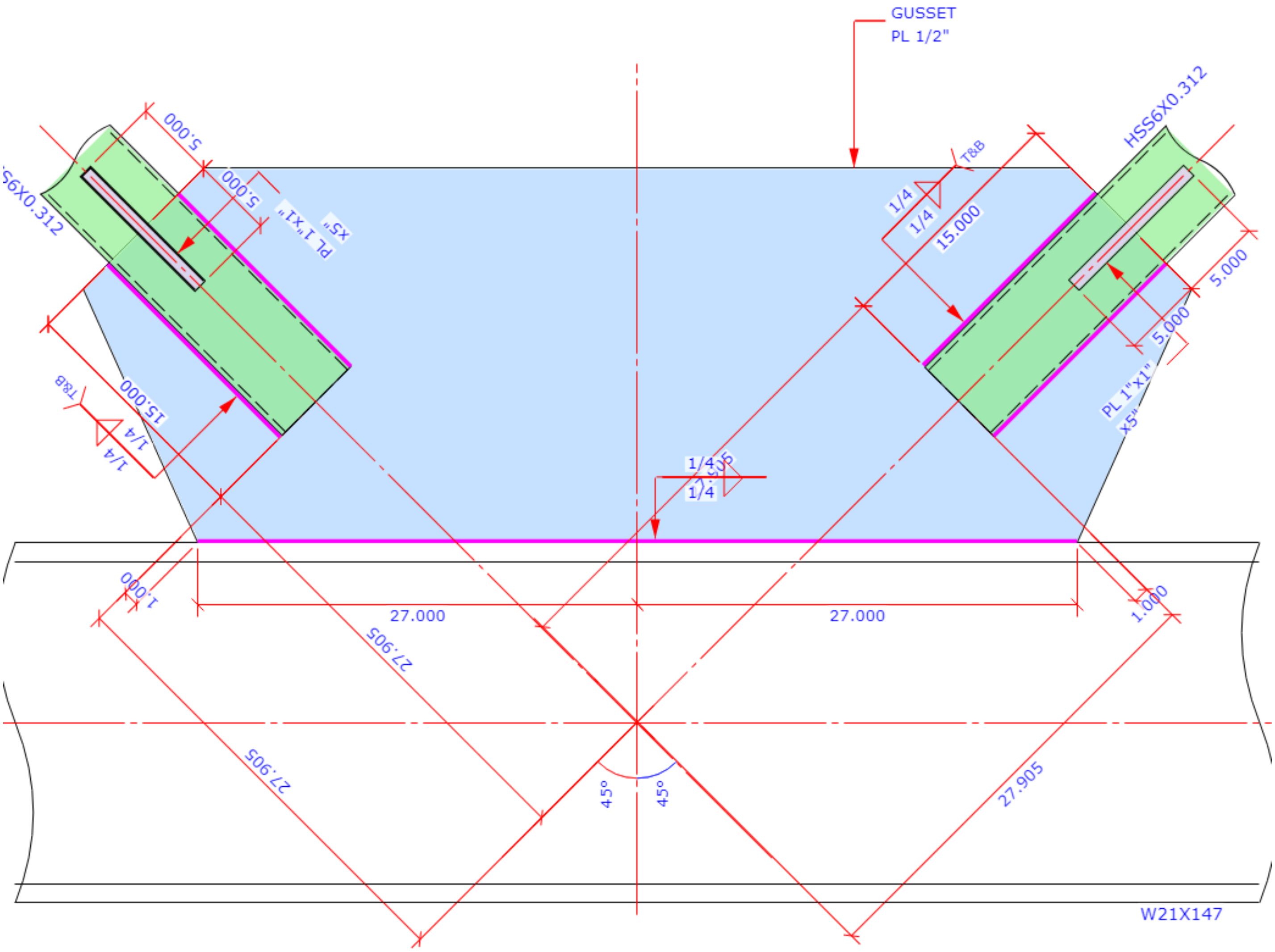
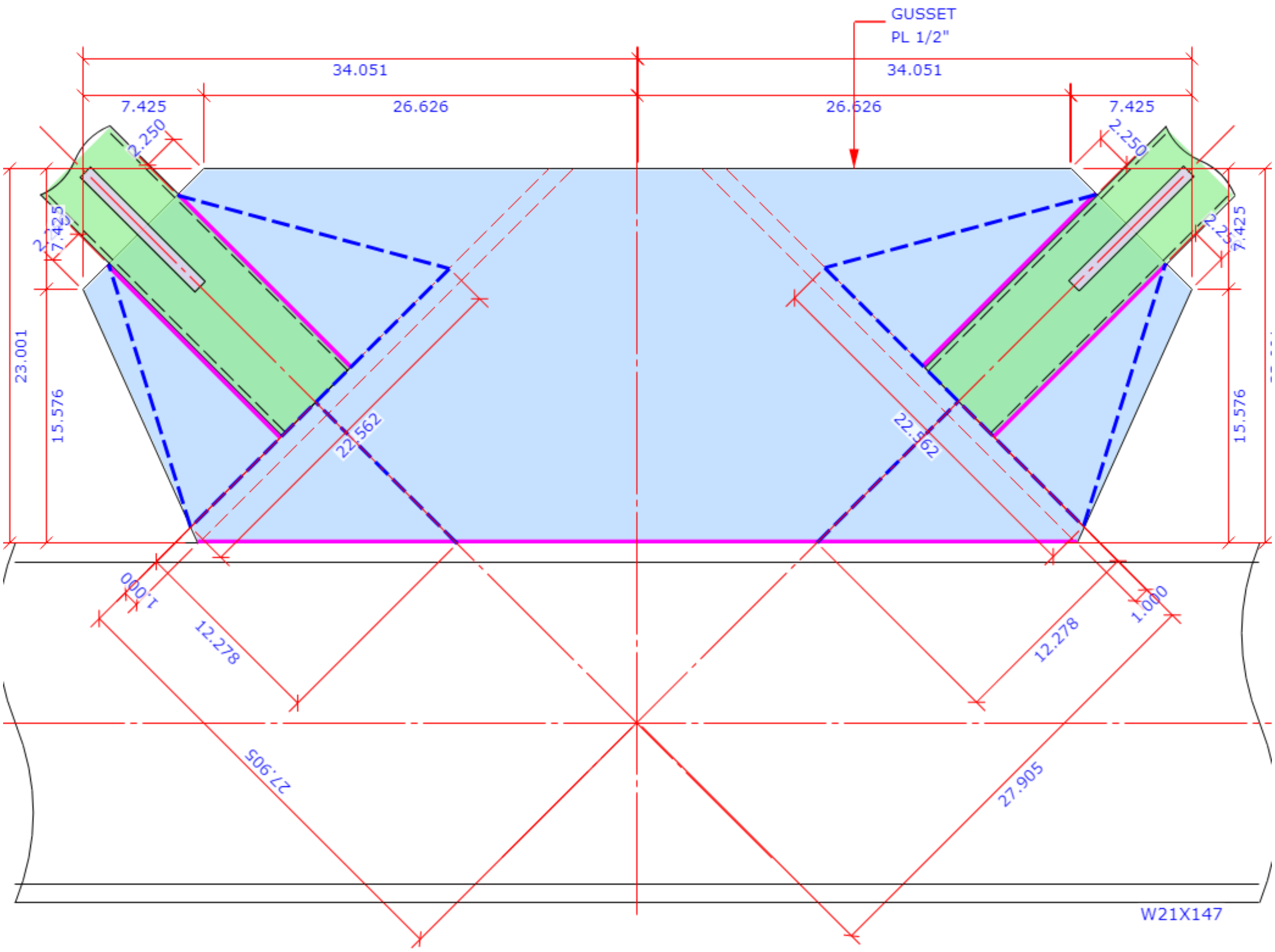
Sketch	Vertical Brace Connection	Code=AISC 360-16 LRFD




GUSSET
PL 1/2"
34.051
34.051
7.425
26.626
26.626
7.425
2.250
2.250
7.425
7.425
23.001
15.576
15.576
22.562
22.562
1.000
1.000
12.278
12.278
27.905
27.905
W21X147

Result Summary - Overall Chevron Brace Connection Code=AISC 360-16 LRFD

Result Summary - Overall geometries & weld limitations = **PASS** limit states max ratio = **1.03** **FAIL**

Seismic - SCBF Load Case LC1 & LC2

Right Brace - Brace to Gusset	geometries & weld limitations =	**PASS**	limit states max ratio = **0.93**	**PASS**
Left Brace - Brace to Gusset	geometries & weld limitations =	**PASS**	limit states max ratio = **0.93**	**PASS**
Gusset to Beam	geometries & weld limitations =	**PASS**	limit states max ratio = **1.03**	**FAIL**

Seismic - SCBF Load Case LC3 & LC4

Gusset to Beam	geometries & weld limitations =	**PASS**	limit states max ratio = **0.90**	**PASS**

Seismic Calculation Brace Seismic System = SCBF Code=AISC 360-16 LRFD

Seismic Brace Axial Forces Calc & Design Cases Summary

Right Brace Section Properties & Member Data

Brace sect HSS6X0.312 Grade = A500 Gr.C Round $F_y = 46.0$ [ksi]

Ratio of expected Fy to specified min Fy $R_y = 1.30$ AISC 341-16 Table A3.1

$A_g = 5.220$ [in^2] $r_y = 2.021$ [in]

$E = 29000$ [ksi]

