00	DL1	0.13	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) =$ **10**[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} =$ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$
$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$)$ = **287.5**[kip] Eq. J4-5

Ratio **0.24**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	241.29	36.00	DL1	0.15	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*8.76$[in2] = **241.29**[kip] Eq. J4-1

Tension rupture	[Kip]	170.44	36.00	DL1	0.21	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 8.76$[in2] - 2*(0.5[in] + 1/8 [in])*0.291[in] = **8.4**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/10$[in] = **0.7** Table D3.1

$A_e = A_n*U = 8.4$[in2]$*0.7 =$ **5.88**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*5.88$[in2] = **170.44**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	280.33	36.00	DL1	0.13	Eq. J4-1

$A_g = L_w * t_p$ = 18.73[in]*0.5[in] = **9.36**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.36[in2] = **280.33**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	280.16	36.00	DL	0.13	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.42$[in]$/0.144$[in]$)^2$ = **4.81E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow$ 4.81E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/4.81E+05$[lb/in2]$)*50000$[lb/in2] =

47870.41[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47870.41[lb/in2]*9.77[in2] = **280.16**[kip] Eq. E3-1

Ratio **0.21**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = -36[kip]*0.572 = **-20.6**[kip]

$V = P*sin\theta$ = -36[kip]*0.82 = **-29.53**[kip]

Load condition :DL1

$H = P*cos\theta$ = 36[kip]*0.572 = **20.6**[kip]

$V = P*sin\theta$ = 36[kip]*0.82 = **29.53**[kip]

Interface between Gusset - Bottom left brace

Connection: Directly welded

DEMANDS

Pu [Kip]	Description	Load type
112.00	DL	Design
-112.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	112.00	DL	0.75	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]*10[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 *$ (0.5*42000[lb/in2]*1.77[in2]) = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX} = 0.6*70000$[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]$*L = (2)^{1/2}/2*4/16$ [in]$*10$[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w) = 2 * (0.5*42000$[lb/in2]$*1.77$[in2]$)$ = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2} = 74.25$[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	112.00	DL	0.46	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.349$[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n = 2 * ((1/\Omega)*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000$[lb/in2]$*6.98$[in2]$)$ = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	112.00	DL	0.57	Eq. J4-4

$L_e = L_t + L_h = 10$[in] + 10[in] = **20**[in]

$A_{nv} = L_e*t_p = 20$[in]$*0.5$[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv} = 0.5*0.60*65000$[lb/in2]$*10$[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	112.00	DL	0.39	Eq. J4-5

$L_{max} = \max(L_t, L_h) = \max(10$[in], 10[in]$) = **10**$[in]

$L = L_{max} + d_w = 10$[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p = 2*10.5$[in]$*0.5$[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv} = $ **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p = 8$[in]$*0.5$[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =$

$0.5*\min(0.6*65000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2], $0.6*50000$[lb/in2]$*10.5$[in2] + $1*65000$[lb/in2]$*4$[in2]$) =$ **287.5**[kip] Eq. J4-5

Ratio **0.75**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	112.00	DL	0.39	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g = 0.599*46000$[lb/in2]$*10.4$[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	112.00	DL	0.55	Eq. J4-2

$A_n = A_g - 2*(t_p + 1/8$ [in]$)*t = 10.4$[in2] - 2*(0.5[in] + 1/8 [in])*0.349[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l = 1 - 3$[in]$/10$[in] = **0.7** Table D3.1

$A_e = A_n*U = 9.96$[in2]$*0.7 = $ **6.97**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e = 0.5*58000$[lb/in2]$*6.97$[in2] = **202.26**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	279.45	112.00	DL	0.40	Eq. J4-1

$A_g = L_w * t_p$ = 18.67[in]*0.5[in] = **9.33**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.33[in2] = **279.45**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	279.30	112.00	DL1	0.40	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07[lb/in2]/(0.65*5.61[in]/0.144[in])^2$ = **4.49E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow$ 4.49E+05[lb/in2]>=0.44*1*50000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000[lb/in2]/4.49E+05[lb/in2])}*50000$[lb/in2] =

47723.75[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g$ = 0.599*47723.75[lb/in2]*9.77[in2] = **279.3**[kip] Eq. E3-1

Ratio **0.55**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta$ = 112[kip]*0.592 = **66.31**[kip]

$V = P*sin\theta$ = 112[kip]*0.806 = **90.26**[kip]

Load condition :DL1

$H = P*cos\theta$ = -112[kip]*0.592 = **-66.31**[kip]

$V = P*sin\theta$ = -112[kip]*0.806 = **-90.26**[kip]

Interface between Gusset - Bottom right brace

Connection: Directly welded

DEMANDS

Pu	Description	Load type
[Kip]		
-112.00	DL	Design
112.00	DL1	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace - Directly welded Connection						
Total weld design strength	[Kip]	148.49	112.00	DL	0.75	Eq. J2-4, Eq. J2-6

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}/2*4/16$ [in]*10[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*1.77[in2]) = **74.25**[kip] Eq. J2-4

$F_w = 0.6*F_{EXX}$ = 0.6*70000[lb/in2] = **42000**[lb/in2] Sec. J2.4

$A_w = (2)^{1/2}/2*D/16$ [in]*L = $(2)^{1/2}/2*4/16$ [in]*10[in] = **1.77**[in2] Sec. J2.4

$(1/\Omega)R_n = 2 * ((1/\Omega)*F_w*A_w)$ = 2 * (0.5*42000[lb/in2]*1.77[in2]) = **74.25**[kip] Eq. J2-4

$(1/\Omega)R_n = (1/\Omega)R_{w1} + (1/\Omega)R_{w2}$ = 74.25[kip] + 74.25[kip] = **148.49**[kip] Eq. J2-6

Maximum weld force that brace can develop	[Kip]	242.90	112.00	DL	0.46	Eq. J4-4

$L_e = L_t + L_h$ = 10[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p$ = 20[in]*0.349[in] = **6.98**[in2] Sec. J4-2

$(1/\Omega)R_n$ = 2 * ($(1/\Omega)$*0.60*F_u*A_{nv}) = 2 * (0.5*0.60*58000[lb/in2]*6.98[in2]) = **242.9**[kip] Eq. J4-4

Gusset

Maximum weld force that gusset can develop	[Kip]	195.00	112.00	DL	0.57	Eq. J4-4

$L_e = L_t + L_h$ = 10[in] + 10[in] = **20**[in]

$A_{nv} = L_e * t_p$ = 20[in]*0.5[in] = **10**[in2] Sec. J4-2

$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_u$*$A_{nv}$ = 0.5*0.60*65000[lb/in2]*10[in2] = **195**[kip] Eq. J4-4

