RAM® Connection
CONNECT Edition

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Steel Connections Results

Connection: 1 - CBB_SP

Family: Column - Beams - Braces (CBB)
Type: Gusset

Design code: AISC 360-16 LRFD, AISC 341-16 LRFD

Demands

	Right beam			Left beam			Column		
Description	**Pu** [kip]	**Vu** [kip]	**Mu33** [kip*ft]	**Pu** [kip]	**Vu** [kip]	**Mu33** [kip*ft]	**Pu** [kip]	**Vu** [kip]	**Load type**
DL	0.00	3.68	0.00	0.00	1.15	0.00	-2.57	0.00	Design
LL	0.00	4.51	0.00	0.00	1.73	0.00	0.00	0.00	Design
SL	0.00	0.00	0.00	0.00	0.00	0.00	6.17	0.00	Design
Wx	-10.02	0.00	0.00	-0.03	-0.01	0.00	0.00	0.01	Design
EQx	-21.75	0.00	0.00	-0.08	-0.02	0.00	0.00	0.03	Design
D1	0.00	5.15	0.00	0.00	1.61	0.00	-3.60	0.00	Design
D2	0.00	11.63	0.00	0.00	4.14	0.00	-3.09	0.00	Design
D3	0.00	4.41	0.00	0.00	1.38	0.00	0.00	0.00	Design
D4	0.00	11.63	0.00	0.00	4.15	0.00	0.00	0.00	Design
D5	0.00	4.41	0.00	0.00	1.39	0.00	6.78	0.00	Design
D6	-5.01	4.41	0.00	-0.02	1.38	0.00	-3.09	0.01	Design
D7	0.00	8.92	0.00	0.00	3.11	0.00	6.78	0.00	Design
D8	-5.01	4.41	0.00	-0.02	1.38	0.00	6.78	0.01	Design
D9	-10.02	4.41	0.00	-0.03	1.37	0.00	-3.09	0.01	Design
D10	-10.02	4.41	0.00	-0.03	1.37	0.00	0.00	0.01	Design
D11	-10.02	8.92	0.00	-0.03	3.10	0.00	-3.09	0.01	Design
D12	-10.02	8.92	0.00	-0.03	3.10	0.00	0.00	0.01	Design
D13	-10.02	3.31	0.00	-0.03	1.02	0.00	-2.32	0.01	Design
D14	0.00	4.41	0.00	0.00	1.38	0.00	-1.86	0.00	Design
D15	-21.75	4.41	0.00	-0.08	1.36	0.00	-3.09	0.03	Seismic
D16	0.00	8.92	0.00	0.00	3.11	0.00	-1.86	0.00	Design
D17	-21.75	4.41	0.00	-0.08	1.36	0.00	-1.86	0.03	Seismic
D18	-21.75	8.92	0.00	-0.08	3.08	0.00	-3.09	0.03	Seismic
D19	-21.75	8.92	0.00	-0.08	3.08	0.00	-1.86	0.03	Seismic
D20	-21.75	3.31	0.00	-0.08	1.01	0.00	-2.32	0.03	Seismic

	Pu				
Description	**Brace1** [kip]	**Brace2** [kip]	**Brace3** [kip]	**Brace4** [kip]	**Load type**
DL	0.00	-0.16	0.00	0.00	Design
LL	0.00	-0.05	0.00	0.00	Design
SL	0.00	0.00	0.00	0.00	Design
Wx	0.00	-14.01	0.00	0.00	Design
EQx	0.00	-30.39	0.00	0.00	Design
D1	0.00	-0.22	0.00	0.00	Design

D2	0.00	-0.26	0.00	0.00	Design
D3	0.00	-0.19	0.00	0.00	Design
D4	0.00	-0.26	0.00	0.00	Design
D5	0.00	-0.19	0.00	0.00	Design
D6	0.00	-7.19	0.00	0.00	Design
D7	0.00	-0.24	0.00	0.00	Design
D8	0.00	-7.19	0.00	0.00	Design
D9	0.00	-14.20	0.00	0.00	Design
D10	0.00	-14.20	0.00	0.00	Design
D11	0.00	-14.24	0.00	0.00	Design
D12	0.00	-14.24	0.00	0.00	Design
D13	0.00	-14.15	0.00	0.00	Design
D14	0.00	-0.19	0.00	0.00	Design
D15	0.00	-30.58	0.00	0.00	Seismic
D16	0.00	-0.24	0.00	0.00	Design
D17	0.00	-30.58	0.00	0.00	Seismic
D18	0.00	-30.63	0.00	0.00	Seismic
D19	0.00	-30.63	0.00	0.00	Seismic
D20	0.00	-30.53	0.00	0.00	Seismic

Design calculations

Interface between Gusset - Top left brace

Connection: Directly bolted

Demands

Pu [kip]	**Description**	**Load type**
-0.16	DL	Design
-0.05	LL	Design
0.00	SL	Design
-14.01	Wx	Design
-30.39	EQx	Design
-0.22	D1	Design
-0.26	D2	Design
-0.19	D3	Design
-0.26	D4	Design
-0.19	D5	Design
-7.19	D6	Design
-0.24	D7	Design
-7.19	D8	Design
-14.20	D9	Design
-14.20	D10	Design
-14.24	D11	Design
-14.24	D12	Design
-14.15	D13	Design
-0.19	D14	Design
-30.58	D15	Seismic
-0.24	D16	Design
-30.58	D17	Seismic
-30.63	D18	Seismic
-30.63	D19	Seismic
-30.53	D20	Seismic

Geometric Considerations

Dimensions	Unit	Value	Min.	Max.	Sta.	References
Directly bolted						
Transverse edge distance	[in]	2.00	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$						
= 1[in] + 0[in]						
= **1**[in]						Tables J3.4, J3.5
Longitudinal edge distance	[in]	2.00	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$						
= 1[in] + 0[in]						
= **1**[in]						Tables J3.4, J3.5
Transverse center-to-center spacing (gage)	[in]	4.00	2.00	12.00	✔	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*0.5[in], 12 [in])						
= **12**[in]						Sec. J3.5
Longitudinal center-to-center spacing (pitch)	[in]	4.00	2.00	12.00	✔	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*0.5[in], 12 [in])						
= **12**[in]						Sec. J3.5
Gusset						
Transverse edge distance	[in]	3.37	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$						
= 1[in] + 0[in]						
= **1**[in]						Tables J3.4, J3.5
Longitudinal edge distance	[in]	2.00	1.00	--	✔	Tables J3.4, J3.5
$L_{emin} = e_{dmin} + C_2$						
= 1[in] + 0[in]						
= **1**[in]						Tables J3.4, J3.5

Welds

Connector to member weld size	[1/16in]	4	3	7	✔	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

Stem to cap plate weld size	[1/16in]	4	3	7	✔	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

Design Check

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Directly bolted						
Bolts shear	[Kip]	143.21	30.63	D18	**0.21**	Tables (7-1..14)

$\phi R_n = \phi * F_{nv} * A_b$
= 0.75*54000[lb/in2]*0.442[in2]
= **17.901**[kip] — Eq. J3-1

$\phi R_n = 2 * (C * \phi R_n)$
= 2 * (4*17.901[kip])
= **143.208**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	313.20	30.63	D18	**0.10**	Eq. J3-6

$L_{c\text{-}end} = Max(0.0, L_e - d_h/2)$
= Max(0.0, 2[in] - 0.813[in]/2)
= **1.594**[in] — Sec. J3.10

$L_{c\text{-}spa} = Max(0.0, s - d_h)$
= Max(0.0, 4[in] - 0.813[in])
= **3.188**[in] — Sec. J3.10

$\phi R_n = 2 * (\phi*(min(k_1*L_{c\text{-}end}, k_2*d) + min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c)$
= 2 * (0.75*(min(1.2*1.594[in], 2.4*0.75[in]) + min(1.2*3.188[in], 2.4*0.75[in])*(2 - 1))*0.5[in]*58000[lb/in2]*2)
= **313.2**[kip] — Eq. J3-6

Axial-flexure interaction of tab and gusset plates		1.00	0.37	D18	**0.37**	Eq. H1-1a

$r = t_p/(12)^{1/2}$
$= 0.5[in]/(12)^{1/2}$
$= \mathbf{0.144}[in]$ Sec. E2

$A_g = L_p*t_p$
$= 8[in]*0.5[in]$
$= \mathbf{4}[in2]$ Sec. D3-1

$K*L/r>25 \longrightarrow 1*13.119[in]/0.144[in]>25 \longrightarrow$ **True**

$F_e = \pi^2*E/(K*L/r)^2$
$= \pi^2*2.90E+07[lb/in2]/(1*13.119[in]/0.144[in])^2$
$= \mathbf{34647.91}[lb/in2]$ Eq. E3-4

$F_e> = 0.44*Q*F_y \longrightarrow 34647.91[lb/in2]>$
$= 0.44*1*36000[lb/in2] \longrightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
$= 0.658^{(1*36000[lb/in2]/34647.91[lb/in2])}*36000[lb/in2]$
$= \mathbf{23304.24}[lb/in2]$ Eq. E7-2

$\phi P_n = \phi*F_{cr}*A_g$
$= 0.9*23304.24[lb/in2]*4[in2]$
$= \mathbf{83.895}[kip]$ Sec. J4.4

$Z = L*t_p^2/4$
$= 8[in]*0.5[in]^2/4$
$= \mathbf{0.5}[in3]$

$M_{cs} = \phi*F_y*Z$
$= 0.9*36000[lb/in2]*0.5[in3]$
$= \mathbf{1.35}[kip*ft]$ Eq. F2-1

$P_r/P_c> = 0.2 \longrightarrow 30.625[kip]/83.895[kip]>$
$= 0.2 \longrightarrow$ **True**

$Int = P_r/P_c + (8/9)*(M_r/M_{cs})$
$= 30.625[kip]/83.895[kip] + (8/9)*(0[kip*ft]/1.35[kip*ft])$
$= \mathbf{0.365}$ Eq. H1-1a

Tee flange

Tee flange shear yielding	[Kip]	172.80	30.63	D18	**0.18**	Eq. J4-3

$A_g = L_p*t_p$
$= 8[in]*0.5[in]$
$= \mathbf{4}[in2]$ Sec. D3-1

$\phi R_n = 2 * (\phi*0.60*F_y*A_g)$
$= 2 * (1*0.60*36000[lb/in2]*4[in2])$
$= \mathbf{172.8}[kip]$ Eq. J4-3

Tee flange shear rupture	[Kip]	208.80	30.63	D18	**0.15**	Eq. J4-4

$A_{nv} = L_e*t_p$
= 8[in]*0.5[in]
= **4**[in2] Sec. J4-2

$\phi R_n = 2 * (\phi*0.60*F_u*A_{nv})$
= 2 * (0.75*0.60*58000[lb/in2]*4[in2])
= **208.8**[kip] Eq. J4-4

Gusset

Bolt bearing on gusset	[Kip]	156.60	30.63	D18	**0.20**	Eq. J3-6

$L_{c\text{-}end} = Max(0.0, L_e - d_h/2)$
= Max(0.0, 2[in] - 0.813[in]/2)
= **1.594**[in] Sec. J3.10

$L_{c\text{-}spa} = Max(0.0, s - d_h)$
= Max(0.0, 4[in] - 0.813[in])
= **3.188**[in] Sec. J3.10

$\phi R_n = \phi*(min(k_1*L_{c\text{-}end}, k_2*d) + min(k_1*L_{c\text{-}spa}, k_2*d)*(n - 1))*t_p*F_u*n_c$
= 0.75*(min(1.2*1.594[in], 2.4*0.75[in]) + min(1.2*3.188[in], 2.4*0.75[in])*(2 - 1))*0.5[in]*58000[lb/in2]*2
= **156.6**[kip] Eq. J3-6