Brace member length & effective length factor K $L = 144.0$ [in] $K = 1.00$

Right Brace Seismic Design Force in Tension

Brace expected yield strength in tension $P_{et} = R_y F_y A_g$ = 312.2 [kips] AISC 341-16 F2.6c (1)

Right Brace seismic design force in tension $P_{s\_t} = P_{et}$ = **-312.2** [kips] AISC 341-16 F2.6c (1)

Right Brace Seismic Design Force in Compression

Member length L & effective length factor K $L = 144.0$ [in] $K = 1.00$

Member radius of gyration & elastic modulus $r = 2.021$ [in] $E = 29000$ [ksi]

Member slenderness ratio $KL/r = K \times L \ / \ r$ = 71.25

Elastic buckling stress $F_e = \dfrac{\pi^2 E}{(KL/r)^2}$ = 56.38 [ksi] AISC 15th Eq E3-4

when $\dfrac{KL}{r} \le 4.71 \left(\dfrac{E}{R_y F_y} \right)^{0.5} = 103.72$ AISC 15th E3

Critical stress $F_{cr} = 0.658^{(R_y F_y / F_e)} R_y F_y$ = 38.36 [ksi] AISC 15th Eq E3-2

Brace expected yield strength in compression $P_{ec} = \min(R_y F_y A_g, 1.14 F_{cr} A_g)$ = 228.3 [kips] AISC 341-16 F2.3

Brace force in compression P_c = from user input in load section = 0.0 [kips]

Right Brace seismic design force in compression	$P_{s\_ci} = P_{ec}$	= **228.3**	[kips]	AISC 341-16 F2.6c (2)
Right Brace seismic design force in compression - post-buckling	$P_{s\_cii} = 0.3 \times P_{ec}$	= **68.5**	[kips]	AISC 341-16 F2.3 (ii)

Left Brace Section Properties & Member Data

Brace sect HSS6X0.312	Grade = A500 Gr.C Round	F_y = 46.0	[ksi]	
Ratio of expected Fy to specified min Fy	R_y = 1.30			AISC 341-16 Table A3.1
	A_g = 5.220 [in^2]	r_y = 2.021	[in]	
	E = 29000 [ksi]			
Brace member length & effective length factor K	L = 144.0 [in]	K = 1.00		

Left Brace Seismic Design Force in Tension

Brace expected yield strength in tension	$P_{et} = R_y F_y A_g$	= 312.2	[kips]	AISC 341-16 F2.6c (1)
Left Brace seismic design force in tension	$P_{s\_t} = P_{et}$	= **-312.2**	[kips]	AISC 341-16 F2.6c (1)

Left Brace Seismic Design Force in Compression

Member length L & effective length factor K	L = 144.0 [in]	K = 1.00		
Member radius of gyration & elastic modulus	r = 2.021 [in]	E = 29000	[ksi]	
Member slenderness ratio	KL/r = K x L / r	= 71.25		
Elastic buckling stress	$F_e = \dfrac{\pi^2 E}{(KL/r)^2}$	= 56.38	[ksi]	AISC 15th Eq E3-4
	when $\dfrac{KL}{r} \le 4.71 \left(\dfrac{E}{R_y F_y}\right)^{0.5}$ = 103.72			AISC 15th E3
Critical stress	$F_{cr} = 0.658^{(R_y F_y / F_e)} R_y F_y$	= 38.36	[ksi]	AISC 15th Eq E3-2
Brace expected yield strength in compression	$P_{ec} = \min(R_y F_y A_g, 1.14 F_{cr} A_g)$	= 228.3	[kips]	AISC 341-16 F2.3
Brace force in compression	P_c = from user input in load section	= 0.0	[kips]	
Left Brace seismic design force in compression	$P_{s\_ci} = P_{ec}$	= **228.3**	[kips]	AISC 341-16 F2.6c (2)
Left Brace seismic design force in compression - post-buckling	$P_{s\_cii} = 0.3 \times P_{ec}$	= **68.5**	[kips]	AISC 341-16 F2.3 (ii)

Brace Axial Force Design Cases Summary

Refer to AISC 341-16 F2.3(i), LC1 & LC2 are the load cases in which all braces are assumed to resist forces corresponding to their expected strength in tension P_{s_t} or in compression P_{s_ci}

F2.3(ii), LC3 & LC4 are the load cases in which all braces are assumed to resist forces corresponding to their expected strength in tension P_{s_t} and all braces in compression are assumed to resist their expected compressive post-buckling strength P_{s_cii}

LC1	Right Brace P_{s_t} =-312.2 kips (T)	Left Brace P_{s_ci} =228.3 kips (C)		AISC 341-16 F2.3(i)
LC2	Right Brace P_{s_ci} =228.3 kips (C)	Left Brace P_{s_t} =-312.2 kips (T)		
LC3	Right Brace P_{s_t} =-312.2 kips (T)	Left Brace P_{s_cii} =68.5 kips (C)	post-buckling	AISC 341-16 F2.3(ii)
LC4	Right Brace P =68.5 kips (C)	Left Brace P =-312.2 kips (T)	post-buckling	

LC1 Right Brace P_{s_cII} = 68.5 kips (C) Left Brace P_{s_t} = 312.2 kips (T) post-buckling

Seismic - SCBF LC1 & LC2 Gusset Interface Forces Calc

Brace Axial Force LC1

Refer to AISC DG29 Fig. 4-5 ~ Fig. 4-7 for all charts and definitions of variables and symbols shown in calculation below

Right brace axial force	P_1 = from seismic brace force calc	= -312.2	[kips]	in tension
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
	H_1 = -220.8 [kips]	V_1 = -220.8	[kips]	
Left brace axial force	P_2 = from seismic brace force calc	= 228.3	[kips]	in compression
Left brace to hor line angle	θ_2 = from user input	= 45.0	[°]	
	H_2 = 161.4 [kips]	V_2 = 161.4	[kips]	
	L_1 = 27.000 [in]	L_2 = 27.000	[in]	
	$L = L_1 + L_2$	= 54.000	[in]	
	$\Delta = (L_2 - L_1)/2$	= 0.000	[in]	
	e = 11.050 [in]	h = 23.001	[in]	
	M_1 = -203.28 [kip-ft]	M_2 = -148.65	[kip-ft]	

Forces on Section a-a AISC DG29 Fig. 4-6

Shear	$V = H_1 - H_2$	= **-382.2**	[kips]	
Axial	$N = V_1 + V_2$	= **-59.3**	[kips]	in tension
Moment	$M = M_1 + M_2$	= **-351.93**	[kip-ft]	

Forces on Section b-b AISC DG29 Fig. 4-7

Shear
$$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$$
= **34.7** [kips]

Axial
$$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$$
= **-29.7** [kips] in tension

Moment
$$M' = \frac{L}{8}(V_1 + V_2) + \frac{h}{4}(H_1 - H_2) + \frac{M}{2} - V_1\Delta - H_1\left(e + \frac{h}{2}\right)$$
= **22.37** [kip-ft]

Brace Axial Force LC2

Refer to AISC DG29 Fig. 4-5 ~ Fig. 4-7 for all charts and definitions of variables and symbols shown in calculation below

Right brace axial force	P_1 = from seismic brace force calc	= 228.3	[kips]	in compression
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
	H_1 = 161.4 [kips]	V_1 = 161.4	[kips]	
Left brace axial force	P_2 = from seismic brace force calc	= -312.2	[kips]	in tension
Left brace to hor line angle	θ_2 = from user input	= 45.0	[°]	
	H_2 = -220.8 [kips]	V_2 = -220.8	[kips]	
	L_1 = 27.000 [in]	L_2 = 27.000	[in]	
	$L = L_1 + L_2$	= 54.000	[in]	
	$\Delta = (L_2 - L_1)/2$	= 0.000	[in]	
	e = 11.050 [in]	h = 23.001	[in]	

e = 11.050 [in] h = 23.001 [in]

M_1 = 148.65 [kip-ft] M_2 = 203.28 [kip-ft]

Forces on Section a-a AISC DG29 Fig. 4-6

Shear	$V = H_1 - H_2$	= **382.2**	[kips]	
Axial	$N = V_1 + V_2$	= **-59.3**	[kips]	in tension
Moment	$M = M_1 + M_2$	= **351.93**	[kip-ft]	

Forces on Section b-b AISC DG29 Fig. 4-7

Shear	$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$	= **-34.7**	[kips]	
Axial	$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$	= **-29.7**	[kips]	in tension
Moment	$M' = \frac{L}{8}(V_1+V_2) + \frac{h}{4}(H_1-H_2) + \frac{M}{2} - V_1\Delta - H_1(e + \frac{h}{2})$	= **22.37**	[kip-ft]	

Right Brace - Brace to Gusset Sect=HSS 6 x 0.312 P_1 =-312.2 kips (T) P_2 =228.3 kips (C) Code=AISC 360-16 LRFD

Result Summary geometries & weld limitations = **PASS** limit states max ratio = **0.93** **PASS**

Seismic SCBF Brace Highly Ductile Section Check **PASS**

HSS Section Limiting Width-to-Thickness Ratio Check

Check HSS section limiting width-to-thickness ratio for HSS wall in compression as Highly Ductile section per AISC Seismic Design Manual 3rd Ed Table 1-D — AISC SDM 3rd Table 1-D