Block shear on gusset	[Kip]	287.50	112.00	DL1	0.39	Eq. J4-5

L_{max} = max(L_t, L_h) = max(10[in], 10[in]) = **10**[in]

$L = L_{max} + d_w$ = 10[in] + 0.5[in] = **10.5**[in] Sec. J4.3

$A_{gv} = 2*L*t_p$ = 2*10.5[in]*0.5[in] = **10.5**[in2] Sec. J4.3

$A_{nv} = A_{gv}$ = **10.5**[in2] Sec. J4.3

$A_{nt} = b*t_p$ = 8[in]*0.5[in] = **4**[in2] Sec. J4.3

$(1/\Omega)R_n = (1/\Omega)$*min(0.6*$F_u$*$A_{nv}$ + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) =
0.5*min(0.6*65000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2], 0.6*50000[lb/in2]*10.5[in2] + 1*65000[lb/in2]*4[in2]) = **287.5**[kip] Eq. J4-5

Ratio **0.75**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Brace

Yielding strength due to axial load	[Kip]	286.47	112.00	DL1	0.39	Eq. J4-1

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*46000[lb/in2]*10.4[in2] = **286.47**[kip] Eq. J4-1

Tension rupture	[Kip]	202.26	112.00	DL1	0.55	Eq. J4-2

$A_n = A_g$ - 2*(t_p + 1/8 [in])*t = 10.4[in2] - 2*(0.5[in] + 1/8 [in])*0.349[in] = **9.96**[in2] Sec. D3.2

$U = 1 - x/l$ = 1 - 3[in]/10[in] = **0.7** Table D3.1

$A_e = A_n*U$ = 9.96[in2]*0.7 = **6.97**[in2] Eq. D3-1

$(1/\Omega)R_n = (1/\Omega)*F_u*A_e$ = 0.5*58000[lb/in2]*6.97[in2] = **202.26**[kip] Eq. J4-2

Gusset

Tension yielding on the Whitmore section	[Kip]	279.45	112.00	DL1	0.40	Eq. J4-1

$A_g = L_w*t_p$ = 18.67[in]*0.5[in] = **9.33**[in2]

$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*9.33[in2] = **279.45**[kip] Eq. J4-1

Buckling on the Whitmore section	[Kip]	279.30	112.00	DL	0.40	Eq. E3-1

$F_e = \pi^2*E/(K*L/r)^2 = \pi^2*2.90E+07$[lb/in2]$/(0.65*5.61$[in]$/0.144$[in]$)^2 =$ **4.49E+05**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \rightarrow 4.49E+05$[lb/in2]$>=0.44*1*50000$[lb/in2] $\rightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y = 0.658^{(1*50000}$[lb/in2]$/4.49E+05$[lb/in2]$)*50000$[lb/in2] =

47723.75[lb/in2] Eq. E7-2

$(1/\Omega)P_n = (1/\Omega)*F_{cr}*A_g = 0.599*47723.75$[lb/in2]$*9.77$[in2] = **279.3**[kip] Eq. E3-1

Ratio **0.55**

Calculation of the brace interface forces

Load condition :DL

$H = P*cos\theta = -112$[kip]$*0.592 =$ **-66.31**[kip]

$V = P*sin\theta = -112$[kip]$*0.806 =$ **-90.26**[kip]

Load condition :DL1

$H = P*cos\theta = 112$[kip]$*0.592 =$ **66.31**[kip]

$V = P*sin\theta = 112$[kip]$*0.806 =$ **90.26**[kip]

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left} = 20.6$[kip] - -20.6[kip] = **41.19**[kip]

$V = V_{Right} + V_{Left} = 29.53$[kip] + -29.53[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = 29.53$[kip]$*6.24$[in] - -29.53[kip]$*6.24$[in] = **30.72**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left} = -20.6$[kip] - 20.6[kip] = **-41.19**[kip]

$V = V_{Right} + V_{Left} = -29.53$[kip] + 29.53[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left} = -29.53$[kip]$*6.24$[in] - 29.53[kip]$*6.24$[in] = **-30.72**[kip*ft]

Upper gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	41.19	0.00	30.72	0.00	0.00	0.00	Design
DL1	-41.19	0.00	-30.72	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	610.54	54.24	DL	0.09	Eq. J4-1
$A_g = L_p*t_p$ = 40.78[in]*0.5[in] = **20.39**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*20.39[in2] = **610.54**[kip]						Eq. J4-1
Shear yielding	[Kip]	407.84	41.19	DL	0.10	Eq. J4-3
$A_g = L_p*t_p$ = 40.78[in]*0.5[in] = **20.39**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*20.39[in2] = **407.84**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*40.78[in]) = **0**[lb/in2]						9
Gusset edge shear stress	[Lb/ft2]	2880000.00	290897.30	DL	0.10	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = 41.19[kip]/(0.5[in]*40.78[in]) = **2020.12**[lb/in2]						9
Weld capacity	[Kip]	303.55	85.14	DL	0.28	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*4*40.78[in]) = **303.55**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/40.78[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = 41.19[kip]/40.78[in] = **1.01**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = 30.72[kip*ft]/(40.78[in]^2/6) = **1.33**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 1.33[kip/in])^2 + 1.01[kip/in]^2)$^{1/2}$ = **1.67**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 1.33[kip/in])^2 + 1.01[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 1.33[kip/in])^2 + 1.01[kip/in]^2)$^{1/2}$) = **1.67**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 40.78[in]*max(1.67[kip/in], 1.25*1.67[kip/in]) = **85.14**[kip]						9
Beam						
Web crippling	[Kip]	159.71	13.56	DL	0.08	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **20.39**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.315[in]^2*(1 + 3*(20.39[in]/17.9[in])*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])$^{1/2}$ = **159.71**[kip]						Eq. J10-4
Local web yielding	[Kip]	262.78	13.56	DL	0.05	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **20.39**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.927[in] + 20.39[in])*50000[lb/in2]*0.315[in] = **262.78**[kip]						Eq. J10-2

Ratio **0.28**

Calculation of the brace interface forces

Load condition :DL

$H = H_{Right} - H_{Left}$ = -66.31[kip] - 66.31[kip] = **-132.61**[kip]

$V = V_{Right} + V_{Left}$ = -90.26[kip] + 90.26[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = -90.26[kip]*6.57[in] - 90.26[kip]*6.57[in] = **-98.91**[kip*ft]

Load condition :DL1

$H = H_{Right} - H_{Left}$ = 66.31[kip] - -66.31[kip] = **132.61**[kip]

$V = V_{Right} + V_{Left}$ = 90.26[kip] + -90.26[kip] = **0**[kip]