Member

Side wall local yielding	[Kip]	139.60	0.00	DL	**0.00**	Eq. J10-2

$5.0*t_p + l_b<B \longrightarrow$ 5.0*0.5[in] + 1.5[in]<5[in] $\longrightarrow$ **True**

$\phi R_n = \phi*2*F_y*t_p*(5.0*t_p + l_b)$
= 1*2*50000[lb/in2]*0.349[in]*(5.0*0.5[in] + 1.5[in])
= **139.6**[kip] Eq. J10-2

Side wall local crippling	[Kip]	505.50	30.63	D18	**0.06**	Eq. J10-4

$\phi R_n = \phi*N_{walls}*0.8*t_p^2*(1 + (6*l_b/B)*(t_p/t_p)^{1.5})*(E*F_y*t_p/t_p)^{0.5}$
= 0.75*2*0.8*0.349[in]^2*(1 + (6*2[in]/5[in])*(0.349[in]/0.5[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.5[in]/0.349[in])$^{0.5}$
= **505.501**[kip] Eq. J10-4

Ratio **0.37**

Checks for gusset and brace

Required Resistance of Braced Connections

Requirement	**Value** [kip]
Required tensile strength	401.70
Required compressive strength	156.96

Geometric Considerations

Dimensions	Unit	Value	Min.	Max.	Sta.	References
Slenderness		93.69	--	200.00	✔	Sec. E2
λ_{max} = 200						Sec. E2
λ_b = L/r						
= 175.56[in]/1.874[in]						
= **93.689**						
Local buckling		11.33	0.00	16.05	✔	Seismic Manual Table D1.1
λ = Max(b/t_p, h/t_p)						
= Max(3.953[in]/0.349[in], 3.953[in]/0.349[in])						
= **11.327**						Seismic Manual Table I-8-1
$\lambda_{md} = 0.76*(E/(R_y*F_y))^{1/2}$						
$= 0.76*(2.90E+07[lb/in2]/(1.3*50000[lb/in2]))^{1/2}$						
= **16.053**						Seismic Manual Table D1.1

Ratio **0.23**

Design Check

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Member						
Compression	[Kip]	146.38	30.39	EQx	**0.21**	Eq. E3-1
$F_e = \pi^2*E/(K*L/r)^2$						
$= \pi^2*2.90E+07[lb/in2]/(1*175.56[in]/1.874[in])^2$						
= **32607.53**[lb/in2]						Eq. E3-4
F_e> = 0.44*Q*F_y ⟶ 32607.53[lb/in2]>						
= 0.44*1*50000[lb/in2] ⟶ **True**						
$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$						
$= 0.658^{(1*50000[lb/in2]/32607.53[lb/in2])}*50000[lb/in2]$						
= **26317.2**[lb/in2]						Eq. E7-2
$\phi P_n = \phi*F_{cr}*A_g$						
= 0.9*26317.2[lb/in2]*6.18[in2]						
= **146.376**[kip]						Eq. E3-1
Gusset						
Buckling on the Whitmore section	[Kip]	133.24	30.63	D18	**0.23**	Eq. E3-1
$A_g = L_p*t_p$						
= 8.619[in]*0.5[in]						
= **4.309**[in2]						Sec. D3-1
$F_e = \pi^2*E/(K*L/r)^2$						
$= \pi^2*2.90E+07[lb/in2]/(0.65*6.619[in]/0.144[in])^2$						
= **3.22E+05**[lb/in2]						Eq. E3-4
F_e> = 0.44*Q*F_y ⟶ 3.22E+05[lb/in2]>						
= 0.44*1*36000[lb/in2] ⟶ **True**						

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
$= 0.658^{(1*36000[lb/in2]/3.22E+05[lb/in2])}*36000[lb/in2]$
= **34355.07**[lb/in2] Eq. E7-2

$\phi P_n = \phi*F_{cr}*A_g$
= 0.9*34355.07[lb/in2]*4.309[in2]
= **133.245**[kip] Eq. E3-1

⚠ *WARNINGS*
- Connector length less than allowable Table D3.1

Calculation of the interface forces

Load condition :DL

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.157[kip]/15.97[in]
= **-0.0868**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.157[kip]/15.97[in]
= **-0.0246**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-0.157[kip]/15.97[in] - 0[kip]
= **-0.0683**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-0.157[kip]/15.97[in] + 0[kip]
= **-0.0423**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-0.0683[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-0.0246[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :LL

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.047[kip]/15.97[in]
= **-0.026**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.047[kip]/15.97[in]
= **-0.007357**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-0.047[kip]/15.97[in] - 0[kip]
= **-0.0205**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-0.047[kip]/15.97[in] + 0[kip]
= **-0.0127**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-0.0205[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-0.007357[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :SL

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha$*P/r
= 8.828[in]*0[kip]/15.97[in]
= **0**[kip] p. 13-5

$H_c = e_c$*P/r
= 2.5[in]*0[kip]/15.97[in]
= **0**[kip] p. 13-5

$V_b = e_b$*P/r - ΔV
= 6.95[in]*0[kip]/15.97[in] - 0[kip]
= **0**[kip] p. 13-5

$V_c = \beta$*P/r + ΔV
= 4.307[in]*0[kip]/15.97[in] + 0[kip]
= **0**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α)
= abs(0[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar}))
= abs(0[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :Wx

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)$*tanθ - e_c
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

r = $((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= $((8.828$[in] + 2.5[in]$)^2$ + (4.307[in] + 6.95[in]$)^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha$*P/r
= 8.828[in]*-14.007[kip]/15.97[in]
= **-7.743**[kip] p. 13-5

$H_c = e_c$*P/r
= 2.5[in]*-14.007[kip]/15.97[in]
= **-2.193**[kip] p. 13-5

$V_b = e_b$*P/r - ΔV
= 6.95[in]*-14.007[kip]/15.97[in] - 0[kip]
= **-6.096**[kip] p. 13-5

$V_c = \beta$*P/r + ΔV
= 4.307[in]*-14.007[kip]/15.97[in] + 0[kip]
= **-3.778**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-6.096[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-2.193[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :EQx

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-30.39[kip]/15.97[in]
= **-16.799**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-30.39[kip]/15.97[in]
= **-4.757**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-30.39[kip]/15.97[in] - 0[kip]
= **-13.225**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-30.39[kip]/15.97[in] + 0[kip]
= **-8.196**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-13.225[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-4.757[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D1

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])² + (4.307[in] + 6.95[in])²)^1/2
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.22[kip]/15.97[in]
= **-0.122**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.22[kip]/15.97[in]
= **-0.0344**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-0.22[kip]/15.97[in] - 0[kip]
= **-0.0957**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-0.22[kip]/15.97[in] + 0[kip]
= **-0.0593**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-0.0957[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-0.0344[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D2

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])² + (4.307[in] + 6.95[in])²)^1/2
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.264[kip]/15.97[in]
= **-0.146**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.264[kip]/15.97[in]
= **-0.0413**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
$= 6.95[in]*-0.264[kip]/15.97[in] - 0[kip]$
$= \mathbf{-0.115}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V$
$= 4.307[in]*-0.264[kip]/15.97[in] + 0[kip]$
$= \mathbf{-0.0711}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
$= abs(-0.115[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])$
$= \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
$= abs(-0.0413[kip]*(4.307[in] - 4.307[in]))$
$= \mathbf{0}[kip*ft]$ p. 13-10

Load condition :D3

General case DG29 p. 24-33

$\beta = \beta_{bar}$
$= \mathbf{4.307}[in]$ p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
$= (4.307[in] + 6.95[in])*1.006 - 2.5[in]$
$= \mathbf{8.828}[in]$ p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
$= \mathbf{15.97}[in]$ p. 13-5

$H_b = \alpha*P/r$
$= 8.828[in]*-0.188[kip]/15.97[in]$
$= \mathbf{-0.104}[kip]$ p. 13-5

$H_c = e_c*P/r$
$= 2.5[in]*-0.188[kip]/15.97[in]$
$= \mathbf{-0.0295}[kip]$ p. 13-5

$V_b = e_b*P/r - \Delta V$
$= 6.95[in]*-0.188[kip]/15.97[in] - 0[kip]$
$= \mathbf{-0.082}[kip]$ p. 13-5

$V_c = \beta*P/r + \Delta V$
$= 4.307[in]*-0.188[kip]/15.97[in] + 0[kip]$
$= \mathbf{-0.0508}[kip]$ p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
$= abs(-0.082[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])$
$= \mathbf{0}[kip*ft]$ p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
$= abs(-0.0295[kip]*(4.307[in] - 4.307[in]))$
$= \mathbf{0}[kip*ft]$ p. 13-10

Load condition :D4

General case — DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] — p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] — p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] — p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.264[kip]/15.97[in]
= **-0.146**[kip] — p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.264[kip]/15.97[in]
= **-0.0413**[kip] — p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-0.264[kip]/15.97[in] - 0[kip]
= **-0.115**[kip] — p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-0.264[kip]/15.97[in] + 0[kip]
= **-0.0711**[kip] — p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-0.115[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] — p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-0.0413[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] — p. 13-10

Load condition :D5

General case — DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] — p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] — p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] — p. 13-5

$H_b = \alpha * P/r$
= 8.828[in]*-0.188[kip]/15.97[in]
= **-0.104**[kip] p. 13-5

$H_c = e_c * P/r$
= 2.5[in]*-0.188[kip]/15.97[in]
= **-0.0295**[kip] p. 13-5

$V_b = e_b * P/r - \Delta V$
= 6.95[in]*-0.188[kip]/15.97[in] - 0[kip]
= **-0.082**[kip] p. 13-5

$V_c = \beta * P/r + \Delta V$
= 4.307[in]*-0.188[kip]/15.97[in] + 0[kip]
= **-0.0508**[kip] p. 13-5

$M_b = abs(V_b * (\alpha - \alpha_{bar})) + abs(\Delta V * \alpha)$
= abs(-0.082[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c * (\beta - \beta_{bar}))$
= abs(-0.0295[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D6

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b) * \tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha * P/r$
= 8.828[in]*-7.192[kip]/15.97[in]
= **-3.976**[kip] p. 13-5

$H_c = e_c * P/r$
= 2.5[in]*-7.192[kip]/15.97[in]
= **-1.126**[kip] p. 13-5

$V_b = e_b * P/r - \Delta V$
= 6.95[in]*-7.192[kip]/15.97[in] - 0[kip]
= **-3.13**[kip] p. 13-5

$V_c = \beta * P/r + \Delta V$
= 4.307[in]*-7.192[kip]/15.97[in] + 0[kip]
= **-1.94**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-3.13[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-1.126[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D7

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.235[kip]/15.97[in]
= **-0.13**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.235[kip]/15.97[in]
= **-0.0368**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-0.235[kip]/15.97[in] - 0[kip]
= **-0.102**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-0.235[kip]/15.97[in] + 0[kip]
= **-0.0635**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-0.102[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-0.0368[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D8

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
$= (4.307[in] + 6.95[in])*1.006 - 2.5[in]$
$=$ **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
$=$ **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
$= 8.828[in]*-7.192[kip]/15.97[in]$
$=$ **-3.976**[kip] p. 13-5

$H_c = e_c*P/r$
$= 2.5[in]*-7.192[kip]/15.97[in]$
$=$ **-1.126**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
$= 6.95[in]*-7.192[kip]/15.97[in] - 0[kip]$
$=$ **-3.13**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
$= 4.307[in]*-7.192[kip]/15.97[in] + 0[kip]$
$=$ **-1.94**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
$= abs(-3.13[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])$
$=$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
$= abs(-1.126[kip]*(4.307[in] - 4.307[in]))$
$=$ **0**[kip*ft] p. 13-10