CHS sect HSS6X0.312	D = 6.000 [in]	t = 0.291	[in]	
HSS sect HSS6X0.312	F_y = A500 Gr.C Round	= 46.0	[ksi]	
	E = 29000 [ksi]			
Ratio of expected Fy to specified min Fy	R_y = 1.30			AISC 341-16 Table A3.1
CHS width-to-thickness ratio limit	$\lambda_{hd} = 0.053 \frac{E}{R_y F_y}$	= **25.70**		AISC SDM 3rd Table 1-D
CHS width-to-thickness ratio actual	D/t = D/t	= **20.62**		
		$\le \lambda_{hd}$	OK	

Brace Slot Effective Net Area Check				**PASS**
HSS With Reinforcing Plates Effective Net Area				
CHS sect HSS6X0.312	D = 6.000 [in]	t = 0.291	[in]	
	A_g = 5.220 [in^2]			
Gusset plate thickness	t_{gp} = from user input	= 0.500	[in]	
HSS cut slot width	$w = t_{gp}$ + 1/8"	= 0.625	[in]	
HSS brace net area	$A_{nb} = A_g - 2\ w\ t$	= 4.856	[in^2]	
Reinforcing plate	w_r = 1.000 [in]	t_r = 1.000	[in]	
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.000	[in^2]	
CHS 1/2 net area $A_1 = 0.5A_{nb}$	A_1 = 2.428 [in^2]	r_1 = 1.817	[in]	
Reinforce plate	A_2 = 1.000 [in^2]	r_2 = 3.500	[in]	
Dist to centroid of comb sect	$\bar{x} = \frac{A_1 r_1 + A_2 r_2}{A_1 + A_2}$	= 2.308	[in]	
Length of connection	L =	= 15.000	[in]	
Shear lag factor	$U = 1 - \bar{x} / L$	= 0.846		AISC 15[th] Table D3.1
Total net area	$A_n = A_{nb} + 2 \times A_r$	= 6.856	[in^2]	
Total effective net area	$A_e = U\ A_n$	= **5.801**	[in^2]	
The brace effective net area shall not be less than the brace gross area				AISC 341-16 F2.5b (3)
HSS sect HSS6X0.312	A_g = brace gross area	= **5.220**	[in^2]	
Total brace effective net area	$A_e = U\ A_n$	= **5.801**	[in^2]	
		$\geq A_g$	OK	AISC 341-16 F2.5b (3)
The specified minimum yield strength of the reinforce plate shall be at least the specified minimum yield strength of the brace				AISC 341-16 F2.5b (3)(i)
HSS sect HSS6X0.312	F_y = A500 Gr.C Round	= **46.0**	[ksi]	
Reinforce plate	F_{yp} = A992	= **50.0**	[ksi]	
		$\geq F_y$	OK	AISC 341-16 F2.5b (3)(i)

Brace Slot to Gusset Plate Weld Limitation Check				**PASS**
Min Fillet Weld Size				
Thinner part joined thickness	t =	= 0.291	[in]	
Min fillet weld size allowed	w_{min} =	= **0.188**	[in]	AISC 15[th] Table J2.4
Fillet weld size provided	w =	= **0.250**	[in]	
		$\geq w_{min}$	OK	
Min Fillet Weld Length				
Fillet weld size provided	w =	= 0.250	[in]	
Min fillet weld length allowed	$L_{min} = 4 \times w$	= **1.000**	[in]	AISC 15[th] J2.2b
Min fillet weld length	L =	= **15.000**	[in]	
		$\geq L_{min}$	OK	

Seismic SCBF LC1 Sect=HSS 6 x 0.312 P =-312.2 kips (T) ratio = **0.93** **PASS**

HSS Brace Wall - Gusset PL - Shear Yield	ratio = 312.2 / 626.5	= **0.50**	**PASS**		

HSS Brace Wall-Gusset Plate Shear Yielding

HSS sect HSS6X0.312 wall thick	t = 0.291 [in]	F_y = 46.0	[ksi]	
HSS brace wall-gusset overlap length	L = 15.000 [in]			
Ratio of expected Fy to specified min Fy	R_y = 1.30			AISC 341-16 Table A3.1
Beam axial load	P_u = from seismic load calc	= **312.2**	[kips]	
HSS brace wall-gusset shear yielding	$R_n = 0.6\ R_y F_y t\ L$ x 4 walls	= 626.5	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	$\phi\ R_n$ =	= **626.5**	[kips]	
	ratio = **0.50**	> P_u	OK	

HSS Brace Wall - Gusset PL - Shear Rupture	ratio = 312.2 / 584.6	= **0.53**	**PASS**		

HSS Brace Wall-Gusset Plate Shear Yielding

HSS sect HSS6X0.312 wall thick	t = 0.291 [in]	F_u = 62.0	[ksi]	
HSS brace wall-gusset overlap length	L = 15.000 [in]			
Ratio of expected Fu to specified min Fu	R_t = 1.20			AISC 341-16 Table A3.1
Beam axial load	P_u = from seismic load calc	= **312.2**	[kips]	
HSS brace wall-gusset shear rupture	$R_n = 0.6\ R_t F_u t\ L$ x 4 walls	= 779.4	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	$\phi\ R_n$ =	= **584.6**	[kips]	
	ratio = **0.53**	> P_u	OK	

Gusset Plate - Block Shear Rupture	ratio = 312.2 / 483.8	= **0.65**	**PASS**		

Plate Block Shear - Center Strip

Plate thickness	t_p = 0.500 [in]			
Plate strength	F_y = 50.0 [ksi]	F_u = 65.0	[ksi]	
C shape weld group size	width b = 15.000 [in]	depth d = 6.000	[in]	
Gross area subject to shear	$A_{gv} = b\ t_p$ x 2	= 15.000	[in^2]	
Net area subject to shear	$A_{nv} = A_{gvb}$	= 15.000	[in^2]	
Net area subject to tension	$A_{nt} = d\ t_p$	= 3.000	[in^2]	
Block shear strength required	V_u =	= **312.2**	[kips]	
Uniform tension stress factor	U_{bs} = 1.00			AISC 15th Fig C-J4.2
Bolt shear resistance provided	$R_n = \min(0.6F_u A_{nv},\ 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$	= 645.0	[kips]	AISC 15th Eq J4-5
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-5
	$\phi\ R_n$ =	= **483.8**	[kips]	
	ratio = **0.65**	> V_u	OK	

Gusset Plate - Tensile Yield (Whitmore) ratio = 312.2 / 507.6 = **0.62** PASS

Plate Tensile Yielding Check

Plate size	width b_p = 22.562 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 11.281	[in^2]	
Tensile force required	P_u =	= **312.2**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 564.1	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th Eq J4-1
	ϕR_n =	= **507.6**	[kips]	
	ratio = **0.61**	> P_u	OK	

Gusset Plate - Tensile Rupture (Whitmore) ratio = 312.2 / 549.9 = **0.57** PASS

Plate Tensile Rupture Check

Plate size	width b_p = 22.562 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$	= 11.281	[in^2]	
Tensile force required	P_u =	= **312.2**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 733.3	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-2
	ϕR_n =	= **549.9**	[kips]	AISC 15th Eq J4-2
	ratio = **0.57**	> P_u	OK	

Brace Slot to Gusset Plate Weld Strength ratio = 312.2 / 334.1 = **0.93** PASS

Fillet Weld Strength Check

Fillet weld leg size	w = $^1/_4$ [in]	load angle θ = 0.0	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5}\theta)$	= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n\text{-}w} = 0.6\,(C_1 \times 70\text{ ksi})\,0.707\,w\,n\,C_2$	= 14.847	[kip/in]	AISC 15th Eq 8-1
Base metal - brace	thickness t = 0.500 [in]	tensile F_u = 65.0	[ksi]	
Base metal - brace is in shear, shear rupture as per AISC 15th Eq J4-4 is checked				AISC 15th J2.4
Base metal shear rupture	$R_{n\text{-}b} = 0.6\,F_u\,t$	= 19.500	[kip/in]	AISC 15th Eq J4-4
Double fillet linear shear strength	$R_n = \min(R_{n\text{-}w}, R_{n\text{-}b})$	= **14.847**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq 8-1
	ϕR_n =	= **11.135**	[kip/in]	
Shear resistance required	V_u =	= **312.2**	[kips]	
Fillet weld length - double fillet	L =	= 30.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **334.1**	[kips]	
	ratio = **0.93**	> V_u	OK	

Reinforce Plate to Brace Wall Weld Strength		ratio = 55.0 / 76.6	= **0.72**	**PASS**
Reinforcing plate	w_r = 1.000 [in]	t_r = 1.000	[in]	
	F_y = 50.0 [ksi]			
Ratio of expected Fy to specified min Fy	R_y = 1.10			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.000	[in^2]	
Required strength of weld	$P_u = R_y F_y A_r$	= **55.0**	[kips]	
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	L_L = reinforce plate length	= 5.000	[in]	
Transverse weld length	L_T = reinforce plate width	= 1.000	[in]	
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 11.000	[in]	AISC 15th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 10.000	[in]	AISC 15th Eq J2-10b
	$L = \max(L_1, L_2)$	= **11.000**	[in]	AISC 15th J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = 5/16$ [in]	load angle θ = 0.0	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 1 for single fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi})\ 0.707\ w\ n\ C_2$	= 9.279	[kip/in]	AISC 15th Eq 8-1
Base metal - reinforce plate	thickness t = 1.000 [in]	tensile F_u = 65.0	[ksi]	
Base metal - reinforce plate is in shear, shear rupture as per AISC 15th Eq J4-4 is checked				AISC 15th J2.4
Base metal shear rupture	$R_{n-b} = 0.6\ F_u\ t$	= 39.000	[kip/in]	AISC 15th Eq J4-4
Single fillet linear shear strength	$R_n = \min(R_{n-w}, R_{n-b})$	= **9.279**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq 8-1
	ϕR_n =	= **6.960**	[kip/in]	
Shear resistance required	P_u =	= **55.0**	[kips]	
Fillet weld length - single fillet	L =	= 11.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **76.6**	[kips]	
	ratio = **0.72**	> P_u	OK	