$M = V_{Right}*x_{Right} - V_{Left}*x_{Left}$ = 90.26[kip]*6.57[in] - -90.26[kip]*6.57[in] = **98.91**[kip*ft]

Lower gusset interface - beam

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru**	**Pu**	**Mu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip*ft]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	-132.61	0.00	-98.91	0.00	0.00	0.00	Design
DL1	132.61	0.00	98.91	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	630.05	169.20	DL	0.27	Eq. J4-1
$A_g = L_p*t_p$ = 42.09[in]*0.5[in] = **21.04**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*F_y*A_g$ = 0.599*50000[lb/in2]*21.04[in2] = **630.05**[kip]						Eq. J4-1
Shear yielding	[Kip]	420.87	132.61	DL	0.32	Eq. J4-3
$A_g = L_p*t_p$ = 42.09[in]*0.5[in] = **21.04**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)$*0.60*$F_y*A_g$ = 0.667*0.60*50000[lb/in2]*21.04[in2] = **420.87**[kip]						Eq. J4-3
Gusset edge tension stress	[Lb/ft2]	4311377.00	0.00	DL	0.00	J4-1
$(1/\Omega)F_n = (1/\Omega)*F_y$ = 0.599*50000[lb/in2] = **29940.12**[lb/in2]						J4-1
$f_{ua} = V_b/(t_p*l)$ = 0[kip]/(0.5[in]*42.09[in]) = **0**[lb/in2]						9

Gusset edge shear stress	[Lb/ft2]	2880000.00	907451.90	DL	0.32	J4-1
$(1/\Omega)F_n = (1/\Omega)*0.6*F_y$ = 0.667*0.6*50000[lb/in2] = **20000**[lb/in2]						J4-1
$f_{uv} = H_b/(t_p*l)$ = -132.61[kip]/(0.5[in]*42.09[in]) = **-6301.75**[lb/in2]						9
Weld capacity	[Kip]	313.26	268.72	DL	0.86	Tables 8-4 .. 8-11
$(1/\Omega)R_n = 2 * ((1/\Omega)*C*C_1*D*L)$ = 2 * (0.5*1.86[kip/in]*1*4*42.09[in]) = **313.26**[kip]						Tables 8-4 .. 8-11
$f_{ua} = V_b/l$ = 0[kip]/42.09[in] = **0**[kip/in]						9
$f_{uv} = H_b/l$ = -132.61[kip]/42.09[in] = **-3.15**[kip/in]						9
$f_{ub} = M_b/(l^2/6)$ = -98.91[kip*ft]/(42.09[in]^2/6) = **-4.02**[kip/in]						9
$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$ = ((0[kip/in] + 4.02[kip/in])^2 + 3.15[kip/in]^2)$^{1/2}$ = **5.11**[kip/in]						9
$f_{uAve} = 0.5*(((f_{ua} - f_{ub})^2 + f_{uv}^2)^{1/2} + ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2})$ = 0.5*(((0[kip/in] - 4.02[kip/in])^2 + 3.15[kip/in]^2)$^{1/2}$ + ((0[kip/in] + 4.02[kip/in])^2 + 3.15[kip/in]^2)$^{1/2}$) = **5.11**[kip/in]						9
$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$ = 42.09[in]*max(5.11[kip/in], 1.25*5.11[kip/in]) = **268.72**[kip]						9

Beam

Web crippling	[Kip]	162.84	42.30	DL	0.26	Eq. J10-4
IsBeamReaction → **False**						
$N = N$ = **21.04**[in]						Sec. J10-2
$(1/\Omega)R_n = (1/\Omega)*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}$ = 0.5*0.80*0.315[in]^2*(1 + 3*(21.04[in]/17.9[in])*(0.315[in]/0.525[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.525[in]/0.315[in])$^{1/2}$ = **162.84**[kip]						Eq. J10-4
Local web yielding	[Kip]	269.62	42.30	DL	0.16	Eq. J10-2
IsBeamReaction → **False**						
$N = N$ = **21.04**[in]						Sec. J10-2
IsMemberEnd → **False**						
$(1/\Omega)R_n = (1/\Omega)*(5*k + N)*F_{yw}*t_w$ = 0.667*(5*0.927[in] + 21.04[in])*50000[lb/in2]*0.315[in] = **269.62**[kip]						Eq. J10-2

Ratio **0.86**

Global critical strength ratio **0.86**

NOTATION

A_e: Effective net area

A_g: Gross area

A_{gv}:Gross area subject to shear

A_n: Net area

A_{nt}: Net area subject to tension

A_{nv}:Net area subjected to shear

A_w: Effective area of the weld

b: Plate, connector or member width

N: Bearing length

C_1: Electrode strength coefficient

C: Weld group coefficient

$cos\theta$: Cosine of the brace with the horizontal angle

d_w: Distance between weld and the end of the plate

d: Beam depth

D: Number of sixteenths of an inch in the weld size

E: Elastic modulus

F_{cr}: Critical stress, flexural stress buckling

F_e: Elastic critical buckling stress

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uAve}: Average weld stress on welds along gusset-beam or gusset-column interface

f_{ub}: Bending stress on welds along gusset-beam or gusset-column interface

f_{uPeak}: Peak weld stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

f_{uWeld}: Design weld force on welds along gusset-beam or gusset-column interface

F_w: Nominal strength of the weld metal per unit area

F_y: Specified minimum yield stress

F_{yw}: Specified minimum yield stress of web

H_b: Required shear force on the beam to gusset connection

H: Brace axial force horizontal component

H_{Left}: Left brace axial force horizontal component

H_{Right}: Right brace axial force horizontal component

IsBeamReaction: Is beam reaction

IsMemberEnd: Is member end

K: Effective length factor

k: Distance from outer face of flange to the web toe of fillet

l: Length

L: Length

L_e: Effective length

L_h: Weld length on heel

L_{max}: Maximum length

L_p: Plate length

L_t: Weld length on toe

L: Length of weld

L_w: Width of Whitmore section

M: Bending required

M_b: Required moment on the beam to gusset connection

N: Bearing length

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)P_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