Load condition :D9

General case DG29 p. 24-33

$\beta = \beta_{bar}$
$=$ **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
$= (4.307[in] + 6.95[in])*1.006 - 2.5[in]$
$=$ **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
$=$ **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
$= 8.828[in]*-14.195[kip]/15.97[in]$
$=$ **-7.847**[kip] p. 13-5

$H_c = e_c*P/r$
$= 2.5[in]*-14.195[kip]/15.97[in]$
$=$ **-2.222**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-14.195[kip]/15.97[in] - 0[kip]
= **-6.178**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-14.195[kip]/15.97[in] + 0[kip]
= **-3.829**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-6.178[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-2.222[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D10

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-14.195[kip]/15.97[in]
= **-7.847**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-14.195[kip]/15.97[in]
= **-2.222**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-14.195[kip]/15.97[in] - 0[kip]
= **-6.178**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-14.195[kip]/15.97[in] + 0[kip]
= **-3.829**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-6.178[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-2.222[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D11

General case DG29 p. 24-33

$\beta = \beta_{bar}$
$= \mathbf{4.307}$[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
$= \mathbf{8.828}$[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
$= \mathbf{15.97}$[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-14.242[kip]/15.97[in]
$= \mathbf{-7.873}$[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-14.242[kip]/15.97[in]
$= \mathbf{-2.229}$[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-14.242[kip]/15.97[in] - 0[kip]
$= \mathbf{-6.198}$[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-14.242[kip]/15.97[in] + 0[kip]
$= \mathbf{-3.841}$[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-6.198[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
$= \mathbf{0}$[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-2.229[kip]*(4.307[in] - 4.307[in]))
$= \mathbf{0}$[kip*ft] p. 13-10

Load condition :D12

General case DG29 p. 24-33

$\beta = \beta_{bar}$
$= \mathbf{4.307}$[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
$= \mathbf{8.828}$[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
$= \mathbf{15.97}$[in] p. 13-5

$H_b = \alpha * P/r$
= 8.828[in]*-14.242[kip]/15.97[in]
= **-7.873**[kip] p. 13-5

$H_c = e_c * P/r$
= 2.5[in]*-14.242[kip]/15.97[in]
= **-2.229**[kip] p. 13-5

$V_b = e_b * P/r - \Delta V$
= 6.95[in]*-14.242[kip]/15.97[in] - 0[kip]
= **-6.198**[kip] p. 13-5

$V_c = \beta * P/r + \Delta V$
= 4.307[in]*-14.242[kip]/15.97[in] + 0[kip]
= **-3.841**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V * \alpha)$
= abs(-6.198[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-2.229[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D13

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha * P/r$
= 8.828[in]*-14.148[kip]/15.97[in]
= **-7.821**[kip] p. 13-5

$H_c = e_c * P/r$
= 2.5[in]*-14.148[kip]/15.97[in]
= **-2.215**[kip] p. 13-5

$V_b = e_b * P/r - \Delta V$
= 6.95[in]*-14.148[kip]/15.97[in] - 0[kip]
= **-6.157**[kip] p. 13-5

$V_c = \beta * P/r + \Delta V$
= 4.307[in]*-14.148[kip]/15.97[in] + 0[kip]
= **-3.816**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α)
= abs(-6.157[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar}))
= abs(-2.215[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D14

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

H_b = α*P/r
= 8.828[in]*-0.188[kip]/15.97[in]
= **-0.104**[kip] p. 13-5

H_c = e_c*P/r
= 2.5[in]*-0.188[kip]/15.97[in]
= **-0.0295**[kip] p. 13-5

V_b = e_b*P/r - ΔV
= 6.95[in]*-0.188[kip]/15.97[in] - 0[kip]
= **-0.082**[kip] p. 13-5

V_c = β*P/r + ΔV
= 4.307[in]*-0.188[kip]/15.97[in] + 0[kip]
= **-0.0508**[kip] p. 13-5

M_b = abs(V_b*(α - α_{bar})) + abs(ΔV*α)
= abs(-0.082[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

M_c = abs(H_c*(β - β_{bar}))
= abs(-0.0295[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D15

General case DG29 p. 24-33

$F_e = \pi^2*E/(K*L/r)^2$
= π^2*2.90E+07[lb/in2]/(1*175.56[in]/1.874[in])^2
= **32607.53**[lb/in2] Eq. E3-4

F_e> = 0.44*Q*F_y ⟶ 32607.53[lb/in2]>
= 0.44*1*65000[lb/in2] ⟶ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
= $0.658^{(1*65000[lb/in2]/32607.53[lb/in2])}$*65000[lb/in2]
= **28220.45**[lb/in2] Eq. E7-2

$\phi R_n = \phi*R_y*F_y*A_g$
= 1*1.3*50000[lb/in2]*6.18[in2]
= **401.7**[kip] AISC 341 Sec. F1.a.

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-30.578[kip]/15.97[in]
= **-16.903**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-30.578[kip]/15.97[in]
= **-4.787**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-30.578[kip]/15.97[in] - 0[kip]
= **-13.307**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-30.578[kip]/15.97[in] + 0[kip]
= **-8.247**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-13.307[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-4.787[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D16

General case DG29 p. 24-33

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-0.235[kip]/15.97[in]
= **-0.13**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-0.235[kip]/15.97[in]
= **-0.0368**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-0.235[kip]/15.97[in] - 0[kip]
= **-0.102**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-0.235[kip]/15.97[in] + 0[kip]
= **-0.0635**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-0.102[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-0.0368[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D17

General case DG29 p. 24-33

$F_e = \pi^2*E/(K*L/r)^2$
= π^2*2.90E+07[lb/in2]/(1*175.56[in]/1.874[in])^2
= **32607.53**[lb/in2] Eq. E3-4

F_e> = 0.44*Q*F_y $\longrightarrow$ 32607.53[lb/in2]>
= 0.44*1*65000[lb/in2] $\longrightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
= 0.658$^{(1*65000[lb/in2]/32607.53[lb/in2])}$*65000[lb/in2]
= **28220.45**[lb/in2] Eq. E7-2

$\phi R_n = \phi*R_y*F_y*A_g$
= 1*1.3*50000[lb/in2]*6.18[in2]
= **401.7**[kip] AISC 341 Sec. F1.a.

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-30.578[kip]/15.97[in]
= **-16.903**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-30.578[kip]/15.97[in]
= **-4.787**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-30.578[kip]/15.97[in] - 0[kip]
= **-13.307**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-30.578[kip]/15.97[in] + 0[kip]
= **-8.247**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-13.307[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-4.787[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D18

General case DG29 p. 24-33

$F_e = \pi^2*E/(K*L/r)^2$
= π^2*2.90E+07[lb/in2]/(1*175.56[in]/1.874[in])^2
= **32607.53**[lb/in2] Eq. E3-4

F_e> = 0.44*Q*F_y → 32607.53[lb/in2]>
= 0.44*1*65000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
= 0.658$^{(1*65000[lb/in2]/32607.53[lb/in2])}$*65000[lb/in2]
= **28220.45**[lb/in2] Eq. E7-2

$\phi R_n = \phi*R_y*F_y*A_g$
= 1*1.3*50000[lb/in2]*6.18[in2]
= **401.7**[kip] AISC 341 Sec. F1.a.

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
$= (4.307[in] + 6.95[in])*1.006 - 2.5[in]$
$=$ **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
$=$ **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
$= 8.828[in]*-30.625[kip]/15.97[in]$
$=$ **-16.929**[kip] p. 13-5

$H_c = e_c*P/r$
$= 2.5[in]*-30.625[kip]/15.97[in]$
$=$ **-4.794**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
$= 6.95[in]*-30.625[kip]/15.97[in] - 0[kip]$
$=$ **-13.328**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
$= 4.307[in]*-30.625[kip]/15.97[in] + 0[kip]$
$=$ **-8.26**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
$= abs(-13.328[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])$
$=$ **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
$= abs(-4.794[kip]*(4.307[in] - 4.307[in]))$
$=$ **0**[kip*ft] p. 13-10

Load condition :D19

General case DG29 p. 24-33

$F_e = \pi^2*E/(K*L/r)^2$
$= \pi^2*2.90E+07[lb/in2]/(1*175.56[in]/1.874[in])^2$
$=$ **32607.53**[lb/in2] Eq. E3-4

$F_e >= 0.44*Q*F_y \longrightarrow 32607.53[lb/in2] >$
$= 0.44*1*65000[lb/in2] \longrightarrow$ **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
$= 0.658^{(1*65000[lb/in2]/32607.53[lb/in2])}*65000[lb/in2]$
$=$ **28220.45**[lb/in2] Eq. E7-2

$\phi R_n = \phi*R_y*F_y*A_g$
$= 1*1.3*50000[lb/in2]*6.18[in2]$
$=$ **401.7**[kip] AISC 341 Sec. F1.a.

$\beta = \beta_{bar}$
$=$ **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
$= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-30.625[kip]/15.97[in]
= **-16.929**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-30.625[kip]/15.97[in]
= **-4.794**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-30.625[kip]/15.97[in] - 0[kip]
= **-13.328**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-30.625[kip]/15.97[in] + 0[kip]
= **-8.26**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-13.328[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-4.794[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Load condition :D20
General case DG29 p. 24-33

$F_e = \pi^2*E/(K*L/r)^2$
$= \pi^2*2.90E+07[lb/in2]/(1*175.56[in]/1.874[in])^2$
= **32607.53**[lb/in2] Eq. E3-4

F_e> = 0.44*Q*F_y → 32607.53[lb/in2]>
= 0.44*1*65000[lb/in2] → **True**

$F_{cr} = 0.658^{(Q*Fy/Fe)}*F_y$
$= 0.658^{(1*65000[lb/in2]/32607.53[lb/in2])}*65000[lb/in2]$
= **28220.45**[lb/in2] Eq. E7-2

$\phi R_n = \phi*R_y*F_y*A_g$
= 1*1.3*50000[lb/in2]*6.18[in2]
= **401.7**[kip] AISC 341 Sec. F1.a.