Seismic SCBF LC2	Sect=HSS 6 x 0.312	P =228.3 kips (C)	ratio = **0.72**	**PASS**

Gusset Plate - Compression (Whitmore)

ratio = 228.3 / 406.0 = **0.56** **PASS**

Plate Compression Check

Plate size	width b_p = 22.562 [in]	thickness t_p = 0.500 [in]		
	F_y = 50.0 [ksi]	E = 29000 [ksi]		
Plate gross area in compression	$A_g = b_p t_p$	= 11.281	[in^2]	
Plate radius of gyration	$r = t_p / \sqrt{12}$	= 0.144	[in]	
Plate effective length factor	K =	= 0.65		
Plate unbraced length	L_u =	= 12.278	[in]	
Plate slenderness	$KL/r = 0.65 \times L_u / r$	= 55.29		
	when $\frac{KL}{r} > 25$, use Chapter E			AISC 15th J4.4 (b)
Elastic buckling stress	$F_e = \frac{\pi^2 E}{(KL/r)^2}$	= 93.62	[ksi]	AISC 15th Eq E3-4
	when $\frac{KL}{r} \le 4.71 \left(\frac{E}{F_y}\right)^{0.5} = 113.43$			AISC 15th E3 (a)
Critical stress	$F_{cr} = 0.658^{(F_y / F_e)} F_y$	= 39.98	[ksi]	AISC 15th Eq E3-2
Plate compression required	$P_u = P_c = 228.3$	= **228.3**	[kips]	
Plate compression provided	$R_n = F_{cr} \times A_g$	= 451.1	[kips]	AISC 15th Eq E3-1
Resistance factor-LRFD	$\phi = 0.90$			AISC 15th E1
	ϕR_n =	= **406.0**	[kips]	
	ratio = **0.56**	> P_u	OK	

Brace Slot to Gusset Plate Weld Strength

ratio = 228.3 / 334.1 = **0.68** **PASS**

Fillet Weld Strength Check

Fillet weld leg size	w = 1/4 [in]	load angle θ = 0.0 [°]		
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n\text{-}w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707\, w\, n\, C_2$	= 14.847	[kip/in]	AISC 15th Eq 8-1
Base metal - brace	thickness t = 0.500 [in]	tensile F_u = 65.0 [ksi]		
Base metal - brace is in shear, <u>shear</u> rupture as per AISC 15th Eq J4-4 is checked				AISC 15th J2.4
Base metal shear rupture	$R_{n\text{-}b} = 0.6 F_u t$	= 19.500	[kip/in]	AISC 15th Eq J4-4
Double fillet linear shear strength	$R_n = \min(R_{n\text{-}w}, R_{n\text{-}b})$	= **14.847**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15th Eq 8-1
	ϕR_n =	= **11.135**	[kip/in]	
Shear resistance required	V_u =	= **228.3**	[kips]	
Fillet weld length - double fillet	L =	= 30.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **334.1**	[kips]	
	ratio = **0.68**	> V_u	OK	

Reinforce Plate to Brace Wall Weld Strength		ratio = 55.0 / 76.6	= **0.72**	**PASS**
Reinforcing plate	w_r = 1.000 [in]	t_r = 1.000	[in]	
	F_y = 50.0 [ksi]			
Ratio of expected Fy to specified min Fy	R_y = 1.10			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.000	[in^2]	
Required strength of weld	$P_u = R_y F_y A_r$	= **55.0**	[kips]	
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	L_L = reinforce plate length	= 5.000	[in]	
Transverse weld length	L_T = reinforce plate width	= 1.000	[in]	
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 11.000	[in]	AISC 15th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 10.000	[in]	AISC 15th Eq J2-10b
	$L = \max(L_1, L_2)$	= **11.000**	[in]	AISC 15th J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = {}^5/_{16}$ [in]	load angle θ = 0.0	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 1 for single fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6\ (C_1 \times 70\ \text{ksi})\ 0.707\ w\ n\ C_2$	= 9.279	[kip/in]	AISC 15th Eq 8-1
Base metal - reinforce plate	thickness t = 1.000 [in]	tensile F_u = 65.0	[ksi]	
Base metal - reinforce plate is in shear, <u>shear</u> rupture as per AISC 15th Eq J4-4 is checked				AISC 15th J2.4
Base metal shear rupture	$R_{n-b} = 0.6\ F_u\ t$	= 39.000	[kip/in]	AISC 15th Eq J4-4
Single fillet linear shear strength	$R_n = \min(R_{n-w}, R_{n-b})$	= **9.279**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq 8-1
	ϕR_n =	= **6.960**	[kip/in]	
Shear resistance required	P_u =	= **55.0**	[kips]	
Fillet weld length - single fillet	L =	= 11.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **76.6**	[kips]	
	ratio = **0.72**	> P_u	OK	

Left Brace - Brace to Gusset	Sect=HSS 6 x 0.312	P_1 =228.3 kips (C)	P_2 =-312.2 kips (T)	Code=AISC 360-16 LRFD

Result Summary	geometries & weld limitations = **PASS**	limit states max ratio = **0.93**	**PASS**

Seismic SCBF Brace Highly Ductile Section Check — PASS

HSS Section Limiting Width-to-Thickness Ratio Check

Check HSS section limiting width-to-thickness ratio for HSS wall in compression as Highly Ductile section per AISC Seismic Design Manual 3rd Ed Table 1-D — AISC SDM 3rd Table 1-D

CHS sect HSS6X0.312	D = 6.000 [in]	t = 0.291	[in]	
HSS sect HSS6X0.312	F_y = A500 Gr.C Round	= 46.0	[ksi]	
	E = 29000 [ksi]			
Ratio of expected Fy to specified min Fy	R_y = 1.30			AISC 341-16 Table A3.1
CHS width-to-thickness ratio limit	$\lambda_{hd} = 0.053 \frac{E}{R_y F_y}$	= **25.70**		AISC SDM 3rd Table 1-D
CHS width-to-thickness ratio actual	D/t = D/t	= **20.62**		
		$\le \lambda_{hd}$	OK	

Brace Slot Effective Net Area Check — PASS

HSS With Reinforcing Plates Effective Net Area

CHS sect HSS6X0.312	D = 6.000 [in]	t = 0.291	[in]	
	A_g = 5.220 [in^2]			
Gusset plate thickness	t_{gp} = from user input	= 0.500	[in]	
HSS cut slot width	$w = t_{gp} + 1/8"$	= 0.625	[in]	
HSS brace net area	$A_{nb} = A_g - 2\,w\,t$	= 4.856	[in^2]	
Reinforcing plate	w_r = 1.000 [in]	t_r = 1.000	[in]	
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.000	[in^2]	
CHS 1/2 net area $A_1 = 0.5A_{nb}$	A_1 = 2.428 [in^2]	r_1 = 1.817	[in]	
Reinforce plate	A_2 = 1.000 [in^2]	r_2 = 3.500	[in]	
Dist to centroid of comb sect	$\bar{x} = \frac{A_1 r_1 + A_2 r_2}{A_1 + A_2}$	= 2.308	[in]	
Length of connection	L =	= 15.000	[in]	
Shear lag factor	$U = 1 - \bar{x} / L$	= 0.846		AISC 15th Table D3.1
Total net area	$A_n = A_{nb} + 2 \times A_r$	= 6.856	[in^2]	
Total effective net area	$A_e = U\,A_n$	= **5.801**	[in^2]	

The brace effective net area shall not be less than the brace gross area — AISC 341-16 F2.5b (3)

HSS sect HSS6X0.312	A_g = brace gross area	= **5.220**	[in^2]	
Total brace effective net area	$A_e = U\,A_n$	= **5.801**	[in^2]	
		$\geq A_g$	OK	AISC 341-16 F2.5b (3)

The specified minimum yield strength of the reinforce plate shall be at least the specified minimum yield strength of the brace — AISC 341-16 F2.5b (3)(i)

HSS sect HSS6X0.312	F_y = A500 Gr.C Round	= **46.0**	[ksi]	
Reinforce plate	F_{yp} = A992	= **50.0**	[ksi]	
		$\geq F_y$	OK	AISC 341-16 F2.5b (3)(i)

Brace Slot to Gusset Plate Weld Limitation Check — PASS

Min Fillet Weld Size

Thinner part joined thickness	t =	= 0.291	[in]	
Min fillet weld size allowed	w_{min} =	= **0.188**	[in]	AISC 15th Table J2.4
Fillet weld size provided	w =	= **0.250**	[in]	
		$\geq w_{min}$	OK	

Min Fillet Weld Length

Fillet weld size provided	w =	= 0.250	[in]	
Min fillet weld length allowed	$L_{min} = 4 \times w$	= **1.000**	[in]	AISC 15th J2.2b
Min fillet weld length	L =	= **15.000**	[in]	
		$\geq L_{min}$	OK	