$(1/\Omega)R_{w1}$: Fillet weld capacity of the weld element 1

$(1/\Omega)R_{w2}$: Fillet weld capacity of the weld element 2

Q: Prying action coefficient

r: Radius of gyration

$sin\theta$: Sine of the brace with the horizontal angle

t_p: Thickness of the connected material

t: Design wall thickness of HSS member

t_f: Thickness of the loaded flange

t_p: Plate thickness

t_w: Web thickness

U: Shear lag factor

U_{bs}: Stress index

V_b: Required axial force on the beam to gusset connection

V: Brace axial force vertical component

V_{Left}: Left vertical component of the gusset forces

V_{Right}: Right vertical component of the gusset forces

x: Connection eccentricity

x_{Left}: Distance from the gusset center to the left vertical force

x_{Right}: Distance from the gusset center to the right vertical force

f_{ua}: Axial stress on welds along gusset-beam or gusset-column interface

f_{uv}: Shear stress on welds along gusset-beam or gusset-column interface

$(1/\Omega)F_n$: Design or allowable tension/shear yielding stress

REFERENCES

{9} AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

MC-02 BEAM TO GIRDER MOMENT CONNECTION

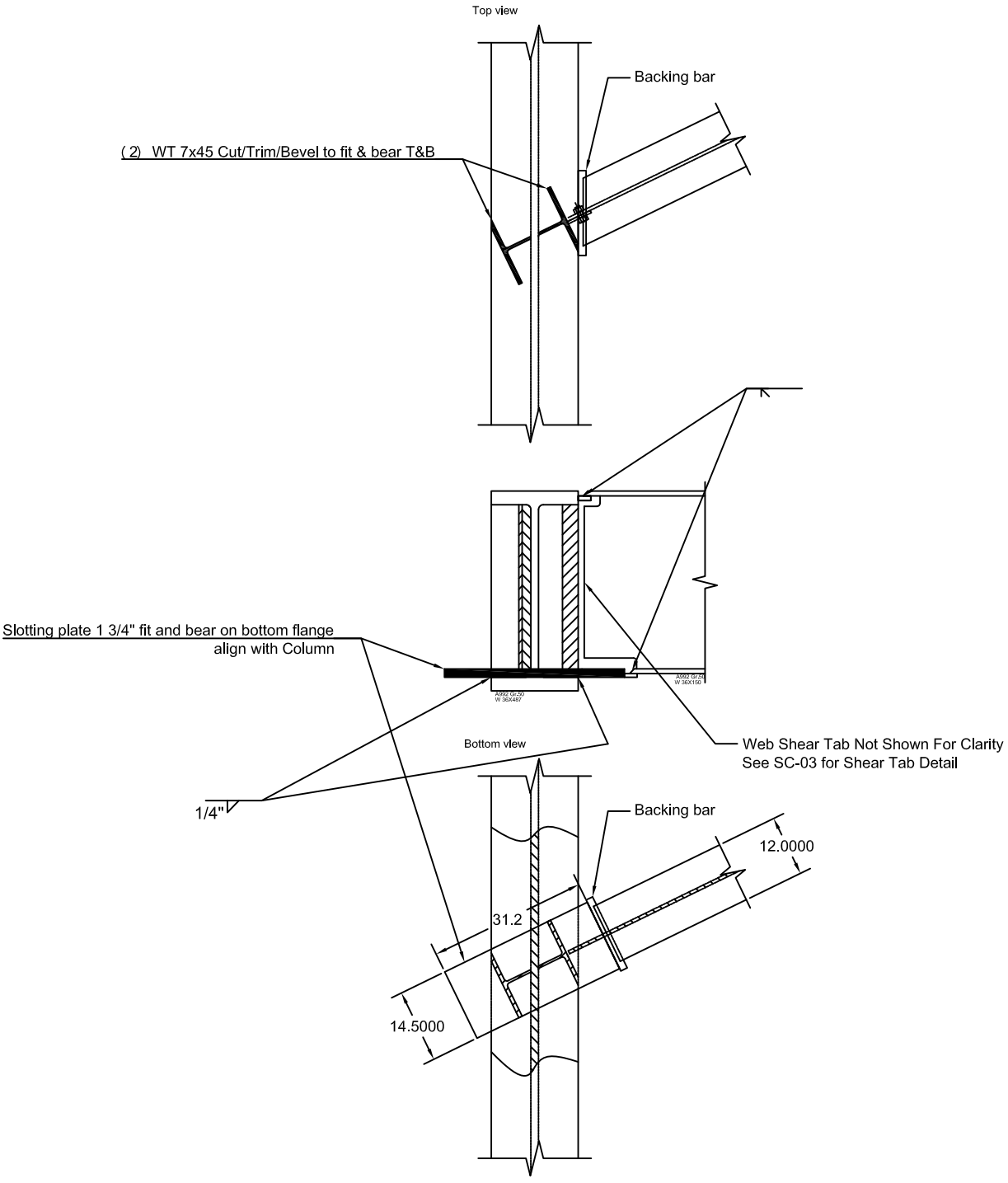
Connection ID	Location		Beam	Girder	Column Size	Moment Load (k-ft)	Shear Load (kips)	Moment * Connection		Shear Tab Connection to WT Stffener** between Girder Flange
MC-02-01	L3	1.6-A.2	W36x150	W36x487	W12x79	745	77	CJP at Top Flange	CJP at Bottom Flange to 1 3/4" Slotting Plate	See SC-03 for connection detail
MC-02-02	L3	1.6-C	W36x170	W36x282	W14x90	1190	160	CJP at Top Flange	Flange Plate 1/2" Fillet Weld at Bottom Flange*	