$\beta = \beta_{bar}$
= **4.307**[in] p. 13-10

$\alpha = (\beta + e_b)*\tan\theta - e_c$
= (4.307[in] + 6.95[in])*1.006 - 2.5[in]
= **8.828**[in] p. 13-10

$r = ((\alpha + e_c)^2 + (\beta + e_b)^2)^{1/2}$
= ((8.828[in] + 2.5[in])^2 + (4.307[in] + 6.95[in])^2)$^{1/2}$
= **15.97**[in] p. 13-5

$H_b = \alpha*P/r$
= 8.828[in]*-30.531[kip]/15.97[in]
= **-16.877**[kip] p. 13-5

$H_c = e_c*P/r$
= 2.5[in]*-30.531[kip]/15.97[in]
= **-4.779**[kip] p. 13-5

$V_b = e_b*P/r - \Delta V$
= 6.95[in]*-30.531[kip]/15.97[in] - 0[kip]
= **-13.287**[kip] p. 13-5

$V_c = \beta*P/r + \Delta V$
= 4.307[in]*-30.531[kip]/15.97[in] + 0[kip]
= **-8.234**[kip] p. 13-5

$M_b = abs(V_b*(\alpha - \alpha_{bar})) + abs(\Delta V*\alpha)$
= abs(-13.287[kip]*(8.828[in] - 8.828[in])) + abs(0[kip]*8.828[in])
= **0**[kip*ft] p. 13-10

$M_c = abs(H_c*(\beta - \beta_{bar}))$
= abs(-4.779[kip]*(4.307[in] - 4.307[in]))
= **0**[kip*ft] p. 13-10

Interface Upper left gusset - beam

Connection: 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	-0.09	-0.07	0.00	0.00	0.00	0.00	Design
LL	-0.03	-0.02	0.00	0.00	0.00	0.00	Design
SL	0.00	0.00	0.00	0.00	0.00	0.00	Design
Wx	-7.74	-6.10	0.00	0.00	0.00	0.00	Design
EQx	-16.80	-13.23	0.00	0.00	0.00	0.00	Design
D1	-0.12	-0.10	0.00	0.00	0.00	0.00	Design
D2	-0.15	-0.11	0.00	0.00	0.00	0.00	Design
D3	-0.10	-0.08	0.00	0.00	0.00	0.00	Design
D4	-0.15	-0.11	0.00	0.00	0.00	0.00	Design
D5	-0.10	-0.08	0.00	0.00	0.00	0.00	Design
D6	-3.98	-3.13	0.00	0.00	0.00	0.00	Design
D7	-0.13	-0.10	0.00	0.00	0.00	0.00	Design
D8	-3.98	-3.13	0.00	0.00	0.00	0.00	Design
D9	-7.85	-6.18	0.00	0.00	0.00	0.00	Design
D10	-7.85	-6.18	0.00	0.00	0.00	0.00	Design
D11	-7.87	-6.20	0.00	0.00	0.00	0.00	Design

D12	-7.87	-6.20	0.00	0.00	0.00	0.00	Design
D13	-7.82	-6.16	0.00	0.00	0.00	0.00	Design
D14	-0.10	-0.08	0.00	0.00	0.00	0.00	Design
D15	-16.90	-13.31	0.00	0.00	0.00	0.00	Seismic
D16	-0.13	-0.10	0.00	0.00	0.00	0.00	Design
D17	-16.90	-13.31	0.00	0.00	0.00	0.00	Seismic
D18	-16.93	-13.33	0.00	0.00	0.00	0.00	Seismic
D19	-16.93	-13.33	0.00	0.00	0.00	0.00	Seismic
D20	-16.88	-13.29	0.00	0.00	0.00	0.00	Seismic

Geometric Considerations

Dimensions	Unit	Value	Min.	Max.	Sta.	References
Gusset						
Weld size	[1/16in]	4	3	6	✔	Sec. J2.2b

$w_{min} = w_{min}$

= **0.0156** — table J2.4

t_p<1/4 [in] → 0.42[in]<1/4 [in] → **False**

$w_{max} = t_p$ - 1/16 [in]

= 0.42[in] - 1/16 [in]

= **0.0298** — Sec. J2.2b

Design Check

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	269.83	13.33	D18	**0.05**	Eq. B-1, Appendix B, DG29

$N_{eq} = V_{ub} + ((4*M_{ub})/L_p)$

= 13.328[kip] + ((4*0[kip*ft])/16.656[in])

= **13.328**[kip] — Eq. B-1, Appendix B, DG29

$\phi R_n = \phi * F_y * A_g$

= 0.9*36000[lb/in2]*8.328[in2]

= **269.835**[kip] — Eq. J4-1

$N_{eq} = V_{ub} + ((4*M_{ub})/L_p)$

= 13.328[kip] + ((4*0[kip*ft])/16.656[in])

= **13.328**[kip] — Eq. B-1, Appendix B, DG29

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear yielding	[Kip]	179.89	16.93	D18	**0.09**	Eq. J4-3

$A_g = L_p * t_p$

= 16.656[in]*0.5[in]

= **8.328**[in2] — Sec. D3-1

$\phi R_n = \phi * 0.60 * F_y * A_g$
= 1*0.60*36000[lb/in2]*8.328[in2]
= **179.89**[kip] Eq. J4-3

Gusset edge tension stress	[Kip/in2]	32.40	1.60	D18	**0.05**	Eq. B-1, Appendix B, DG29

$N_{eq} = V_{ub} + ((4*M_{ub})/L_p)$
= 13.328[kip] + ((4*0[kip*ft])/16.656[in])
= **13.328**[kip] Eq. B-1, Appendix B, DG29

$\phi F_n = \phi * F_y$
= 0.9*36000[lb/in2]
= **32400**[lb/in2] J4-1

$f_{ua} = V_b/(t_p*l)$
= -13.328[kip]/(0.5[in]*16.656[in])
= **-1600.28**[lb/in2] [9]

Gusset edge shear stress	[Kip/in2]	21.60	2.03	D18	**0.09**	J4-1

$\phi F_n = \phi * 0.6 * F_y$
= 1*0.6*36000[lb/in2]
= **21600**[lb/in2] J4-1

$f_{uv} = H_b/(t_p*l)$
= -16.929[kip]/(0.5[in]*16.656[in])
= **-2032.76**[lb/in2] [9]

Weld capacity	[Kip]	230.62	26.93	D18	**0.12**	Tables 8-4 .. 8-11

$\phi R_n = 2 * (\phi * C * C_1 * D * L)$
= 2 * (0.75*2.308[kip/in]*1*4*16.656[in])
= **230.625**[kip] Tables 8-4 .. 8-11

$f_{ua} = V_b/l$
= -13.328[kip]/16.656[in]
= **-0.8**[kip/in] [9]

$f_{uv} = H_b/l$
= -16.929[kip]/16.656[in]
= **-1.016**[kip/in] [9]

$f_{ub} = M_b/(l^2/4)$
= 0[kip*ft]/(16.656[in]^2/4)
= **0**[kip/in] [9]

$f_{uPeak} = ((f_{ua} + f_{ub})^2 + f_{uv}^2)^{1/2}$
= ((0.8[kip/in] + 0[kip/in])^2 + 1.016[kip/in]^2)$^{1/2}$
= **1.294**[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*(((0.8[kip/in] - 0[kip/in])^2 + 1.016[kip/in]^2)$^{1/2}$ + ((0.8[kip/in] + 0[kip/in])^2 + 1.016[kip/in]^2)$^{1/2}$)
= **1.294**[kip/in] [9]

$f_{uWeld} = l*\max(f_{uPeak}, 1.25*f_{uAve})$
= 16.656[in]*max(1.294[kip/in], 1.25*1.294[kip/in])
= **26.932**[kip] [9]

Chord

Weld block shear	[Kip]	206.81	16.93	D18	**0.08**	Eq. J4-5

$A_{gv} = l*t_w$
= 16.656[in]*0.255[in]
= **4.247**[in2] Sec. J4.3

$A_{gt} = (A_g - t_w*T)/2$
= (7.69[in2] - 0.255[in]*12.26[in])/2
= **2.282**[in2] [8]

$A_{nv} = A_{gv}$
= **4.247**[in2] Sec. J4.3

$A_{nt} = A_{gt}$
= **2.282**[in2] Sec. J4.3

$\phi R_n = \phi*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$
= 0.75*min(0.6*65000[lb/in2]*4.247[in2] + 1*65000[lb/in2]*2.282[in2], 0.6*50000[lb/in2]*4.247[in2] + 1*65000[lb/in2]*2.282[in2])
= **206.807**[kip] Eq. J4-5

Web crippling	[Kip]	162.83	13.33	D18	**0.08**	Eq. B-1, Appendix B, DG29

$N_{eq} = V_{ub} + ((4*M_{ub})/L_p)$
= 13.328[kip] + ((4*0[kip*ft])/16.656[in])
= **13.328**[kip] Eq. B-1, Appendix B, DG29

IsBeamReaction ⟶ **False**

$l_b = N$
= **16.656**[in] Sec. J10-2

$\phi R_n = \phi*0.80*t_w^2*(1 + 3*(N/d)*(t_w/t_f)^{1.5})*(E*F_{yw}*t_f/t_w)^{1/2}*Q_f$
= 0.75*0.80*0.255[in]^2*(1 + 3*(16.656[in]/13.9[in])*(0.255[in]/0.42[in])$^{1.5}$)*(2.90E+07[lb/in2]*50000[lb/in2]*0.42[in]/0.255[in])$^{1/2}$*1
= **162.834**[kip] Eq. J10-4

$N_{eq} = V_{ub} + ((4*M_{ub})/L_p)$
= 13.328[kip] + ((4*0[kip*ft])/16.656[in])
= **13.328**[kip] Eq. B-1, Appendix B, DG29

Local web yielding	[Kip]	238.51	13.33	D18	**0.06**	Eq. B-1, Appendix B, DG29

IsBeamReaction → **False**

l_b = N
= **16.656**[in] Sec. J10-2

IsMemberEnd → **True**

$\phi R_n = \phi*(2.5*k + l_b)*F_{yw}*t_w$
= 1*(2.5*0.82[in] + 16.656[in])*50000[lb/in2]*0.255[in]
= **238.507**[kip] Eq. J10-3

$N_{eq} = V_{ub} + ((4*M_{ub})/L_p)$
= 13.328[kip] + ((4*0[kip*ft])/16.656[in])
= **13.328**[kip] Eq. B-1, Appendix B, DG29

Transverse section web yielding	[Kip]	106.33	13.33	D18	**0.13**	Eq. G2-1

$\phi V_n = \phi*0.6*F_y*A_w*C_v$
= 1*0.6*50000[lb/in2]*3.545[in2]*1
= **106.335**[kip] Eq. G2-1

Ratio **0.13**

Interface Upper left gusset - column

Connection: Single plate

Demands

	Beam		Column			
Description	**Ru** [kip]	**Pu** [kip]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	**Load type**
DL	-0.04	-0.02	-2.57	0.00	0.00	Design
LL	-0.01	-0.01	0.00	0.00	0.00	Design
SL	0.00	0.00	6.17	0.00	0.00	Design
Wx	-3.78	-2.19	0.00	0.00	0.00	Design
EQx	-8.20	-4.76	0.00	0.00	0.00	Design
D1	-0.06	-0.03	-3.60	0.00	0.00	Design
D2	-0.07	-0.04	-3.09	0.00	0.00	Design
D3	-0.05	-0.03	0.00	0.00	0.00	Design
D4	-0.07	-0.04	0.00	0.00	0.00	Design
D5	-0.05	-0.03	6.78	0.00	0.00	Design
D6	-1.94	-1.13	-3.09	0.00	0.00	Design
D7	-0.06	-0.04	6.78	0.00	0.00	Design
D8	-1.94	-1.13	6.78	0.00	0.00	Design

D9	-3.83	-2.22	-3.09	0.00	0.00	Design
D10	-3.83	-2.22	0.00	0.00	0.00	Design
D11	-3.84	-2.23	-3.09	0.00	0.00	Design
D12	-3.84	-2.23	0.00	0.00	0.00	Design
D13	-3.82	-2.21	-2.32	0.00	0.00	Design
D14	-0.05	-0.03	-1.86	0.00	0.00	Design
D15	-8.25	-4.79	-3.09	0.00	0.00	Seismic
D16	-0.06	-0.04	-1.86	0.00	0.00	Design
D17	-8.25	-4.79	-1.86	0.00	0.00	Seismic
D18	-8.26	-4.79	-3.09	0.00	0.00	Seismic
D19	-8.26	-4.79	-1.86	0.00	0.00	Seismic
D20	-8.23	-4.78	-2.32	0.00	0.00	Seismic