Seismic SCBF LC1 Sect=HSS 6 x 0.312 P =228.3 kips (C) ratio = **0.72** **PASS**

Gusset Plate - Compression (Whitmore) — ratio = 228.3 / 406.0 = **0.56** **PASS**

Plate Compression Check

Plate size	width b_p = 22.562 [in]	thickness t_p = 0.500 [in]		
	F_y = 50.0 [ksi]	E = 29000 [ksi]		
Plate gross area in compression	$A_g = b_p t_p$	= 11.281	[in^2]	
Plate radius of gyration	$r = t_p / \sqrt{12}$	= 0.144	[in]	
Plate effective length factor	K =	= 0.65		
Plate unbraced length	L_u =	= 12.278	[in]	
Plate slenderness	$KL/r = 0.65 \times L_u / r$	= 55.29		
	when $\frac{KL}{r} > 25$, use Chapter E			AISC 15th J4.4 (b)
Elastic buckling stress	$F_e = \frac{\pi^2 E}{(KL/r)^2}$	= 93.62	[ksi]	AISC 15th Eq E3-4
	when $\frac{KL}{r} \le 4.71 \left(\frac{E}{F_y}\right)^{0.5} = 113.43$			AISC 15th E3 (a)
Critical stress	$F_{cr} = 0.658^{(F_y/F_e)} F_y$	= 39.98	[ksi]	AISC 15th Eq E3-2
Plate compression required	$P_u = P_c = 228.3$	= **228.3**	[kips]	
Plate compression provided	$R_n = F_{cr} \times A_g$	= 451.1	[kips]	AISC 15th Eq E3-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th E1
	ϕR_n =	= **406.0**	[kips]	
	ratio = **0.56**	> P_u	OK	

Brace Slot to Gusset Plate Weld Strength — ratio = 228.3 / 334.1 = **0.68** **PASS**

Fillet Weld Strength Check

Fillet weld leg size	w = 1/4 [in]	load angle θ = 0.0 [°]		
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6\,(C_1 \times 70\text{ ksi})\ 0.707\ w\ n\ C_2$	= 14.847	[kip/in]	AISC 15th Eq 8-1
Base metal - brace	thickness t = 0.500 [in]	tensile F_u = 65.0 [ksi]		
Base metal - brace is in shear, shear rupture as per AISC 15th Eq J4-4 is checked				AISC 15th J2.4
Base metal shear rupture	$R_{n-b} = 0.6\ F_u\ t$	= 19.500	[kip/in]	AISC 15th Eq J4-4
Double fillet linear shear strength	$R_n = \min(R_{n-w}, R_{n-b})$	= **14.847**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq 8-1
	ϕR_n =	= **11.135**	[kip/in]	
Shear resistance required	V_u =	= **228.3**	[kips]	
Fillet weld length - double fillet	L =	= 30.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **334.1**	[kips]	
	ratio = **0.68**	> V_u	OK	

Reinforce Plate to Brace Wall Weld Strength		ratio = 55.0 / 76.6	= **0.72**	**PASS**

Reinforcing plate	w_r = 1.000 [in]	t_r = 1.000	[in]	
	F_y = 50.0 [ksi]			
Ratio of expected Fy to specified min Fy	R_y = 1.10			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.000	[in^2]	
Required strength of weld	$P_u = R_y F_y A_r$	= **55.0**	[kips]	

Reinforce Plate to Brace Wall Fillet Weld Length

Longitudinal weld length	L_L = reinforce plate length	= 5.000	[in]	
Transverse weld length	L_T = reinforce plate width	= 1.000	[in]	
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 11.000	[in]	AISC 15th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 10.000	[in]	AISC 15th Eq J2-10b
	$L = \max(L_1, L_2)$	= **11.000**	[in]	AISC 15th J2.4 (c)

Fillet Weld Strength Check

Fillet weld leg size	$w = 5/16$ [in]	load angle θ = 0.0	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 1 for single fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5}\theta)$	= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6\,(C_1 \times 70\text{ ksi})\,0.707\,w\,n\,C_2$	= 9.279	[kip/in]	AISC 15th Eq 8-1
Base metal - reinforce plate	thickness t = 1.000 [in]	tensile F_u = 65.0	[ksi]	

Base metal - reinforce plate is in shear, shear rupture as per AISC 15th Eq J4-4 is checked — AISC 15th J2.4

Base metal shear rupture	$R_{n-b} = 0.6\,F_u\,t$	= 39.000	[kip/in]	AISC 15th Eq J4-4
Single fillet linear shear strength	$R_n = \min(R_{n-w}, R_{n-b})$	= **9.279**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq 8-1
	ϕR_n =	= **6.960**	[kip/in]	
Shear resistance required	P_u =	= **55.0**	[kips]	
Fillet weld length - single fillet	L =	= 11.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **76.6**	[kips]	
	ratio = **0.72**	> P_u	OK	

Seismic SCBF LC2	Sect=HSS 6 x 0.312	P =-312.2 kips (T)	ratio = **0.93**	**PASS**

HSS Brace Wall - Gusset PL - Shear Yield		ratio = 312.2 / 626.5	= **0.50**	**PASS**

HSS Brace Wall-Gusset Plate Shear Yielding

HSS sect HSS6X0.312 wall thick	t = 0.291 [in]	F_y = 46.0	[ksi]	
HSS brace wall-gusset overlap length	L = 15.000 [in]			
Ratio of expected Fy to specified min Fy	R_y = 1.30			AISC 341-16 Table A3.1
Beam axial load	P_u = from seismic load calc	= **312.2**	[kips]	
HSS brace wall-gusset shear yielding	$R_n = 0.6\ R_y F_y\ t\ L$ x 4 walls	= 626.5	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	$\phi\ R_n$ =	= **626.5**	[kips]	
	ratio = **0.50**	> P_u	OK	

HSS Brace Wall - Gusset PL - Shear Rupture		ratio = 312.2 / 584.6	= **0.53**	**PASS**

HSS Brace Wall-Gusset Plate Shear Yielding

HSS sect HSS6X0.312 wall thick	t = 0.291 [in]	F_u = 62.0	[ksi]	
HSS brace wall-gusset overlap length	L = 15.000 [in]			
Ratio of expected Fu to specified min Fu	R_t = 1.20			AISC 341-16 Table A3.1
Beam axial load	P_u = from seismic load calc	= **312.2**	[kips]	
HSS brace wall-gusset shear rupture	$R_n = 0.6\ R_t F_u\ t\ L$ x 4 walls	= 779.4	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	$\phi\ R_n$ =	= **584.6**	[kips]	
	ratio = **0.53**	> P_u	OK	

Gusset Plate - Block Shear Rupture		ratio = 312.2 / 483.8	= **0.65**	**PASS**

Plate Block Shear - Center Strip

Plate thickness	t_p = 0.500 [in]			
Plate strength	F_y = 50.0 [ksi]	F_u = 65.0	[ksi]	
C shape weld group size	width b = 15.000 [in]	depth d = 6.000	[in]	
Gross area subject to shear	$A_{gv} = b\ t_p$ x 2	= 15.000	[in^2]	
Net area subject to shear	$A_{nv} = A_{gvb}$	= 15.000	[in^2]	
Net area subject to tension	$A_{nt} = d\ t_p$	= 3.000	[in^2]	
Block shear strength required	V_u =	= **312.2**	[kips]	
Uniform tension stress factor	U_{bs} = 1.00			AISC 15th Fig C-J4.2
Bolt shear resistance provided	$R_n = \min(0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$	= 645.0	[kips]	AISC 15th Eq J4-5
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-5
	$\phi\ R_n$ =	= **483.8**	[kips]	
	ratio = **0.65**	> V_u	OK	

Gusset Plate - Tensile Yield (Whitmore)			ratio = 312.2 / 507.6	= **0.62**	**PASS**
Plate Tensile Yielding Check					
Plate size	width b_p = 22.552	[in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0	[ksi]			
Plate gross area in shear	$A_g = b_p t_p$		= 11.281	[in^2]	
Tensile force required	P_u =		= **312.2**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$		= 564.1	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90				AISC 15th Eq J4-1
	ϕR_n =		= **507.6**	[kips]	
	ratio = **0.61**		> P_u	OK	

Gusset Plate - Tensile Rupture (Whitmore)			ratio = 312.2 / 549.9	= **0.57**	**PASS**
Plate Tensile Rupture Check					
Plate size	width b_p = 22.562	[in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0	[ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$		= 11.281	[in^2]	
Tensile force required	P_u =		= **312.2**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 733.3	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75				AISC 15th Eq J4-2
	ϕR_n =		= **549.9**	[kips]	AISC 15th Eq J4-2
	ratio = **0.57**		> P_u	OK	

Brace Slot to Gusset Plate Weld Strength			ratio = 312.2 / 334.1	= **0.93**	**PASS**
Fillet Weld Strength Check					
Fillet weld leg size	w = $^1/_4$	[in]	load angle θ = 0.0	[°]	
Electrode strength	F_{EXX} = 70.0	[ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet				
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5}\theta)$		= 1.00		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707\ w\ n\ C_2$		= 14.847	[kip/in]	AISC 15th Eq 8-1
Base metal - brace	thickness t = 0.500	[in]	tensile F_u = 65.0	[ksi]	
Base metal - brace is in shear, <u>shear</u> rupture as per AISC 15th Eq J4-4 is checked					AISC 15th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$		= 19.500	[kip/in]	AISC 15th Eq J4-4
Double fillet linear shear strength	$R_n = \min(R_{n-w}, R_{n-b})$		= **14.847**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75				AISC 15th Eq 8-1
	ϕR_n =		= **11.135**	[kip/in]	
Shear resistance required	V_u =		= **312.2**	[kips]	
Fillet weld length - double fillet	L =		= 30.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$		= **334.1**	[kips]	
	ratio = **0.93**		> V_u	OK	