* See illustration for connection detail and plate size

** WT Sized to match column size.

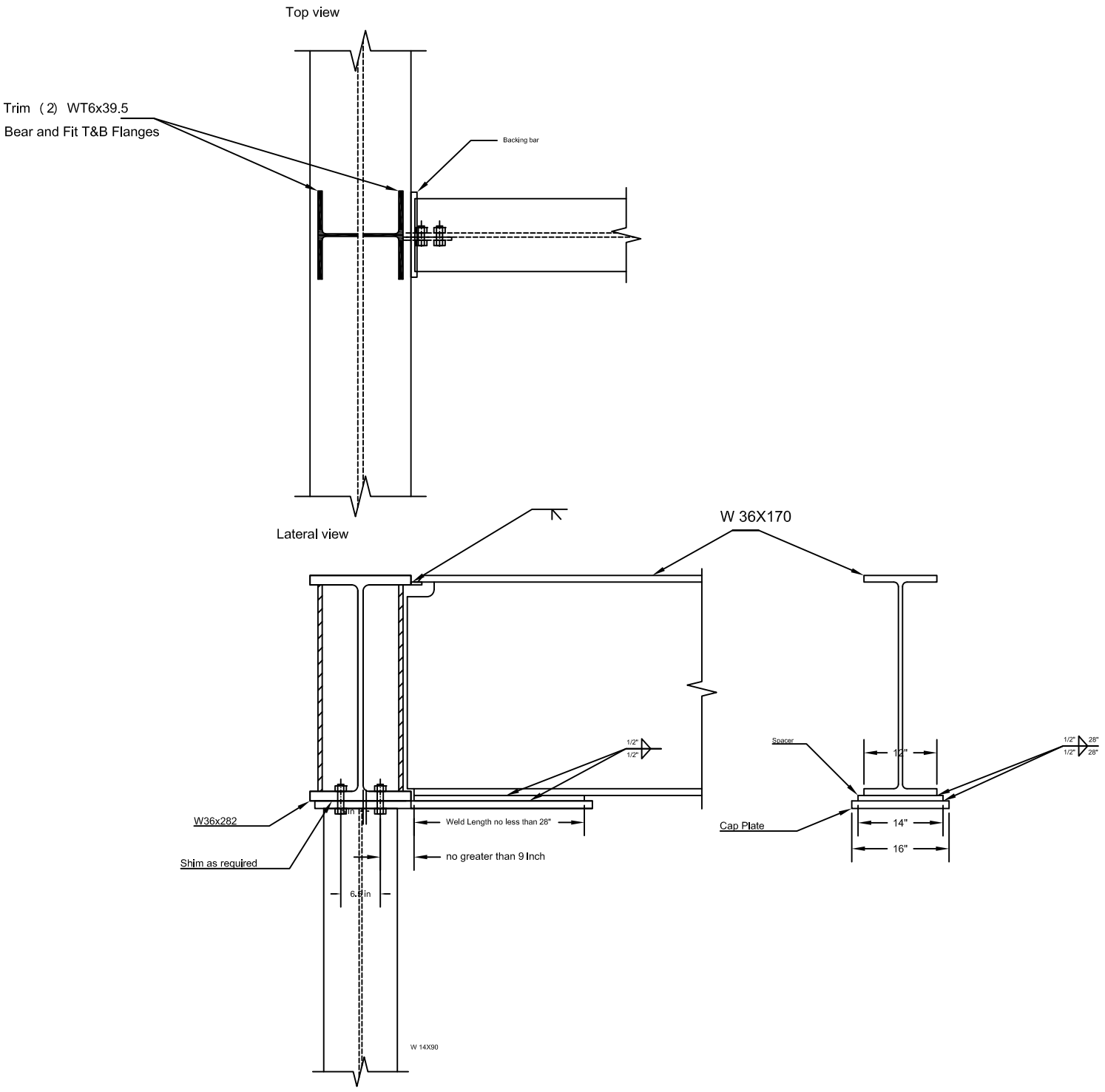
MC-01-1

Beam to Column Moment Connection



MC-01-2

Beam to Column Moment Connection



Current Date: 5/24/2016 4:30 PM

Units system: English

File name: U:\Webster Connection Design Folder\Reports and Calculations\MC-02 Beam to Girder Moment Connection Design\MC.cnx\

Steel connections

Results

Connection name : **SP BCF**
Connection ID : **MC-02-1V**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W 36X150

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	77.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	30.50	16.26	32.52	✔	p. 10-104
$L_{min} = T/2 = 32.52$[in]$/2 =$ **16.26**[in]						p. 10-104
$L_{max} = d$ - max(k, d_{ct}) - max(k, d_{cb}) = 35.9[in] - max(1.69[in], 0[in]) - max(1.69[in], 0[in]) = **32.52**[in]						p. 10-49
Thickness	[in]	0.50	--	0.56	✔	p. 10-102
$t_{pmax} = d/2 + 1/16$ [in] $= 1$[in]$/2 + 1/16$ [in] $=$ **0.563**[in]						p. 10-102
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2$ = 1.75[in] + 0[in] = **1.75**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102

$L_{emin} = 2*d$ = 2*1[in] = **2**[in] — p. 10-102

Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5

$s_{min} = 8/3*d$ = 8/3*1[in] = **2.67**[in] — Sec. J3.3

IsCorrosionConsidered → **False**

s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in] — Sec. J3.5

Beam

Vertical edge distance	[in]	4.45	1.75	--	✔	Tables J3.4, J3.5

$L_{emin} = e_{dmin} + C_2$ = 1.75[in] + 0[in] = **1.75**[in] — Tables J3.4, J3.5

Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102

$L_{emin} = 2*d$ = 2*1[in] = **2**[in] — p. 10-102

Support

Weld size	[1/16in]	5	5	--	✔	p. 10-101

$w_{min} = (5/8)*t_p$ = (5/8)*0.5[in] = **0.026** — p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References

Shear plate

Bolts shear	[Kip]	143.43	77.00	DL	0.54	Tables (7-1..14)

(n>=10) and (n<=12) and (*IsStandardHole*) → (10>=10) and (10<=12) and (False) → **False**

BoltFactor = 1 — p. 10-102

k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1** — Eq. J3-5

(1/Ω)R_n = *(1/Ω)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*0.85*64[kip]*1*1 = **14.34**[kip] — Eq. J3-4

(1/Ω)R_n = C*(1/Ω)R_n**BoltFactor* = 10*14.34[kip]*1 = **143.43**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	363.80	77.00	DL	0.21	Eq. J3-6

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in] — Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] — Sec. J4.10

(1/Ω)R_n = *(1/Ω)*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(10 - 1))*0.5[in]*65000[lb/in2]*1 = **363.8**[kip] — Eq. J3-6