Geometric Considerations

Dimensions	Unit	Value	Min.	Max.	Sta.	References
Shear plate						
Thickness	[in]	0.31	--	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]	2.50	--	3.50	✔	p 10-102
Max. a = 3.4999999999999996 [in]						p 10-102
Minimum plate or beam web thickness	[in]	0.31	--	0.44	✔	Table 10-9
e = 1.25 [in], Max. tp						
= 0.4375 [in]						Table 10-9
Length	[in]	9.00	4.31	9.00	✔	p. 10-104
L_{min} = T/2						
= 8.615[in]/2						
= **4.307**[in]						p. 10-104
L_{max} = L						
= **9**[in]						
Thickness, precludes a punching failure of the HSS...	[in]	0.31	--	--	✔	
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	7.50	✔	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						
Vertical edge distance	[in]	1.31	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]	2.00	1.50	--	✔	p. 10-103
L_{emin} = 2*d						
= 2*0.75[in]						
= **1.5**[in]						p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	50.00	--	--	✔	
Yield stress to tensile stress ratio		0.81	--	--	✔	Table K2.1A
F_y/F_u = F_y/F_u						
= 50000[lb/in2]/62000[lb/in2]						
= **0.806**						Table K2.1A
Weld size	[1/16in]	5	4	--	✔	p. 10-87
w_{min} = (5/8)*t_p						
= (5/8)*0.313[in]						
= **0.195**[in]						p. 10-87
Weld length	[in]	9.00	1.25	--	✔	Sec. J2.2b
L_{min} = 4.0*w						
= 4.0*0.313[in]						
= **1.25**[in]						Sec. J2.2b

⚠ *WARNINGS*
- Connector does not fit on beam

Design Check

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	45.63	9.55	D18	**0.21**	Tables (7-1..14)
e = 1.25 [in], Max. tp						
= 0.4375 [in]						Table 10-9

$\phi R_n = \phi * F_{nv} * A_b$
= 0.75*54000[lb/in2]*0.442[in2]
= **17.901**[kip] — Eq. J3-1

$\phi R_n = C * \phi R_n * BoltFactor$
= 2.549*17.901[kip]*1
= **45.626**[kip] — Tables (7-1..14)

Bolt bearing under shear load	[Kip]	45.48	8.26	D18	**0.18**	p. 7-18

e = 1.25 [in], Max. tp
= 0.4375 [in] — Table 10-9

$L_{c\text{-}end} = Max(0.0, L_e - d_h/2)$
= Max(0.0, 1.5[in] - 0.813[in]/2)
= **1.094**[in] — Sec. J3.10

$L_{c\text{-}spa} = Max(0.0, s - d_h)$
= Max(0.0, 3[in] - 0.813[in])
= **2.188**[in] — Sec. J3.10

$r_{n1} = min(k_1 * l_c * t_p * F_u, k_2 * d * t_p * F_u)$
= min(1.2*1.094[in]*0.313[in]*58000[lb/in2], 2.4*0.75[in]*0.313[in]*58000[lb/in2])
= **23.789**[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*2.188[in]*0.313[in]*58000[lb/in2], 2.4*0.75[in]*0.313[in]*58000[lb/in2])
= **32.625**[kip] — Eq. J3-6

$\phi R_n = \phi * C * min(r_{n1}, r_{n2})$
= 0.75*2.549*min(23.789[kip], 32.625[kip])
= **45.475**[kip] — p. 7-18

Shear yielding	[Kip]	60.75	8.26	D18	**0.14**	Eq. J4-3

$A_g = L_p * t_p$
= 9[in]*0.313[in]
= **2.813**[in2] — Sec. D3-1

$\phi R_n = \phi * 0.60 * F_y * A_g$
= 1*0.60*36000[lb/in2]*2.813[in2]
= **60.75**[kip] — Eq. J4-3

Shear rupture	[Kip]	52.00	8.26	D18	**0.16**	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]
= **6.375**[in] — DG4 Eq. 3-13

$A_{nv} = L_e * t_p$
= 6.375[in]*0.313[in]
= **1.992**[in2] — Sec. J4-2

$\phi R_n = \phi*0.60*F_u*A_{nv}$
= 0.75*0.60*58000[lb/in2]*1.992[in2]
= **51.996**[kip] Eq. J4-4

Block shear	[Kip]	52.41	8.26	D18	**0.16**	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])*0.313[in]
= **0.332**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$
= (1.5[in] + (3 - 1)*3[in])*0.313[in]
= **2.344**[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)*0.313[in]
= **1.66**[in2] Sec. J4-3

IsStressUniform ⟶ **True**

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

$\phi R_n = \phi*min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$
= 0.75*min(0.6*58000[lb/in2]*1.66[in2] + 1*58000[lb/in2]*0.332[in2], 0.6*36000[lb/in2]*2.344[in2] + 1*58000[lb/in2]*0.332[in2])
= **52.412**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	147.57	9.55	D18	**0.06**	Tables 8-4 .. 8-11

$\phi R_n = \phi*C*C_1*D*L$
= 0.75*4.372[kip/in]*1*5*9[in]
= **147.571**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	59.94	8.26	D18	**0.14**	p. 7-18

e = 1.25 [in], Max. tp
= 0.4375 [in] Table 10-9

$L_{c-end} = Max(0.0, L_e - d_h/2)$
= Max(0.0, 1.307[in] - 0.813[in]/2)
= **0.901**[in] Sec. J3.10

$L_{c-spa} = Max(0.0, s - d_h)$
= Max(0.0, 3[in] - 0.813[in])
= **2.188**[in] Sec. J3.10

$r_{n1} = min(k_1*l_c*t_p*F_u, k_2*d*t_p*F_u)$
= min(1.2*0.901[in]*0.5[in]*58000[lb/in2], 2.4*0.75[in]*0.5[in]*58000[lb/in2])
= **31.356**[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*2.188[in]*0.5[in]*58000[lb/in2], 2.4*0.75[in]*0.5[in]*58000[lb/in2])
= **52.2**[kip] Eq. J3-6

$\phi R_n = \phi*C*min(r_{n1}, r_{n2})$
= 0.75*2.549*min(31.356[kip], 52.2[kip])
= **59.94**[kip] p. 7-18

Shear yielding	[Kip]	93.04	8.26	D18	0.09	Eq. J4-3

$A_g = L_p*t_p$
= 8.615[in]*0.5[in]
= **4.307**[in2] Sec. D3-1

$\phi R_n = \phi*0.60*F_y*A_g$
= 1*0.60*36000[lb/in2]*4.307[in2]
= **93.037**[kip] Eq. J4-3

Bolt bearing under axial load	[Kip]	117.45	0.00	D15	0.00	Eq. J3-6

$L_{c\text{-}end} = Max(0.0, L_e - d_h/2)$
= Max(0.0, 2[in] - 0.813[in]/2)
= **1.594**[in] Sec. J3.10

$\phi R_n = \phi*(min(k_1*L_{c\text{-}end}, k_2*d))*t_p*F_u*n_c$
= 0.75*(min(1.2*1.594[in], 2.4*0.75[in]))*0.5[in]*58000[lb/in2]*3
= **117.45**[kip] Eq. J3-6

Support

Welds rupture	[Kip/ft]	155.79	7.21	D18	0.05	p. 9-5

$R_n = 0.6*F_u*t_p$
= 0.6*62000[lb/in2]*0.349[in]
= **12.983**[kip/in] p. 9-5

$D_{min} = P/(\phi*C*C_1*L)$
= 9.55[kip]/(0.75*4.372[kip/in]*1*9[in])
= **0.324** 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*0.324/16 [in]
= **0.601**[kip/in] p. 9-5

Punching shear (shear rupture)	[Kip]	105.16	8.26	D18	0.08	p. 10-153

$R_u = \phi*(F_u*t*l_p^2)/(5*e)$
= 0.75*(62000[lb/in2]*0.349[in]*9$[in]^2$)/(5*2.5[in])
= **105.161**[kip] p. 10-153

HSS wall strength due out-of-plane transverse load [Kip] 48.54 4.79 D18 **0.10** p.9-16

$U_{HSS} = abs(P_r)/(A_g*F_c) + abs(M_r)/(S*F_c)$

= abs(-3.089[kip])/(6.18[in2]*50000[lb/in2]) + abs(0[kip*ft])/(8.7[in3]*50000[lb/in2])

= **0.009996** Eq. K1-6

$Q_f = (1 - U_{HSS}^2)^{0.5}$

$= (1 - 0.009996^2)^{0.5}$

= **1** Eq. K1-17

$\phi R_n = \phi * t_p^2 * F_y*((a + b)*(4*(T*a*b/(a + b))^{0.5} + L)/(a*b))*Q_f/2.0$

$= 1*0.349[in]^2*50000[lb/in2]*((2.344[in] + 2.344[in])*(4*(5[in]*2.344[in]*2.344[in]/(2.344[in] + 2.344[in]))^{0.5} + 9[in])/(2.344[in]*2.344[in]))*1/2.0$

= **48.542**[kip] p.9-16

Ratio **0.21**

Calculation of the interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + 0[kip] + 0[kip]

= **0**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= -0[kip] - 0[kip] - 0[kip]

= **0**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= 0[kip] + 0[kip]

= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 3.677[kip] - 0[kip] + 0[kip]

= **3.677**[kip]

Load condition :LL

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + 0[kip] + 0[kip]

= **0**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= -0[kip] - 0[kip] - 0[kip]

= **0**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= 0[kip] + 0[kip]

= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 4.509[kip] - 0[kip] + 0[kip]

= **4.509**[kip]

Load condition :SL

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + 0[kip] + 0[kip]

= **0**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= -0[kip] - 0[kip] - 0[kip]

= **0**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= 0[kip] + 0[kip]

= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 0[kip] - 0[kip] + 0[kip]

= **0**[kip]

Load condition :Wx

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= -10.022[kip] + 0[kip] + 0[kip]

= **-10.022**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= --10.022[kip] - 0[kip] - 0[kip]

= **10.022**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= 0[kip] + 0[kip]

= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 0[kip] - 0[kip] + 0[kip]

= **0**[kip]

Load condition :EQx

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= -21.748[kip] + 0[kip] + 0[kip]

= **-21.748**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= --21.748[kip] - 0[kip] - 0[kip]

= **21.748**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= 0[kip] + 0[kip]

= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 0[kip] - 0[kip] + 0[kip]

= **0**[kip]

Load condition :D1

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + 0[kip] + 0[kip]

= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 5.148[kip] - 0[kip] + 0[kip]
= **5.148**[kip]

Load condition :D2

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 11.627[kip] - 0[kip] + 0[kip]
= **11.627**[kip]

Load condition :D3

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D4

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 11.627[kip] - 0[kip] + 0[kip]
= **11.627**[kip]

Load condition :D5

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D6

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -5.011[kip] + 0[kip] + 0[kip]
= **-5.011**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --5.011[kip] - 0[kip] - 0[kip]
= **5.011**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D7

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 8.921[kip] - 0[kip] + 0[kip]
= **8.921**[kip]

Load condition :D8
$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -5.011[kip] + 0[kip] + 0[kip]
= **-5.011**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --5.011[kip] - 0[kip] - 0[kip]
= **5.011**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D9
$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -10.022[kip] + 0[kip] + 0[kip]
= **-10.022**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --10.022[kip] - 0[kip] - 0[kip]
= **10.022**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D10
$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -10.022[kip] + 0[kip] + 0[kip]
= **-10.022**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --10.022[kip] - 0[kip] - 0[kip]
= **10.022**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D11

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -10.022[kip] + 0[kip] + 0[kip]
= **-10.022**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --10.022[kip] - 0[kip] - 0[kip]
= **10.022**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 8.921[kip] - 0[kip] + 0[kip]
= **8.921**[kip]

Load condition :D12

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -10.022[kip] + 0[kip] + 0[kip]
= **-10.022**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --10.022[kip] - 0[kip] - 0[kip]
= **10.022**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 8.921[kip] - 0[kip] + 0[kip]
= **8.921**[kip]

Load condition :D13

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -10.022[kip] + 0[kip] + 0[kip]
= **-10.022**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --10.022[kip] - 0[kip] - 0[kip]
= **10.022**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.309[kip] - 0[kip] + 0[kip]
= **3.309**[kip]

Load condition :D14

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D15

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -21.748[kip] + 0[kip] + 0[kip]
= **-21.748**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --21.748[kip] - 0[kip] - 0[kip]
= **21.748**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D16