Reinforce Plate to Brace Wall Weld Strength		ratio = 55.0 / 76.6	= **0.72**	**PASS**
Reinforcing plate	w_r = 1.000 [in]	t_r = 1.000 [in]		
	F_y = 50.0 [ksi]			
Ratio of expected Fy to specified min Fy	R_y = 1.10			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.000	$[in^2]$	
Required strength of weld	$P_u = R_y F_y A_r$	= **55.0**	[kips]	
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	L_L = reinforce plate length	= 5.000	[in]	
Transverse weld length	L_T = reinforce plate width	= 1.000	[in]	
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 11.000	[in]	AISC 15^{th} Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 10.000	[in]	AISC 15^{th} Eq J2-10b
	$L = \max(L_1, L_2)$	= **11.000**	[in]	AISC 15^{th} J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = 5/16$ [in]	load angle θ = 0.0	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15^{th} Table 8-3
Number of weld line	n = 1 for single fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.00		AISC 15^{th} Page 8-9
Fillet weld shear strength	$R_{n\text{-}w} = 0.6 (C_1 \times 70 \text{ ksi}) \, 0.707 \, w \, n \, C_2$	= 9.279	[kip/in]	AISC 15^{th} Eq 8-1
Base metal - reinforce plate	thickness t = 1.000 [in]	tensile F_u = 65.0	[ksi]	
Base metal - reinforce plate is in shear, shear rupture as per AISC 15^{th} Eq J4-4 is checked				AISC 15^{th} J2.4
Base metal shear rupture	$R_{n\text{-}b} = 0.6 F_u t$	= 39.000	[kip/in]	AISC 15^{th} Eq J4-4
Single fillet linear shear strength	$R_n = \min(R_{n\text{-}w}, R_{n\text{-}b})$	= **9.279**	[kip/in]	AISC 15^{th} Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15^{th} Eq 8-1
	ϕR_n =	= **6.960**	[kip/in]	
Shear resistance required	P_u =	= **55.0**	[kips]	
Fillet weld length - single fillet	L =	= 11.000	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= **76.6**	[kips]	
	ratio = **0.72**	> P_u	OK	

Gusset to Beam Direct Weld Connection Code=AISC 360-16 LRFD

Result Summary geometries & weld limitations = **PASS** limit states max ratio = **1.03** **FAIL**

Weld Limitation Checks - Gusset to Beam **PASS**

Min Fillet Weld Size

Thinner part joined thickness	t =	= 0.500	[in]	
Min fillet weld size allowed	w_{min} =	= **0.188**	[in]	AISC 15th Table J2.4
Fillet weld size provided	w =	= **0.250**	[in]	
		≥ w_{min}	OK	

Min Fillet Weld Length

Fillet weld size provided	w =	= 0.250	[in]	
Min fillet weld length allowed	L_{min} = 4 x w	= **1.000**	[in]	AISC 15th J2.2b
Min fillet weld length	L =	= **68.102**	[in]	
		≥ L_{min}	OK	

Brace Force LC1 P_R= -312.2 kips (T) P_L= 228.3 kips (C) ratio = **1.03** **FAIL**

Gusset Plate - Shear Yielding (Sect a-a) ratio = 382.2 / 810.0 = **0.47** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 27.000	[in^2]	
Shear force required	V_u =	= **382.2**	[kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 810.0	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕ R_n =	= **810.0**	[kips]	
	ratio = **0.47**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect a-a) ratio = 382.2 / 789.8 = **0.48** **PASS**

Plate Shear Rupture Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 27.000	[in^2]	
Shear force in demand	V_u =	= **382.2**	[kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 1053.0	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	ϕ R_n =	= **789.8**	[kips]	
	ratio = **0.48**	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect a-a) ratio = 372.1 / 1215.0 = **0.31** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -59.3	[kips]	
Gusset edge moment force	$M =$	= 351.93	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 27.000	[in^2]	
Tensile force required	$P_u =$	= **372.1**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 1350.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th Eq J4-1
	$\phi R_n =$	= **1215.0**	[kips]	
	ratio = **0.31**	> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect a-a) ratio = 372.1 / 1316.3 = **0.28** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -59.3	[kips]	
Gusset edge moment force	$M =$	= 351.93	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$	= 27.000	[in^2]	
Tensile force required	$P_u =$	= **372.1**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 1755.0	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-2
	$\phi R_n =$	= **1316.3**	[kips]	AISC 15th Eq J4-2
	ratio = **0.28**	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= **0.32**	**PASS**
Gusset plate	width b_p = 54.000 [in]	thick t_p = 0.500 [in]		
	yield F_y = 50.0 [ksi]			
Shear plate - gross area	$A_g = b_p \times t_p$	= 27.000 [in^2]		
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 364.50 [in^3]		
Flexural strength available	$M_c = \phi F_y Z_p$ ϕ=0.90	= 1366.88 [kip-ft]		
Flexural strength required	M_r = from gusset interface forces calc	= 351.93 [kip-ft]		
Axial strength available	P_c = from axial tensile yield check	= 1215.0 [kips]		
Axial strength required	P_r = from gusset interface forces calc	= -59.3 [kips]		
Shear strength available	V_c = from shear yielding check	= 810.0 [kips]		
Shear strength required	V_r = from gusset interface forces calc	= 382.2 [kips]		
Flexural yield interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.32**	AISC 15th Eq 10-5	
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a)		ratio =	= **0.31**	**PASS**
Gusset plate	width b_p = 54.000 [in]	thick t_p = 0.500 [in]		
	tensile F_u = 65.0 [ksi]			
Net area of plate	$A_n = b_p \times t_p$	= 27.000 [in^2]		
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 364.50 [in^3]		
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 1480.78 [kip-ft]		
Flexural strength required	M_r = from gusset interface forces calc	= 351.93 [kip-ft]		
Axial strength available	P_c = from axial tensile rupture check	= 1316.3 [kips]		
Axial strength required	P_r = from gusset interface forces calc	= -59.3 [kips]		
Shear strength available	V_c = from shear rupture check	= 789.8 [kips]		
Shear strength required	V_r = from gusset interface forces calc	= 382.2 [kips]		
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.31**	AISC 15th Eq 10-5	
		< 1.0	OK	

Gusset Plate - Shear Yielding (Sect b-b)		ratio = 34.7 / 345.0	= **0.10**	**PASS**
Plate Shear Yielding Check				
Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 11.501 [in^2]		
Shear force required	V_u =	= **34.7** [kips]		
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 345.0 [kips]	AISC 15th Eq J4-3	
Resistance factor-LRFD	ϕ = 1.00		AISC 15th Eq J4-3	
	ϕR_n =	= **345.0** [kips]		
	ratio = **0.10**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect b-b) ratio = 34.7 / 336.4 = **0.10** **PASS**

Plate Shear Rupture Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500	[in]		
Plate tensile strength	F_u = 65.0 [ksi]				
Plate net area in shear	$A_{nv} = b_p t_p$	= 11.501	[in^2]		
Shear force in demand	V_u =	= **34.7**	[kips]		
Plate shear rupture strength	$R_n = 0.6\ F_u A_{nv}$	= 448.5	[kips]	AISC 15th Eq J4-4	
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4	
	ϕR_n =	= **336.4**	[kips]		
	ratio = **0.10**	> V_u	OK		

Gusset Plate - Axial Tensile Yield (Sect b-b) ratio = 76.4 / 517.5 = **0.15** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	N =	= -29.7	[kips]	
Gusset edge moment force	M =	= 22.37	[kip-ft]	
Gusset edge interface length	L =	= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\ M}{L}$	= -76.4	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 11.501	[in^2]	
Tensile force required	P_u =	= **76.4**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 575.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th Eq J4-1
	ϕR_n =	= **517.5**	[kips]	
	ratio = **0.15**	> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect b-b)		ratio = 76.4 / 560.6	= **0.14**	**PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -29.7	[kips]	
Gusset edge moment force	$M =$	= 22.37	[kip-ft]	
Gusset edge interface length	$L =$	= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -76.4	[kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in tension	$A_{nt} = b_p\, t_p$	= 11.501	[in^2]	
Tensile force required	$P_u =$	= **76.4**	[kips]	
Plate tensile rupture strength	$R_n = F_u\, A_{nt}$	= 747.5	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-2
	$\phi\, R_n =$	= **560.6**	[kips]	AISC 15th Eq J4-2
	ratio = **0.14**	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)		ratio =	= **0.03**	**PASS**

Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500	[in]	
	yield F_y = 50.0 [ksi]			
Shear plate - gross area	$A_g = b_p \times t_p$	= 11.501	[in^2]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 66.13	[in^3]	
Flexural strength available	$M_c = \phi\, F_y\, Z_p$ ϕ=0.90	= 247.99	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 22.37	[kip-ft]	
Axial strength available	P_c = from axial tensile yield check	= 517.5	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -29.7	[kips]	
Shear strength available	V_c = from shear yielding check	= 345.0	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 34.7	[kips]	
Flexural yield interaction	ratio $= \left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.03**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect b-b)	ratio =		= **0.03**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500	[in]	
	tensile F_u = 65.0 [ksi]			
Net area of plate	$A_n = b_p \times t_p$	= 11.501	[in^2]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 66.13	[in^3]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 268.66	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 22.37	[kip-ft]	
Axial strength available	P_c = from axial tensile rupture check	= 560.6	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -29.7	[kips]	
Shear strength available	V_c = from shear rupture check	= 336.4	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 34.7	[kips]	
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.03**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset to Beam Weld Strength ratio = 12.08 / 11.70 = **1.03** **FAIL**

Gusset to Beam Interface - Forces

shear V = 382.2 [kips] axial N = -59.3 [kips] in tension

moment M = 351.93 [kip-ft]

Gusset to Beam Interface - Weld Length

Gusset-beam fillet weld length	$L_w =$	= 54.000	[in]	

Gusset to Beam Interface - Combined Weld Stress

Weld stress from axial force	$f_a = N / L_w$	= -1.098	[kip/in]	in tension
Weld stress from shear force	$f_v = V / L_w$	= 7.078	[kip/in]	
Weld stress from moment force	$f_b = \dfrac{M}{L^2 / 6}$	= 8.690	[kip/in]	
Weld stress combined - max	$f_{max} = [\ (f_a - f_b)^2 + f_v^2\ ]^{0.5}$	= **12.079**	[kip/in]	AISC 15th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$	= 54.1	[°]	

Fillet Weld Strength Calc

Fillet weld leg size	$w = {}^1/_4$ [in]	load angle θ = 54.1	[°]	
Electrode strength	$F_{EXX} = 70.0$ [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.36		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n\text{-}w} = 0.6\ (C_1 \times 70\ \text{ksi})\ 0.707\ w\ n\ C_2$	= 20.262	[kip/in]	AISC 15th Eq 8-1

Base metal - gusset plate thickness t = 0.500 [in] tensile F_u = 65.0 [ksi]

Base metal - gusset plate is in shear, <u>shear</u> rupture as per AISC 15th Eq J4-4 is checked AISC 15th J2.4

Base metal shear rupture	$R_{n\text{-}b} = 0.6\ F_u\ t$	= 19.500	[kip/in]	AISC 15th Eq J4-4

Double fillet linear shear strength	$R_n = \min\ (R_{n\text{-}w} , R_{n\text{-}b})$	= **19.500**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15th Eq 8-1
	$\phi\ R_n =$	= 14.625	[kip/in]	

When gusset plate is directly welded to beam or column, apply 1.25 ductility factor to allow adequate force redistribution in the weld group AISC 15th Page 13-11

Weld strength used for design after applying ductility factor	$\phi\ R_n = \phi\ R_n \times (1/1.25)$	= **11.700**	[kip/in]	
	ratio = **1.03**	$< f_{max}$	**NG**	

The fail is caused by base metal rupture not by weld metal rupture as such increasing weld size won't help.

The user has the following options to get this check passed

1) Increase the base metal thickness or strength
2) Increase the weld length
3) Reduce the force in demand

Column Web Local Yielding

ratio = 372.1 / 2241.0 = **0.17** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	N =	= -59.3	[kips]	
Gusset edge moment force	M =	= 351.93	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1

Concentrated force from gusset	P_u =			= **372.1**	[kips]	
Beam section	d = 22.100	[in]		t_f = 1.150	[in]	
	t_w = 0.720	[in]		k = 1.650	[in]	
	yield F_y = 50.0	[ksi]				

Length of bearing	l_b = gusset-beam weld length	= 54.000	[in]	
Beam web local yielding strength	$R_n = F_y t_w (5k + l_b)$	= 2241.0	[kips]	AISC 15th Eq J10-2
Resistance factor-LRFD	ϕ = 1.00			
	ϕR_n =	= **2241.0**	[kips]	
	ratio = **0.17**	> P_u	OK	

Column Web Local Crippling

ratio = 372.1 / 2192.3 = **0.17** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	N =	= -59.3	[kips]	
Gusset edge moment force	M =	= 351.93	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1

Concentrated force from gusset	P_u =		= **372.1**	[kips]
Beam section	d = 22.100	[in]	t_f = 1.150	[in]
	t_w = 0.720	[in]	k = 1.650	[in]
	yield F_y = 50.0	[ksi]	E = 29000	[ksi]

Length of bearing	l_b = gusset-beam weld length	= 54.000	[in]	
Beam web local crippling strength	$R_n = 0.8\, t_w^2 \left[1+3\frac{l_b}{d}\left(\frac{t_w}{t_f}\right)^{1.5}\right] \times \left(\frac{E F_y t_f}{t_w}\right)^{0.5}$	= 2923.0	[kips]	AISC 15th Eq J10-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th J10.3
	ϕR_n =	= **2192.3**	[kips]	
	ratio = **0.17**	> P_u	OK	

Beam Web Longitudinal Shear Yielding ratio = 382.2 / 2638.4 = **0.14** **PASS**

Beam Web Effective Length for Transmitting Shear

Refer to AISC Design Example v14.2 Page IIC-70 for formula below to calculate beam web effective length in transmitting shear along Sect a-a

Beam sect W21X147	d = 22.100 [in]	b_f = 12.500 [in]		
	t_f = 1.150 [in]	t_w = 0.720 [in]		
	k = 1.650 [in]	F_y = 50.0 [ksi]		
Gusset edge interface length	L =	= 54.000	[in]	
	ϕ_t = 0.90	ϕ_v = 1.00		
Beam web effective length for transmitting shear	$L_{eff} = L + 5k + \dfrac{2\,\phi_t b_f t_f}{\phi_v 0.6\, t_w}$	= 122.146	[in]	
Gusset edge shear (Sect a-a)	V_u =	= **382.2**	[kips]	
Beam web shear strength	$R_n = 0.6\, F_y t_w L_{eff}$	= 2638.4	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕR_n =	= **2638.4**	[kips]	
	ratio = **0.14**	> V_u	OK	

Beam Web Transverse Section Shear Yielding ratio = 140.1 / 477.4 = **0.29** **PASS**

Beam sect W21X147	d = 22.100 [in]	t_w = 0.720 [in]		
Right brace axial force	P_1 = from user input	= -312.2	[kips]	in tension
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
Right brace force ver component	$V_1 = P_1 \sin \theta_1$	= -220.8	[kips]	
Gusset edge shear (Sect b-b)	V' =	= 34.7	[kips]	
Transfer force from chev brace on the other side of beam or column	A_b = from user input	= -46.0	[kips]	in compression
Beam web transverse shear	$V_u = V_1 + V' - A_b$	= **140.1**	[kips]	
Beam web shear strength	$R_n = 0.6\, F_y d\, t_w C_v$	= 477.4	[kips]	AISC 15th Eq G2-1
	C_v = 1.00			AISC 15th Eq G2-2
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq G2-1
	ϕR_n =	= **477.4**	[kips]	
	ratio = **0.29**	> V_u	OK	

Brace Force LC2 P_R= 228.3 kips (C) P_L= -312.2 kips (T) ratio = **1.03** **FAIL**

Gusset Plate - Shear Yielding (Sect a-a) ratio = 382.2 / 810.0 = **0.47** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500 [in]		
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 27.000	[in^2]	
Shear force required	V_u =	= **382.2**	[kips]	
Plate shear yielding strength	$R_n = 0.6\, F_y A_{gv}$	= 810.0	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕR_n =	= **810.0**	[kips]	
	ratio = **0.47**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect a-a)		ratio = 382.2 / 789.8	= **0.48**	**PASS**	
Plate Shear Rupture Check					
Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]		
Plate tensile strength	F_u = 65.0 [ksi]				
Plate net area in shear	$A_{nv} = b_p t_p$	= 27.000	[in^2]		
Shear force in demand	V_u =	= **382.2**	[kips]		
Plate shear rupture strength	$R_n = 0.6\, F_u A_{nv}$	= 1053.0	[kips]	AISC 15th Eq J4-4	
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4	
	$\phi\, R_n$ =	= **789.8**	[kips]		
	ratio = **0.48**	> V_u	OK		

Gusset Plate - Axial Tensile Yield (Sect a-a)		ratio = 372.1 / 1215.0	= **0.31**	**PASS**
Gusset Edge Equivalent Normal Force				