Shear yielding	[Kip]	305.00	77.00	DL	0.25	Eq. J4-3
$A_g = L_p*t_p$ = 30.5[in]*0.5[in] = **15.25**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*15.25[in2] = **305**[kip]						Eq. J4-3
Shear rupture	[Kip]	187.69	77.00	DL	0.41	Eq. J4-4
$L_h = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$L_e = L - n*L_h$ = 30.5[in] - 10*1.13[in] = **19.25**[in]						DG4 Eq. 3-13
$A_{nv} = L_e*t_p$ = 19.25[in]*0.5[in] = **9.63**[in2]						Sec. J4-2
$(1/\Omega)R_n = (1/\Omega)*0.60*F_u*A_{nv}$ = 0.5*0.60*65000[lb/in2]*9.63[in2] = **187.69**[kip]						Eq. J4-4
Block shear	[Kip]	197.44	77.00	DL	0.39	Eq. J4-5
$dh_h = d_h$ + 1/16 [in] = 1.31[in] + 1/16 [in] = **1.38**[in]						Sec. D3-2
$dh_v = d_h$ + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in]						Sec. D3-2
$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$ = (2[in] + (1 - 1)*3[in] - (1 - 0.5)* 1.38[in])*0.5[in] = **0.656**[in2]						Sec. J4-3
$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$ = (1.75[in] + (10 - 1)*3[in])*0.5[in] = **14.38**[in2]						Sec. J4-3
$A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p$ = (1.75[in] + (10 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **9.03**[in2]						Sec. J4-3
IsStressUniform → **True**						
U_{bs} = 1						Sec. J4-3
$(1/\Omega)R_n = (1/\Omega)*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ = 0.5*min(0.6*65000[lb/in2]*9.03[in2] + 1*65000[lb/in2]*0.656[in2], 0.6*50000[lb/in2]*14.38[in2] + 1* 65000[lb/in2]*0.656[in2]) = **197.44**[kip]						Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	283.06	77.00	DL	0.27	Tables 8-4 .. 8-11
$(1/\Omega)R_n = (1/\Omega)*C*C_1*D*L$ = 0.5*3.71[kip/in]*1*5*30.5[in] = **283.06**[kip]						Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	473.79	77.00	DL	0.16	Eq. J3-6
$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2) = \text{Max}(0.0, 4.45[in] - 1.06[in]/2) =$ **3.92**[in]						Sec. J4.10
$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h) = \text{Max}(0.0, 3[in] - 1.06[in]) =$ **1.94**[in]						Sec. J4.10
$(1/\Omega)R_n = (1/\Omega)*(\min(k_1*L_{c\text{-}end}, k_2*d) + \min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*$ F_u*n_c = 0.5*(min(1.2*3.92[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(10 - 1))*0.625[in]* 65000[lb/in2]*1 = **473.79**[kip]						Eq. J3-6
Shear yielding	[Kip]	448.75	77.00	DL	0.17	Eq. J4-3
$A_g = L_p*t_p$ = 35.9[in]*0.625[in] = **22.44**[in2]						Sec. D3-1
$(1/\Omega)R_n = (1/\Omega)*0.60*F_y*A_g$ = 0.667*0.60*50000[lb/in2]*22.44[in2] = **448.75**[kip]						Eq. J4-3

Support

Welds rupture	[Kip/ft]	332.28	30.30	DL	0.09	p. 9-5
$R_n = 0.6*F_u*t_p$ = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in]						p. 9-5
$D_{min} = P/((1/\Omega)*C*C_1*L)$ = 77[kip]/(0.5*3.71[kip/in]*1*30.5[in]) = **1.36**						tables 8-4..11
HasWeldsOnBothSides → **False**						
$R_u = 0.6*F_{EXX}*(2)^{1/2}/2*D_{min}/16$ [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*1.36/16 [in] = **2.52**[kip/in]						p. 9-5

Global critical strength ratio	**0.54**

NOTATION

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

F_y: Specified minimum yield stress

h_{sc}: Hole factor

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

k_s: Slip resistance factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

L: Length of weld

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t_p: Plate thickness

t_{pmax}: Maximum plate thickness

T_u: Tension force

U_{bs}: Stress index

w_{min}: Minimum weld size required

MC-02-01

BEAM TO GIRDER MOMENT CONNECTION

SHEAR CONNECTION USING SHEAR TAB AT WEB. SEE CALCULATION FROM SOFTWARE OUTPUT.

MOMENT CONNECTION USING DIRECT WELD AT TOP & BOTTOM FLANGES.

$V = 77$ KIPS $M = 745$ K-ft FOR W 30X130, AISC 2005, ASD

FULL PLASTIC MOMENT CAN BE DEVELOPED BY WELDING ONLY THE FLANGE. THE TOP FLANGE IS OKAY BY INSPECTION!

FOR BOTTOM FLANGE USING SLOTTING PLATE. CHECK THE COMPRESSION STRENGTH OF THE SLOTTING PLATE.

PL. SIZE: $1\frac{3}{4}'' \times 14\frac{1}{2}'' \times 31\frac{1}{4}''$ A572 Gr. 50

$A_p = L_p \cdot t_p = 14.5 \times 1.75 = 25.375\ in^2$

$(\phi_n)R = 0.599 \times 50 \times 25.375 = 760$ KIPS

$r = \frac{t_p}{\sqrt{12}} = \frac{1.75}{\sqrt{12}} = 0.505$ $\quad \frac{KL}{r} = \frac{31.12 \times 0.65}{1.75/\sqrt{12}} = 40.143 < 200$

$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} = \frac{3.14^2 \times 29000}{40.143^2} = 177.4 > 0.44 \times 50 = 22$ ksi

$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y = 0.658^{\frac{50}{177.4}} \times 50 = 44$ ksi

$\frac{P_n}{\Omega} = 0.599 \times 44 \times 25.375 = 668.8$ KIPS (CONTROLS)

COMPRESSION AT BOTTOM FLANGE

$$F_u = \frac{M}{(d - t_f)} = \frac{745 \times 12}{(31.9 - 0.94)} = 253.7 \text{ kips} < \frac{P_n}{\Omega}$$

OKAY!!!

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Steel connections

Results

Connection name : **SP BCF**
Connection ID : **MC-02-02(V)**

Family: Beam - Column flange (BCF)

Type: Single plate

Description: W 36X170

Design code: AISC 360-05 ASD

DEMANDS

	Beam		Column			
Description	**Ru**	**Pu**	**Pu**	**Mu22**	**Mu33**	**Load type**
	[Kip]	[Kip]	[Kip]	[Kip*ft]	[Kip*ft]	
DL	160.00	0.00	0.00	0.00	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Length	[in]	30.50	16.25	32.50	✔	p. 10-104
$L_{min} = T/2 = 32.5[in]/2 =$ **16.25**[in]						p. 10-104
$L_{max} = d - \max(k, d_{ct}) - \max(k, d_{cb}) = 36.2[in] - \max(1.85[in], 0[in]) - \max(1.85[in], 0[in]) =$ **32.5**[in]						p. 10-49
Thickness	[in]	0.50	--	1.08	✔	p. 10-103
$M_{max} = 1.25*F_v*A_b*C' = 1.25*60000[lb/in2]*0.785[in2]*142.85[in] =$ **700.88**[kip*ft]						p. 10-103
$t_{max} = (6*M_{max})/(F_y*d^2) = (6*700.88[kip*ft])/(50000[lb/in2]*30.5[in]^2) =$ **1.08**[in]						p. 10-103
Vertical edge distance	[in]	1.75	1.75	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] =$ **1.75**[in]						Tables J3.4, J3.5