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 8.921[kip] - 0[kip] + 0[kip]
= **8.921**[kip]

Load condition :D17

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -21.748[kip] + 0[kip] + 0[kip]
= **-21.748**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --21.748[kip] - 0[kip] - 0[kip]
= **21.748**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.412[kip] - 0[kip] + 0[kip]
= **4.412**[kip]

Load condition :D18

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -21.748[kip] + 0[kip] + 0[kip]
= **-21.748**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --21.748[kip] - 0[kip] - 0[kip]
= **21.748**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 8.921[kip] - 0[kip] + 0[kip]
= **8.921**[kip]

Load condition :D19

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -21.748[kip] + 0[kip] + 0[kip]
= **-21.748**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --21.748[kip] - 0[kip] - 0[kip]
= **21.748**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 8.921[kip] - 0[kip] + 0[kip]
= **8.921**[kip]

Load condition :D20

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -21.748[kip] + 0[kip] + 0[kip]
= **-21.748**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --21.748[kip] - 0[kip] - 0[kip]
= **21.748**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 3.309[kip] - 0[kip] + 0[kip]

= **3.309**[kip]

Interface Right beam - column

Connection: Single plate

Demands

Description	Beam Ru [kip]	Beam Pu [kip]	Column Pu [kip]	Column Mu22 [kip*ft]	Column Mu33 [kip*ft]	Load type
DL	3.68	0.00	-2.57	0.00	0.00	Design
LL	4.51	0.00	0.00	0.00	0.00	Design
SL	0.00	0.00	6.17	0.00	0.00	Design
Wx	0.00	-10.02	0.00	0.00	0.00	Design
EQx	0.00	-21.75	0.00	0.00	0.00	Design
D1	5.15	0.00	-3.60	0.00	0.00	Design
D2	11.63	0.00	-3.09	0.00	0.00	Design
D3	4.41	0.00	0.00	0.00	0.00	Design
D4	11.63	0.00	0.00	0.00	0.00	Design
D5	4.41	0.00	6.78	0.00	0.00	Design
D6	4.41	-5.01	-3.09	0.00	0.00	Design
D7	8.92	0.00	6.78	0.00	0.00	Design
D8	4.41	-5.01	6.78	0.00	0.00	Design
D9	4.41	-10.02	-3.09	0.00	0.00	Design
D10	4.41	-10.02	0.00	0.00	0.00	Design
D11	8.92	-10.02	-3.09	0.00	0.00	Design
D12	8.92	-10.02	0.00	0.00	0.00	Design
D13	3.31	-10.02	-2.32	0.00	0.00	Design
D14	4.41	0.00	-1.86	0.00	0.00	Design
D15	4.41	-21.75	-3.09	0.00	0.00	Seismic
D16	8.92	0.00	-1.86	0.00	0.00	Design
D17	4.41	-21.75	-1.86	0.00	0.00	Seismic
D18	8.92	-21.75	-3.09	0.00	0.00	Seismic
D19	8.92	-21.75	-1.86	0.00	0.00	Seismic
D20	3.31	-21.75	-2.32	0.00	0.00	Seismic

Geometric Considerations

Dimensions	Unit	Value	Min.	Max.	Sta.	References
Shear plate						
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]	2.50	--	3.50	✔	p 10-102
Max. a = 3.4999999999999996 [in]						p 10-102
Minimum plate or beam web thickness	[in]	0.26	--	0.44	✔	Table 10-9
e = 1.25 [in], Max. tp = 0.4375 [in]						Table 10-9

Length	[in]	8.50	6.13	12.26	✔	p. 10-104
L_{min} = T/2						
= 12.26[in]/2						
= **6.13**[in]						p. 10-104
L_{max} = d - max(k_{Top}, d_{ct}) - max(k_{Bot}, d_{cb})						
= 13.9[in] - max(0.82[in], 0[in]) - max(0.82[in], 0[in])						
= **12.26**[in]						p. 10-49
Thickness, precludes a punching failure of the HSS...	[in]	0.31	--	--	✔	
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]	1.50	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	6.12	✔	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*0.255[in], 12 [in])						
= **6.12**[in]						Sec. J3.5
Beam						
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]	2.00	1.50	--	✔	p. 10-103
L_{emin} = 2*d						
= 2*0.75[in]						
= **1.5**[in]						p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	50.00	--	--	✔	
Yield stress to tensile stress ratio		0.81	--	--	✔	Table K2.1A
F_y/F_u = F_y/F_u						
= 50000[lb/in2]/62000[lb/in2]						
= **0.806**						Table K2.1A

Weld size	[1/16in]	4	4	--	✔	p. 10-87

w_{min} = (5/8)*t_p
= (5/8)*0.313[in]
= **0.195**[in] — p. 10-87

Weld length	[in]	8.50	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]	46.53	23.51	D18	**0.51**	Tables (7-1..14)

e = 1.25 [in], Max. tp
= 0.4375 [in] — Table 10-9

ϕR_n = ϕ*F_{nv}*A_b
= 0.75*54000[lb/in2]*0.442[in2]
= **17.901**[kip] — Eq. J3-1

ϕR_n = C*ϕR_n*BoltFactor
= 2.599*17.901[kip]*1
= **46.526**[kip] — Tables (7-1..14)

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Bolt bearing under shear load	[Kip]	35.77	8.92	D18	**0.25**	p. 7-18

e = 1.25 [in], Max. tp
= 0.4375 [in] — Table 10-9

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2)
= Max(0.0, 1.25[in] - 0.813[in]/2)
= **0.844**[in] — Sec. J3.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h)
= Max(0.0, 3[in] - 0.813[in])
= **2.188**[in] — Sec. J3.10

r_{n1} = min(k_1*l_c*t_p*F_u, k_2*d*t_p*F_u)
= min(1.2*0.844[in]*0.313[in]*58000[lb/in2], 2.4*0.75[in]*0.313[in]*58000[lb/in2])
= **18.352**[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*2.188[in]*0.313[in]*58000[lb/in2], 2.4*0.75[in]*0.313[in]*58000[lb/in2])
= **32.625**[kip] — Eq. J3-6

ϕR_n = ϕ*C*min(r_{n1}, r_{n2})
= 0.75*2.599*min(18.352[kip], 32.625[kip])
= **35.773**[kip] — p. 7-18

Shear yielding	[Kip]	57.38	8.92	D18	**0.16**	Eq. J4-3

$A_g = L_p*t_p$
= 8.5[in]*0.313[in]
= **2.656**[in2] Sec. D3-1

$\phi R_n = \phi*0.60*F_y*A_g$
= 1*0.60*36000[lb/in2]*2.656[in2]
= **57.375**[kip] Eq. J4-3

Shear rupture	[Kip]	47.92	8.92	D18	**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]
= **5.875**[in] DG4 Eq. 3-13

$A_{nv} = L_e*t_p$
= 5.875[in]*0.313[in]
= **1.836**[in2] Sec. J4-2

$\phi R_n = \phi*0.60*F_u*A_{nv}$
= 0.75*0.60*58000[lb/in2]*1.836[in2]
= **47.918**[kip] Eq. J4-4

Block shear	[Kip]	51.15	8.92	D18	**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

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$
= (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.313[in]
= **0.332**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$
= (1.25[in] + (3 - 1)*3[in])*0.313[in]
= **2.266**[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]
= **1.582**[in2] Sec. J4-3

IsStressUniform ⟶ **True**

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

$\phi R_n = \phi * \min(0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt}, 0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$
= 0.75*min(0.6*58000[lb/in2]*1.582[in2] + 1*58000[lb/in2]*0.332[in2], 0.6*36000[lb/in2]*2.266[in2] + 1*58000[lb/in2]*0.332[in2])
= **51.146**[kip] — Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	136.78	23.51	D18	**0.17**	Tables 8-4 .. 8-11

$\phi R_n = \phi * C * C_1 * D * L$
= 0.75*5.364[kip/in]*1*4*8.5[in]
= **136.785**[kip] — Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	58.16	8.92	D18	**0.15**	p. 7-18

e = 1.25 [in], Max. tp
= 0.4375 [in] — Table 10-9

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$
= Max(0.0, 3.95[in] - 0.813[in]/2)
= **3.544**[in] — Sec. J3.10

$L_{c\text{-}spa} = \text{Max}(0.0, s - d_h)$
= Max(0.0, 3[in] - 0.813[in])
= **2.188**[in] — Sec. J3.10

$r_{n1} = \min(k_1 * l_c * t_p * F_u, k_2 * d * t_p * F_u)$
= min(1.2*3.544[in]*0.255[in]*65000[lb/in2], 2.4*0.75[in]*0.255[in]*65000[lb/in2])
= **29.835**[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*2.188[in]*0.255[in]*65000[lb/in2], 2.4*0.75[in]*0.255[in]*65000[lb/in2])
= **29.835**[kip] — Eq. J3-6

$\phi R_n = \phi * C * \min(r_{n1}, r_{n2})$
= 0.75*2.599*min(29.835[kip], 29.835[kip])
= **58.158**[kip] — p. 7-18

Shear yielding	[Kip]	106.33	8.92	D18	**0.08**	Eq. J4-3

$A_g = L_p * t_p$
= 13.9[in]*0.255[in]
= **3.545**[in2] — Sec. D3-1

$\phi R_n = \phi * 0.60 * F_y * A_g$
= 1*0.60*50000[lb/in2]*3.545[in2]
= **106.335**[kip] — Eq. J4-3

Bolt bearing under axial load	[Kip]	67.13	0.00	D15	**0.00**	Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$
= Max(0.0, 2[in] - 0.813[in]/2)
= **1.594**[in] — Sec. J3.10

$\phi R_n = \phi*(min(k_1*L_{c-end}, k_2*d))*t_p*F_u*n_c$
= 0.75*(min(1.2*1.594[in], 2.4*0.75[in]))*0.255[in]*65000[lb/in2]*3
= **67.129**[kip] Eq. J3-6

Support

Welds rupture	[Kip/ft]	155.79	15.31	D18	0.10	p. 9-5

$R_n = 0.6*F_u*t_p$
= 0.6*62000[lb/in2]*0.349[in]
= **12.983**[kip/in] p. 9-5

$D_{min} = P/(\phi*C*C_1*L)$
= 23.507[kip]/(0.75*5.364[kip/in]*1*8.5[in])
= **0.687** 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*0.687/16 [in]
= **1.276**[kip/in] p. 9-5

Punching shear (shear rupture)	[Kip]	93.80	8.92	D18	0.10	p. 10-153

$R_u = \phi*(F_u*t*l_p^2)/(5*e)$
= 0.75*(62000[lb/in2]*0.349[in]*8.5[in]^2)/(5*2.5[in])
= **93.801**[kip] p. 10-153

HSS wall strength due out-of-plane transverse load	[Kip]	47.24	21.75	D15	0.46	p.9-16

$U_{HSS} = abs(P_r)/(A_g*F_c) + abs(M_r)/(S*F_c)$
= abs(-3.089[kip])/(6.18[in2]*50000[lb/in2]) + abs(0[kip*ft])/(8.7[in3]*50000[lb/in2])
= **0.009996** Eq. K1-6

$Q_f = (1 - U_{HSS}^2)^{0.5}$
= (1 - 0.009996^2)^0.5
= **1** Eq. K1-17

$\phi R_n = \phi*t_p^2*F_y*((a + b)*(4*(T*a*b/(a + b))^{0.5} + L)/(a*b))*Q_f/2.0$
= 1*0.349[in]^2*50000[lb/in2]*((2.344[in] + 2.344[in])*(4*(5[in]*2.344[in]*2.344[in]/(2.344[in] + 2.344[in]))^0.5 + 8.5[in])/(2.344[in]*2.344[in]))*1/2.0
= **47.243**[kip] p.9-16