Horizontal edge distance	[in]	2.00	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Vertical center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Horizontal center-to-center spacing (gage)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
s_{min} = 8/3*d = 8/3*1[in] = **2.67**[in]						Sec. J3.3
IsCorrosionConsidered → **False**						
s_{max} = min(24*t_p, 12 [in]) = min(24*0.5[in], 12 [in]) = **12**[in]						Sec. J3.5
Eccentricity	[in]	4.50	4.50	--	✔	
Min. eb=4.5 [in]						
Beam						
Vertical edge distance	[in]	4.60	1.75	--	✔	Tables J3.4, J3.5
L_{emin} = e_{dmin} + C_2 = 1.75[in] + 0[in] = **1.75**[in]						Tables J3.4, J3.5
Horizontal edge distance	[in]	2.50	2.00	--	✔	p. 10-102
L_{emin} = 2*d = 2*1[in] = **2**[in]						p. 10-102
Support						
Weld size	[1/16in]	5	5	--	✔	p. 10-101
w_{min} = (5/8)*t_p = (5/8)*0.5[in] = **0.026**						p. 10-101

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	244.12	160.00	DL	0.66	Tables (7-1..14)
(n>=10) and (n<=12) and (*IsStandardHole*) → (10>=10) and (10<=12) and (False) → **False**						
BoltFactor = 1						p. 10-102
k_s = max(1 - T_u/((*1/Ω*)*D_u*T_b*N_b), 0.0) = max(1 - 0[kip]/(0.667*1.13*64[kip]*1), 0.0) = **1**						Eq. J3-5
(*1/Ω*)R_n = (*1/Ω*)*μ*D_u*h_{sc}*T_b*N_s*k_s = 0.667*0.35*1.13*0.85*64[kip]*1*1 = **14.34**[kip]						Eq. J3-4
(*1/Ω*)R_n = C*(*1/Ω*)R_n**BoltFactor* = 17.02*14.34[kip]*1 = **244.12**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	619.16	160.00	DL	0.26	p. 7-18, Sec. J3.10
$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 1.75[in] - 1.06[in]/2) = **1.22**[in]						Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(17.02/(2*10))*(min(1.2*1.22[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(10 - 1))*0.5[in]*65000[lb/in2]*2 = **619.16**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	305.00	160.00	DL	0.52	Eq. J4-3

A_g = L_p*t_p = 30.5[in]*0.5[in] = **15.25**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*15.25[in2] = **305**[kip] Eq. J4-3

Shear rupture	[Kip]	187.69	160.00	DL	0.85	Eq. J4-4

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

L_e = L - n*L_h = 30.5[in] - 10*1.13[in] = **19.25**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p = 19.25[in]*0.5[in] = **9.63**[in2] Sec. J4-2

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_u*A_{nv} = 0.5*0.60*65000[lb/in2]*9.63[in2] = **187.69**[kip] Eq. J4-4

Block shear	[Kip]	199.98	160.00	DL	0.80	Eq. J4-5

dh_h = d_h + 1/16 [in] = 1.31[in] + 1/16 [in] = **1.38**[in] Sec. D3-2

dh_v = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p = (2[in] + (2 - 1)*3[in] - (2 - 0.5)*1.38[in])*0.5[in] = **1.47**[in2] Sec. J4-3

A_{gv} = (L_{ev} + (n - 1)*s)*t_p = (1.75[in] + (10 - 1)*3[in])*0.5[in] = **14.38**[in2] Sec. J4-3

A_{nv} = (L_{ev} + (n - 1)*(s - dh_v) - dh_v/2)*t_p = (1.75[in] + (10 - 1)*(3[in] - 1.13[in]) - 1.13[in]/2)*0.5[in] = **9.03**[in2] Sec. J4-3

IsStressUniform → **False**

U_{bs} = 0.5 Sec. J4-3

$(1/\Omega)R_n$ = $(1/\Omega)$*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt}) = 0.5*min(0.6*65000[lb/in2]*9.03[in2] + 0.5*65000[lb/in2]*1.47[in2], 0.6*50000[lb/in2]*14.38[in2] + 0.5*65000[lb/in2]*1.47[in2]) = **199.98**[kip] Eq. J4-5

Flexural rupture	[Kip]	814.67	160.00	DL	0.20	p. 9-6

L_h = d_h + 1/16 [in] = 1.06[in] + 1/16 [in] = **1.13**[in] Sec. D3-2

Z_{net} = t_p/4*(L^2 - s^2*n*(n^2 - 1)*L_h/L) = 0.5[in]/4*(30.5[in]^2 - 3[in]^2*10*(10^2 - 1)*1.13[in]/30.5[in]) = **75.2**[in3] 4

$(1/\Omega)R_n$ = $(1/\Omega)$*F_u*Z_{net}/e = 0.5*65000[lb/in2]*75.2[in3]/3[in] = **814.67**[kip] p. 9-6

Plate (support side)

Weld capacity	[Kip]	283.06	160.00	DL	0.57	Tables 8-4 .. 8-11

$(1/\Omega)R_n$ = $(1/\Omega)$*C*C_1*D*L = 0.5*3.71[kip/in]*1*5*30.5[in] = **283.06**[kip] Tables 8-4 .. 8-11

Flexure with the Von-Mises shear reduction	[Kip*ft]	230.57	40.00	DL	0.17	p. 10-103

A_g = L_p*t_p = 30.5[in]*0.5[in] = **15.25**[in2] Sec. D3-1

f_v = V/A_g = 160[kip]/15.25[in2] = **10491.8**[lb/in2] p. 10-103

$(1/\Omega)F_{cr}$ = (max(0, (($(1/\Omega)$*F_y)^2 - 3*f_v^2))$^{1/2}$ = (max(0, (0.599*50000[lb/in2])^2 - 3*10491.8[lb/in2]^2))$^{1/2}$ = **23794.47**[lb/in2] p. 10-103

Z_x = t_p*L^2/4 = 0.5[in]*30.5[in]^2/4 = **116.28**[in3] T. 17-27

$(1/\Omega)M_n$ = $(1/\Omega)F_{cr}$*Z = 23794.47[lb/in2]*116.28[in3] = **230.57**[kip*ft] p. 10-103

Beam

Bolt bearing under shear load	[Kip]	877.32	160.00	DL	0.18	p. 7-18, Sec. J3.10

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2) = Max(0.0, 4.6[in] - 1.06[in]/2) = **4.07**[in] Sec. J4.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h) = Max(0.0, 3[in] - 1.06[in]) = **1.94**[in] Sec. J4.10

$(1/\Omega)R_n$ = $(1/\Omega)$*(C/(n_c*n))*(min(k_1*$L_{c\text{-}end}$, k_2*d) + min(k_1*$L_{c\text{-}spa}$, k_2*d)*(n - 1))*t_p*F_u*n_c = 0.5*(17.02/(2*10))*(min(1.2*4.07[in], 2.4*1[in]) + min(1.2*1.94[in], 2.4*1[in])*(10 - 1))*0.68[in]*65000[lb/in2]*2 = **877.32**[kip] p. 7-18, Sec. J3.10