Ratio **0.51**

Calculation of the interface forces

Load condition :DL

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.0868[kip] + 0[kip]
= **-0.0868**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.0868[kip] - 0[kip]
= **0.0868**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.0246[kip] + 0[kip]
= **-0.0246**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.151[kip] - -0.0683[kip] + 0[kip]
= **1.219**[kip]

Load condition :LL

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.026[kip] + 0[kip]
= **-0.026**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.026[kip] - 0[kip]
= **0.026**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.007357[kip] + 0[kip]
= **-0.007357**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.727[kip] - -0.0205[kip] + 0[kip]
= **1.747**[kip]

Load condition :SL

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + 0[kip] + 0[kip]
= **0**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - 0[kip] - 0[kip]
= **0**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= 0[kip] + 0[kip]
= **0**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 0.003[kip] - 0[kip] + 0[kip]
= **0.003**[kip]

Load condition :Wx

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.032[kip] + -7.743[kip] + 0[kip]
= **-7.775**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.032[kip] - -7.743[kip] - 0[kip]
= **7.775**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -2.193[kip] + 0[kip]
= **-2.193**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= -0.011[kip] - -6.096[kip] + 0[kip]
= **6.085**[kip]

Load condition :EQx

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.083[kip] + -16.799[kip] + 0[kip]
= **-16.882**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.083[kip] - -16.799[kip] - 0[kip]
= **16.882**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -4.757[kip] + 0[kip]
= **-4.757**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= -0.024[kip] - -13.225[kip] + 0[kip]
= **13.201**[kip]

Load condition :D1

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.122[kip] + 0[kip]
= **-0.122**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.122[kip] - 0[kip]
= **0.122**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.0344[kip] + 0[kip]
= **-0.0344**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.611[kip] - -0.0957[kip] + 0[kip]
= **1.707**[kip]

Load condition :D2

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.146[kip] + 0[kip]
= **-0.146**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.146[kip] - 0[kip]
= **0.146**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.0413[kip] + 0[kip]
= **-0.0413**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 4.144[kip] - -0.115[kip] + 0[kip]
= **4.259**[kip]

Load condition :D3

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + -0.104[kip] + 0[kip]

= **-0.104**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= -0[kip] - -0.104[kip] - 0[kip]

= **0.104**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= -0.0295[kip] + 0[kip]

= **-0.0295**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 1.383[kip] - -0.082[kip] + 0[kip]

= **1.465**[kip]

Load condition :D4

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + -0.146[kip] + 0[kip]

= **-0.146**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= -0[kip] - -0.146[kip] - 0[kip]

= **0.146**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= -0.0413[kip] + 0[kip]

= **-0.0413**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 4.146[kip] - -0.115[kip] + 0[kip]

= **4.261**[kip]

Load condition :D5

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= 0[kip] + -0.104[kip] + 0[kip]

= **-0.104**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$

= -0[kip] - -0.104[kip] - 0[kip]

= **0.104**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$

= -0.0295[kip] + 0[kip]

= **-0.0295**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$

= 1.386[kip] - -0.082[kip] + 0[kip]

= **1.468**[kip]

Load condition :D6

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$

= -0.016[kip] + -3.976[kip] + 0[kip]

= **-3.992**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.016[kip] - -3.976[kip] - 0[kip]
= **3.992**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -1.126[kip] + 0[kip]
= **-1.126**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.376[kip] - -3.13[kip] + 0[kip]
= **4.505**[kip]

Load condition :D7

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.13[kip] + 0[kip]
= **-0.13**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.13[kip] - 0[kip]
= **0.13**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.0368[kip] + 0[kip]
= **-0.0368**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.113[kip] - -0.102[kip] + 0[kip]
= **3.215**[kip]

Load condition :D8

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.016[kip] + -3.976[kip] + 0[kip]
= **-3.992**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.016[kip] - -3.976[kip] - 0[kip]
= **3.992**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -1.126[kip] + 0[kip]
= **-1.126**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.381[kip] - -3.13[kip] + 0[kip]
= **4.51**[kip]

Load condition :D9

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.032[kip] + -7.847[kip] + 0[kip]
= **-7.879**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.032[kip] - -7.847[kip] - 0[kip]
= **7.879**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -2.222[kip] + 0[kip]
= **-2.222**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.37[kip] - -6.178[kip] + 0[kip]
= **7.548**[kip]

Load condition :D10

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.032[kip] + -7.847[kip] + 0[kip]
= **-7.879**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.032[kip] - -7.847[kip] - 0[kip]
= **7.879**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -2.222[kip] + 0[kip]
= **-2.222**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.372[kip] - -6.178[kip] + 0[kip]
= **7.549**[kip]

Load condition :D11

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.032[kip] + -7.873[kip] + 0[kip]
= **-7.905**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.032[kip] - -7.873[kip] - 0[kip]
= **7.905**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -2.229[kip] + 0[kip]
= **-2.229**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.097[kip] - -6.198[kip] + 0[kip]
= **9.295**[kip]

Load condition :D12

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.032[kip] + -7.873[kip] + 0[kip]
= **-7.905**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.032[kip] - -7.873[kip] - 0[kip]
= **7.905**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -2.229[kip] + 0[kip]
= **-2.229**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.099[kip] - -6.198[kip] + 0[kip]
= **9.297**[kip]

Load condition :D13

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.032[kip] + -7.821[kip] + 0[kip]
= **-7.853**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.032[kip] - -7.821[kip] - 0[kip]
= **7.853**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -2.215[kip] + 0[kip]
= **-2.215**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.025[kip] - -6.157[kip] + 0[kip]
= **7.182**[kip]

Load condition :D14

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.104[kip] + 0[kip]
= **-0.104**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.104[kip] - 0[kip]
= **0.104**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.0295[kip] + 0[kip]
= **-0.0295**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.382[kip] - -0.082[kip] + 0[kip]
= **1.464**[kip]

Load condition :D15

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.083[kip] + -16.903[kip] + 0[kip]
= **-16.986**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.083[kip] - -16.903[kip] - 0[kip]
= **16.986**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -4.787[kip] + 0[kip]
= **-4.787**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.357[kip] - -13.307[kip] + 0[kip]
= **14.664**[kip]

Load condition :D16

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= 0[kip] + -0.13[kip] + 0[kip]
= **-0.13**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= -0[kip] - -0.13[kip] - 0[kip]
= **0.13**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -0.0368[kip] + 0[kip]
= **-0.0368**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.109[kip] - -0.102[kip] + 0[kip]
= **3.211**[kip]

Load condition :D17

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.083[kip] + -16.903[kip] + 0[kip]
= **-16.986**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.083[kip] - -16.903[kip] - 0[kip]
= **16.986**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -4.787[kip] + 0[kip]
= **-4.787**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.358[kip] - -13.307[kip] + 0[kip]
= **14.665**[kip]

Load condition :D18

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.083[kip] + -16.929[kip] + 0[kip]
= **-17.012**[kip]

$\Sigma F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.083[kip] - -16.929[kip] - 0[kip]
= **17.012**[kip]

$\Sigma F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -4.794[kip] + 0[kip]
= **-4.794**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.084[kip] - -13.328[kip] + 0[kip]
= **16.412**[kip]

Load condition :D19

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.083[kip] + -16.929[kip] + 0[kip]
= **-17.012**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.083[kip] - -16.929[kip] - 0[kip]
= **17.012**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -4.794[kip] + 0[kip]
= **-4.794**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 3.085[kip] - -13.328[kip] + 0[kip]
= **16.412**[kip]

Load condition :D20

$H_{BeamToColumn} = H_{Beam} + H_{TopBeam} + H_{BotBeam}$
= -0.083[kip] + -16.877[kip] + 0[kip]
= **-16.96**[kip]

$\sum F_{AtBeam} = -H_{Beam} - H_{TopBeam} - H_{BotBeam}$
= --0.083[kip] - -16.877[kip] - 0[kip]
= **16.96**[kip]

$\sum F_{AtColumn} = H_{TopCol} + H_{BotCol}$
= -4.779[kip] + 0[kip]
= **-4.779**[kip]

$V_{BeamToColumn} = V_{Beam} - V_{Top} + V_{Bot}$
= 1.012[kip] - -13.287[kip] + 0[kip]
= **14.298**[kip]

Interface Left beam - column

Connection: Single plate

Demands

	Beam		Column			
Description	**Ru** [kip]	**Pu** [kip]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	**Load type**
DL	1.22	-0.09	-2.57	0.00	0.00	Design
LL	1.75	-0.03	0.00	0.00	0.00	Design
SL	0.00	0.00	6.17	0.00	0.00	Design
Wx	6.08	-7.77	0.00	0.00	0.00	Design
EQx	13.20	-16.88	0.00	0.00	0.00	Design
D1	1.71	-0.12	-3.60	0.00	0.00	Design
D2	4.26	-0.15	-3.09	0.00	0.00	Design
D3	1.46	-0.10	0.00	0.00	0.00	Design
D4	4.26	-0.15	0.00	0.00	0.00	Design
D5	1.47	-0.10	6.78	0.00	0.00	Design
D6	4.51	-3.99	-3.09	0.00	0.00	Design
D7	3.22	-0.13	6.78	0.00	0.00	Design
D8	4.51	-3.99	6.78	0.00	0.00	Design
D9	7.55	-7.88	-3.09	0.00	0.00	Design
D10	7.55	-7.88	0.00	0.00	0.00	Design
D11	9.30	-7.90	-3.09	0.00	0.00	Design
D12	9.30	-7.90	0.00	0.00	0.00	Design
D13	7.18	-7.85	-2.32	0.00	0.00	Design
D14	1.46	-0.10	-1.86	0.00	0.00	Design
D15	14.66	-16.99	-3.09	0.00	0.00	Seismic

D16	3.21	-0.13	-1.86	0.00	0.00	Design
D17	14.66	-16.99	-1.86	0.00	0.00	Seismic
D18	16.41	-17.01	-3.09	0.00	0.00	Seismic
D19	16.41	-17.01	-1.86	0.00	0.00	Seismic
D20	14.30	-16.96	-2.32	0.00	0.00	Seismic

Geometric Considerations

Dimensions	Unit	Value	Min.	Max.	Sta.	References
Shear plate						
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]	2.50	--	3.50	✔	p 10-102
Max. a = 3.4999999999999996 [in]						p 10-102
Minimum plate or beam web thickness	[in]	0.26	--	0.44	✔	Table 10-9
e = 1.25 [in], Max. tp = 0.4375 [in]						Table 10-9
Length	[in]	8.50	6.13	12.26	✔	p. 10-104
L_{min} = T/2 = 12.26[in]/2 = **6.13**[in]						p. 10-104
L_{max} = d - max(k_{Top}, d_{ct}) - max(k_{Bot}, d_{cb}) = 13.9[in] - max(0.82[in], 0[in]) - max(0.82[in], 0[in]) = **12.26**[in]						p. 10-49
Thickness, precludes a punching failure of the HSS...	[in]	0.31	--	--	✔	
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]	1.50	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	6.12	✔	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*0.255[in], 12 [in]) = **6.12**[in]						Sec. J3.5

Beam						
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]	2.00	1.50	--	✔	p. 10-103
L_{emin} = 2*d						
= 2*0.75[in]						
= **1.5**[in]						p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	50.00	--	--	✔	
Yield stress to tensile stress ratio		0.81	--	--	✔	Table K2.1A
$F_y/F_u = F_y/F_u$						
= 50000[lb/in2]/62000[lb/in2]						
= **0.806**						Table K2.1A
Weld size	[1/16in]	4	4	--	✔	p. 10-87
$w_{min} = (5/8)*t_p$						
= (5/8)*0.313[in]						
= **0.195**[in]						p. 10-87
Weld length	[in]	8.50	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]	45.42	23.64	D19	**0.52**	Tables (7-1..14)
e = 1.25 [in], Max. tp						
= 0.4375 [in]						Table 10-9
$\phi R_n = \phi * F_{nv} * A_b$						
= 0.75*54000[lb/in2]*0.442[in2]						
= **17.901**[kip]						Eq. J3-1
$\phi R_n = C * \phi R_n$ *BoltFactor						
= 2.537*17.901[kip]*1						
= **45.419**[kip]						Tables (7-1..14)
Bolt bearing under shear load	[Kip]	34.92	16.41	D19	**0.47**	p. 7-18
e = 1.25 [in], Max. tp						
= 0.4375 [in]						Table 10-9

$L_{c\text{-}end}$ = Max(0.0, L_e - d_h/2)
= Max(0.0, 1.25[in] - 0.813[in]/2)
= **0.844**[in] Sec. J3.10

$L_{c\text{-}spa}$ = Max(0.0, s - d_h)
= Max(0.0, 3[in] - 0.813[in])
= **2.188**[in] Sec. J3.10

r_{n1} = min(k_1*l_c*t_p*F_u, k_2*d*t_p*F_u)
= min(1.2*0.844[in]*0.313[in]*58000[lb/in2], 2.4*0.75[in]*0.313[in]*58000[lb/in2])
= **18.352**[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*2.188[in]*0.313[in]*58000[lb/in2], 2.4*0.75[in]*0.313[in]*58000[lb/in2])
= **32.625**[kip] Eq. J3-6

ϕR_n = ϕ*C*min(r_{n1}, r_{n2})
= 0.75*2.537*min(18.352[kip], 32.625[kip])
= **34.922**[kip] p. 7-18

Shear yielding	[Kip]	57.38	16.41	D19	0.29	Eq. J4-3

A_g = L_p*t_p
= 8.5[in]*0.313[in]
= **2.656**[in2] Sec. D3-1

ϕR_n = ϕ*0.60*F_y*A_g
= 1*0.60*36000[lb/in2]*2.656[in2]
= **57.375**[kip] Eq. J4-3

Shear rupture	[Kip]	47.92	16.41	D19	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
= 8.5[in] - 3*0.875[in]
= **5.875**[in] DG4 Eq. 3-13

A_{nv} = L_e*t_p
= 5.875[in]*0.313[in]
= **1.836**[in2] Sec. J4-2

ϕR_n = ϕ*0.60*F_u*A_{nv}
= 0.75*0.60*58000[lb/in2]*1.836[in2]
= **47.918**[kip] Eq. J4-4

Block shear	[Kip]	51.15	16.41	D19	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

$A_{nt} = (L_{eh} + (n_c - 1)*spa - (n_c - 0.5)*dh_h)*t_p$
= (1.5[in] + (1 - 1)*3[in] - (1 - 0.5)*0.875[in])*0.313[in]
= **0.332**[in2] Sec. J4-3

$A_{gv} = (L_{ev} + (n - 1)*s)*t_p$
= (1.25[in] + (3 - 1)*3[in])*0.313[in]
= **2.266**[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]
= **1.582**[in2] Sec. J4-3

IsStressUniform → **True**

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

$\phi R_n = \phi*\min(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt}, 0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$
= 0.75*min(0.6*58000[lb/in2]*1.582[in2] + 1*58000[lb/in2]*0.332[in2], 0.6*36000[lb/in2]*2.266[in2] + 1*58000[lb/in2]*0.332[in2])
= **51.146**[kip] Eq. J4-5

Plate (support side)

Weld capacity	[Kip]	123.56	23.64	D19	0.19	Tables 8-4 .. 8-11

$\phi R_n = \phi*C*C_1*D*L$
= 0.75*4.846[kip/in]*1*4*8.5[in]
= **123.562**[kip] Tables 8-4 .. 8-11

Beam

Bolt bearing under shear load	[Kip]	56.77	16.41	D19	0.29	p. 7-18

e = 1.25 [in], Max. tp
= 0.4375 [in] Table 10-9

$L_{c\text{-}end} = Max(0.0, L_e - d_h/2)$
= Max(0.0, 3.95[in] - 0.813[in]/2)
= **3.544**[in] Sec. J3.10

$L_{c\text{-}spa} = Max(0.0, s - d_h)$
= Max(0.0, 3[in] - 0.813[in])
= **2.188**[in] Sec. J3.10

$r_{n1} = \min(k_1*l_c*t_p*F_u, k_2*d*t_p*F_u)$
= min(1.2*3.544[in]*0.255[in]*65000[lb/in2], 2.4*0.75[in]*0.255[in]*65000[lb/in2])
= **29.835**[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*2.188[in]*0.255[in]*65000[lb/in2], 2.4*0.75[in]*0.255[in]*65000[lb/in2])
= **29.835**[kip] Eq. J3-6

$\phi R_n = \phi * C * \min(r_{n1}, r_{n2})$

= 0.75*2.537*min(29.835[kip], 29.835[kip])

= **56.774**[kip] p. 7-18

Shear yielding [Kip] 106.33 16.41 D19 **0.15** Eq. J4-3

$A_g = L_p * t_p$

= 13.9[in]*0.255[in]

= **3.545**[in2] Sec. D3-1

$\phi R_n = \phi * 0.60 * F_y * A_g$

= 1*0.60*50000[lb/in2]*3.545[in2]

= **106.335**[kip] Eq. J4-3

Bolt bearing under axial load [Kip] 67.13 0.00 D15 **0.00** Eq. J3-6

$L_{c\text{-}end} = \text{Max}(0.0, L_e - d_h/2)$

= Max(0.0, 2[in] - 0.813[in]/2)

= **1.594**[in] Sec. J3.10

$\phi R_n = \phi * (\min(k_1 * L_{c\text{-}end}, k_2 * d)) * t_p * F_u * n_c$

= 0.75*(min(1.2*1.594[in], 2.4*0.75[in]))*0.255[in]*65000[lb/in2]*3

= **67.129**[kip] Eq. J3-6

Support

Welds rupture [Kip/ft] 155.79 17.04 D19 **0.11** p. 9-5

$R_n = 0.6 * F_u * t_p$

= 0.6*62000[lb/in2]*0.349[in]

= **12.983**[kip/in] p. 9-5

$D_{min} = P/(\phi * C * C_1 * L)$

= 23.639[kip]/(0.75*4.846[kip/in]*1*8.5[in])

= **0.765** 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*0.765/16 [in]

= **1.42**[kip/in] p. 9-5

Punching shear (shear rupture) [Kip] 93.80 16.41 D19 **0.17** p. 10-153

$R_u = \phi * (F_u * t * l_p^2)/(5 * e)$

= 0.75*(62000[lb/in2]*0.349[in]*8.5$[in]^2$)/(5*2.5[in])

= **93.801**[kip] p. 10-153

HSS wall strength due out-of-plane transverse load [Kip] 47.24 17.01 D18 **0.36** p.9-16

$U_{HSS} = \text{abs}(P_r)/(A_g * F_c) + \text{abs}(M_r)/(S * F_c)$

= abs(-3.089[kip])/(6.18[in2]*50000[lb/in2]) + abs(0[kip*ft])/(8.7[in3]*50000[lb/in2])

= **0.009996** Eq. K1-6

$Q_f = (1 - U_{HSS}^2)^{0.5}$

= $(1 - 0.009996^2)^{0.5}$

= **1** Eq. K1-17

$\phi R_n = \phi * t_p^2 * F_y * ((a + b)*(4*(T*a*b/(a + b))^{0.5} + L)/(a*b))*Q_f/2.0$
$= 1*0.349[in]^2*50000[lb/in2]*((2.344[in] + 2.344[in])*(4*(5[in]*2.344[in]*2.344[in]/(2.344[in] + 2.344[in]))^{0.5} + 8.5[in])/(2.344[in]*2.344[in]))*1/2.0$
= **47.243**[kip] p.9-16

Ratio	**0.52**
Global critical strength ratio	**0.52**

Notes

The plate is designed with the conventional configuration criteria.

Notation

a: Plate depth
A_b: Nominal bolt area
A_g: Gross area
A_{gt}: Gross area subject to tension
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
b: Plate, connector or member width
B: Width of a rectangular HSS
b: Clear distance between the webs less the inside corner radius on each side
ϕR_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
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: Eccentricity, taken as the distance from the HSS wall to the center of gravity of the bolt group
e_c: One half the depth of the column
F_c: Available stress
F_{cr}: Critical stress, flexural stress buckling
F_e: Elastic critical buckling stress
F_{EXX}: Electrode classification number
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_{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_{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_y: Specified minimum yield stress
F_y/F_u: Yield stress to tensile stress ratio
F_{yw}: Specified minimum yield stress of web
h: Clear distance between flanges
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
$H_{BotBeam}$: Bottom horizontal component of the gusset forces at beam
H_{BotCol}: Bottom horizontal component of the gusset forces at column
H_c: Required axial force on the column to gusset connection
$H_{TopBeam}$: Top horizontal component of the gusset forces at beam
H_{TopCol}: Top horizontal component of the gusset forces at column
HasWeldsOnBothSides: Has welds on both sides
Int: Interaction value
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_{Bot}: Outside corner radius of the bottom flange
k: Distance from outer face of flange to the web toe of fillet
k_{Top}: Outside corner radius of the top flange
l: Length
L: Length
l_b: Bearing 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_p: Length of the single-plate shear connection
L: Length of weld
λ_b: Brace Slenderness
λ_{max}: Maximum slenderness
λ_{md}: Limiting Width-Thickness ratio (moderately ductile)
λ: Width-thickness ratio
M_b: Required moment on the beam to gusset connection
M_c: Required moment on the column to gusset connection
M_{cs}: Available flexural strength
M_r: Required flexural strength in chord
M_r: Required flexural strength
M_{ub}: Moment applied to the interface
e_{dmin}: Minimum edge distance
n: Bolts rows number
N: Bearing length
n_c: Number of bolt columns
N_{eq}: Equivalent normal force
N_{walls}: Number of walls
P: Required axial force
P_c: Available axial compressive strength

P_r: Required axial stress
P_r: Required axial strength
ϕ: Strength reduction factor
ϕ: Design factors
ϕF_n: Design or allowable tension/shear yielding stress
ϕP_n: Design or allowable strength
ϕR_n: Design or allowable strength
Q: Prying action coefficient
Q_f: Chord stress interaction parameter
r: Radius of gyration
R_n: Nominal strength
r_{n1}: Nominal strength of one bolt
r_{n2}: Nominal strength of one bolt
R_u: Required strength
R_u: Required strength
r: Uniform force method parameter
R_y: Ratio of the expected yield stress to the specified minimum yield stress
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-spa}: Distance between adjacent holes edges
t_p: Thickness of the connected material
T: Clear distance between web fillets
t: Design wall thickness of HSS member
t_f: Thickness of the loaded flange
t: The weld effective throat
t: Limit wall thickness for the HSS support
t_p: Plate thickness
t_{pmax}: Maximum plate thickness
t_w: Web thickness
$\tan\theta$: Tangent of the brace with the vertical angle
U_{bs}: Stress index
U_{HSS}: Utilization ratio
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
V_{ub}: Shear applied to the interface
w_{max}: Maximum weld size required
w_{min}: Minimum weld size required
w_{min}: Minimum weld size required
w: Weld size
Z: Plastic modulus
ΣF_{AtBeam}: Beam to column total horizontal force equilibrium at beam
$\Sigma F_{AtColumn}$: Beam to column total horizontal force equilibrium at column
A_w: Area of web
C_v: Shear coefficient
F_y: Yield stress of steel
ϕ: Design factors
ϕV_n: Member design shear strength

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