Shear yielding	[Kip]	492.32	160.00	DL	0.32	Eq. J4-3

A_g = L_p*t_p = 36.2[in]*0.68[in] = **24.62**[in2] Sec. D3-1

$(1/\Omega)R_n$ = $(1/\Omega)$*0.60*F_y*A_g = 0.667*0.60*50000[lb/in2]*24.62[in2] = **492.32**[kip] Eq. J4-3

Support

Welds rupture	[Kip/ft]	332.28	62.95	DL	0.19	p. 9-5

R_n = 0.6*F_u*t_p = 0.6*65000[lb/in2]*0.71[in] = **27.69**[kip/in] p. 9-5

D_{min} = P/($(1/\Omega)$*C*C_1*L) = 160[kip]/(0.5*3.71[kip/in]*1*30.5[in]) = **2.83** tables 8-4..11

HasWeldsOnBothSides → **False**

R_u = 0.6*F_{EXX}*$(2)^{1/2}$/2*D_{min}/16 [in] = 0.6*70000[lb/in2]*$(2)^{1/2}$/2*2.83/16 [in] = **5.25**[kip/in] p. 9-5

Global critical strength ratio **0.85**

NOTATION

A_b: Nominal bolt area

A_g: Gross area

A_{gv}: Gross area subject to shear

A_{nt}: Net area subject to tension

A_{nv}: Net area subjected to shear

$(1/\Omega)R_n$: Available shear strength per bolt

BoltFactor: Bolt capacity factor

C: Bolt group coefficient

c: Coped length

C_1: Electrode strength coefficient

C_2: Edge distance increment

C: Weld group coefficient

C': Coefficient for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

d: Nominal bolt diameter

d_{cb}: Bottom cope depth

d_{ct}: Top cope depth

d_h: Nominal hole dimension

D_u: Bolt pretension ratio

dh_h: Horizontal hole dimension

dh_v: Vertical hole dimension

D: Number of sixteenths of an inch in the weld size

D_{min}: Number of sixteenths of an inch in the minimum weld size

e: Load eccentricity

F_{EXX}: Electrode classification number

F_u: Specified minimum tensile strength

f_v: Required shear stress

F_v: Nominal shear strength of bolt

F_y: Specified minimum yield stress

h_o: Reduced beam depth

h_{sc}: Hole factor

HasWeldsOnBothSides: Has welds on both sides

IsCorrosionConsidered: Is corrosion considered

IsStandardHole: Is standard hole (STD)

IsStressUniform: Is the stress uniform

k_1: Bearing factor

k_2: Bearing factor

k: Outside corner radius

k_s: Slip resistance factor

L: Length

$L_{c\text{-}end}$: Clear distance

L_e: Effective length

L_e: Edge distance

L_{eh}: Horizontal edge distance

L_{emin}: Minimum horizontal edge distance

L_{emin}: Minimum edge distance

L_{ev}: Vertical edge distance

L_h: Hole dimension for tension and shear net area

L_{max}: Maximum length

L_{min}: Minimum length

L_p: Plate length

d: Plate length

L: Length of weld

λ: Slenderness

M_{max}: Moment strength of the bolt group for a moment-only condition

e_{dmin}: Minimum edge distance

μ: Mean slip coefficient

n: Bolts rows number

N_b: Number of bolts carrying the applied tension

n_c: Number of bolt columns

N_s: Number of slip planes

P: Required axial force

$(1/\Omega)$: Design factors

$(1/\Omega)F_{cr}$: Design or allowable flexural stress buckling

$(1/\Omega)M_n$: Design or allowable strength

$(1/\Omega)R_n$: Design or allowable strength

R_n: Nominal strength

R_u: Required strength

s_{max}: Maximum spacing

s_{min}: Minimum spacing

spa: Transversal spacing between bolts or welds

s: Longitudinal bolt spacing

$L_{c\text{-}spa}$: Distance between adjacent holes edges

t_p: Thickness of the connected material

T: Clear distance between web fillets

T_b: Minimum fastener pretension

t_{max}: Maximum thickness

t_p: Plate thickness

T_u: Tension force

t_w: Web thickness

U_{bs}: Stress index

V: Shear load

w_{min}: Minimum weld size required

Z: Plastic modulus

Z_{net}: Net plastic section modulus

Z_x: Plastic section modulus about the x-axis

REFERENCES

{4} AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

MC-02-02

W36X170 to W36X282. $V = 100^K$

$M = 1190\ k\text{-}ft$

SHEAR TAB CONNECTION USING SHEAR TAB. SEE CALCULATION FROM SOFTWARE OUTPUT.

MOMENT CONNECTION USING DIRECT WELD AT TOP & BOTTOM FLANGE (CJP)

TOP FLANGE CONNECTION IS OKAY BY INSPECTION!

COMPRESSION AT BOTTOM FLANGE.

$$F_u = \frac{M_u}{(d - t_f)} = \frac{1190 \times 12}{(30.2 - 1.1)} = 406.8\ Kips$$

Required Weld Length AT BOTTOM SPACER / CAP PLATE:

$\frac{R_n}{\sqrt{2}} = 0.928 D \ell \times 2$ If $\frac{1}{2}$" WELD IS USED,

$$L = \frac{406.8}{0.928 \times 2 \times 8} = 27.4" \quad \text{USE } 2'\text{-}4" \text{ EACH SIDE}$$

SPACE PLATE STRENGTH (1" x 14")

$$R_n = \frac{1}{\sqrt{2}} F_y \cdot A_y = 0.599 \times 50 \times 1 \times 14 = 419.3 > F_u \quad \underline{\text{OKAY!!}}$$

BOTTOM CAP PLATE STRENGTH ($1\frac{1}{4}$" x 16")

$$A_n = 1.25 \times (16 - 2 \times (\tfrac{3}{4} + \tfrac{1}{16})) = 17.97\ in^2$$

$$R_n = \frac{1}{\sqrt{2}} F_y A_e = 0.599 \times 50 \times 17.97 = 538\ Kips > F_u \quad \underline{\text{OKAY!!}}$$

CAP PLATE STABILITY CHECK: L - DISTANCE FROM BOLT TO WELD START = 9"

$r = \frac{1.25}{\sqrt{12}} = 0.3608$ $\quad \frac{KL}{r} = \frac{9 \times 1.0}{0.3608} = 24.9 < 25$

(K = 1.0, CONSERVATIVELY)

$(\frac{1}{\Omega})P_n = 0.599 \times 50 \times 16 \times 1.25 = 599\ \text{kip} > F_u$ OKAY!!!