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	N =	= -59.3	[kips]	
Gusset edge moment force	M =	= 351.93	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 27.000	[in^2]	
Tensile force required	P_u =	= **372.1**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 1350.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th Eq J4-1
	$\phi\, R_n$ =	= **1215.0**	[kips]	
	ratio = **0.31**	> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect a-a)		ratio = 372.1 / 1316.3	= **0.28**		**PASS**
Gusset Edge Equivalent Normal Force					
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force					
Gusset edge axial force	$N =$		= -59.3	[kips]	
Gusset edge moment force	$M =$		= 351.93	[kip-ft]	
Gusset edge interface length	$L =$		= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$		= -372.1	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check					
Plate size	width b_p = 54.000 [in]	thickness t_p =	0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]				
Plate net area in tension	$A_{nt} = b_p t_p$		= 27.000	[in^2]	
Tensile force required	$P_u =$		= **372.1**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 1755.0	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75				AISC 15th Eq J4-2
	$\phi R_n =$		= **1316.3**	[kips]	AISC 15th Eq J4-2
	ratio = **0.28**		> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= **0.32**		**PASS**
Gusset plate	width b_p = 54.000 [in]	thick t_p =	0.500	[in]	
	yield F_y = 50.0 [ksi]				
Shear plate - gross area	$A_g = b_p \times t_p$		= 27.000	[in^2]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$		= 364.50	[in^3]	
Flexural strength available	$M_c = \phi F_y Z_p$ ϕ=0.90		= 1366.88	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc		= 351.93	[kip-ft]	
Axial strength available	P_c = from axial tensile yield check		= 1215.0	[kips]	
Axial strength required	P_r = from gusset interface forces calc		= -59.3	[kips]	
Shear strength available	V_c = from shear yielding check		= 810.0	[kips]	
Shear strength required	V_r = from gusset interface forces calc		= 382.2	[kips]	
Flexural yield interaction	ratio $= \left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$		= **0.32**		AISC 15th Eq 10-5
			< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a)		ratio =	= **0.31**	**PASS**
Gusset plate	width b_p = 54.000 [in]	thick t_p = 0.500 [in]		
	tensile F_u = 65.0 [ksi]			
Net area of plate	$A_n = b_p \times t_p$	= 27.000 [in^2]		
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 364.50 [in^3]		
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 1480.78 [kip-ft]		
Flexural strength required	M_r = from gusset interface forces calc	= 351.93 [kip-ft]		
Axial strength available	P_c = from axial tensile rupture check	= 1316.3 [kips]		
Axial strength required	P_r = from gusset interface forces calc	= -59.3 [kips]		
Shear strength available	V_c = from shear rupture check	= 789.8 [kips]		
Shear strength required	V_r = from gusset interface forces calc	= 382.2 [kips]		
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.31**	AISC 15th Eq 10-5	
		< 1.0	OK	

Gusset Plate - Shear Yielding (Sect b-b)		ratio = 34.7 / 345.0	= **0.10**	**PASS**
Plate Shear Yielding Check				
Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 11.501 [in^2]		
Shear force required	V_u =	= **34.7** [kips]		
Plate shear yielding strength	$R_n = 0.6\, F_y A_{gv}$	= 345.0 [kips]	AISC 15th Eq J4-3	
Resistance factor-LRFD	ϕ = 1.00		AISC 15th Eq J4-3	
	ϕR_n =	= **345.0** [kips]		
	ratio = **0.10**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect b-b)		ratio = 34.7 / 336.4	= **0.10**	**PASS**
Plate Shear Rupture Check				
Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 11.501 [in^2]		
Shear force in demand	V_u =	= **34.7** [kips]		
Plate shear rupture strength	$R_n = 0.6\, F_u A_{nv}$	= 448.5 [kips]	AISC 15th Eq J4-4	
Resistance factor-LRFD	ϕ = 0.75		AISC 15th Eq J4-4	
	ϕR_n =	= **336.4** [kips]		
	ratio = **0.10**	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect b-b) ratio = 76.4 / 517.5 = **0.15** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -29.7	[kips]	
Gusset edge moment force	$M =$	= 22.37	[kip-ft]	
Gusset edge interface length	$L =$	= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -76.4	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width $b_p = 23.001$	[in]	thickness $t_p = 0.500$	[in]		
Plate yield strength	$F_y = 50.0$	[ksi]				
Plate gross area in shear	$A_g = b_p t_p$		= 11.501	[in^2]		
Tensile force required	$P_u =$		= **76.4**	[kips]		
Plate tensile yielding strength	$R_n = F_y A_g$		= 575.0	[kips]	AISC 15th Eq J4-1	
Resistance factor-LRFD	$\phi = 0.90$				AISC 15th Eq J4-1	
	$\phi R_n =$		= **517.5**	[kips]		
	ratio = **0.15**		$> P_u$	OK		

Gusset Plate - Axial Tensile Rupture (Sect b-b) ratio = 76.4 / 560.6 = **0.14** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -29.7	[kips]	
Gusset edge moment force	$M =$	= 22.37	[kip-ft]	
Gusset edge interface length	$L =$	= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -76.4	[kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width $b_p = 23.001$	[in]	thickness $t_p = 0.500$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$		= 11.501	[in^2]	
Tensile force required	$P_u =$		= **76.4**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 747.5	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$				AISC 15th Eq J4-2
	$\phi R_n =$		= **560.6**	[kips]	AISC 15th Eq J4-2
	ratio = **0.14**		$> P_u$	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)		ratio =	= **0.03**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500	[in]	
	yield F_y = 50.0 [ksi]			
Shear plate - gross area	$A_g = b_p \times t_p$	= 11.501	[in^2]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 66.13	[in^3]	
Flexural strength available	$M_c = \phi F_y Z_p$ ϕ=0.90	= 247.99	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 22.37	[kip-ft]	
Axial strength available	P_c = from axial tensile yield check	= 517.5	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -29.7	[kips]	
Shear strength available	V_c = from shear yielding check	= 345.0	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 34.7	[kips]	
Flexural yield interaction	ratio $= \left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.03**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect b-b)		ratio =	= **0.03**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500	[in]	
	tensile F_u = 65.0 [ksi]			
Net area of plate	$A_n = b_p \times t_p$	= 11.501	[in^2]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 66.13	[in^3]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 268.66	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 22.37	[kip-ft]	
Axial strength available	P_c = from axial tensile rupture check	= 560.6	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -29.7	[kips]	
Shear strength available	V_c = from shear rupture check	= 336.4	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 34.7	[kips]	
Flexural rupture interaction	ratio $= \left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.03**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset to Beam Weld Strength		ratio = 12.08 / 11.70	= **1.03**	**FAIL**

Gusset to Beam Interface - Forces

	shear V = 382.2	[kips]	axial N = -59.3	[kips] in tension
	moment M = 351.93	[kip-ft]		

Gusset to Beam Interface - Weld Length

Gusset-beam fillet weld length	L_w =	= 54.000	[in]	

Gusset to Beam Interface - Combined Weld Stress

Weld stress from axial force	$f_a = N / L_w$	= -1.098	[kip/in]	in tension
Weld stress from shear force	$f_v = V / L_w$	= 7.078	[kip/in]	
Weld stress from moment force	$f_b = \dfrac{M}{L^2 / 6}$	= 8.690	[kip/in]	
Weld stress combined - max	$f_{max} = [\ (f_a - f_b)^2 + f_v^2\ ]^{0.5}$	= **12.079**	[kip/in]	AISC 15th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$	= 54.1	[°]	

Fillet Weld Strength Calc

Fillet weld leg size	$w = {}^1/_4$ [in]	load angle θ = 54.1	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.36		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n\text{-}w} = 0.6\ (C_1 \times 70\ \text{ksi})\ 0.707\ w\ n\ C_2$	= 20.262	[kip/in]	AISC 15th Eq 8-1

Base metal - gusset plate	thickness t = 0.500 [in]	tensile F_u = 65.0	[ksi]	

Base metal - gusset plate is in shear, shear rupture as per AISC 15th Eq J4-4 is checked — AISC 15th J2.4

Base metal shear rupture	$R_{n\text{-}b} = 0.6\ F_u\ t$	= 19.500	[kip/in]	AISC 15th Eq J4-4

Double fillet linear shear strength	$R_n = \min\ (R_{n\text{-}w}, R_{n\text{-}b})$	= **19.500**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15th Eq 8-1
	$\phi\ R_n$ =	= 14.625	[kip/in]	

When gusset plate is directly welded to beam or column, apply 1.25 ductility factor to allow adequate force redistribution in the weld group — AISC 15th Page 13-11

Weld strength used for design after applying ductility factor	$\phi\ R_n = \phi\ R_n \times (1/1.25)$	= **11.700**	[kip/in]	
	ratio = **1.03**	$< f_{max}$	**NG**	

The fail is caused by base metal rupture not by weld metal rupture as such increasing weld size won't help.

The user has the following options to get this check passed

1) Increase the base metal thickness or strength
2) Increase the weld length
3) Reduce the force in demand

Column Web Local Yielding		ratio = 372.1 / 2241.0 = **0.17**		**PASS**
Gusset Edge Equivalent Normal Force				
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force				
Gusset edge axial force	N =	= -59.3	[kips]	
Gusset edge moment force	M =	= 351.93	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1
Concentrated force from gusset	P_u =	= **372.1**	[kips]	
Beam section	d = 22.100 [in]	t_f = 1.150	[in]	
	t_w = 0.720 [in]	k = 1.650	[in]	
	yield F_y = 50.0 [ksi]			
Length of bearing	l_b = gusset-beam weld length	= 54.000	[in]	
Beam web local yielding strength	$R_n = F_y t_w (5 k + l_b)$	= 2241.0	[kips]	AISC 15th Eq J10-2
Resistance factor-LRFD	ϕ = 1.00			
	ϕR_n =	= **2241.0**	[kips]	
	ratio = **0.17**	> P_u	OK	

Column Web Local Crippling		ratio = 372.1 / 2192.3 = **0.17**		**PASS**
Gusset Edge Equivalent Normal Force				
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force				
Gusset edge axial force	N =	= -59.3	[kips]	
Gusset edge moment force	M =	= 351.93	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -372.1	[kips]	AISC DG29 Fig B-1
Concentrated force from gusset	P_u =	= **372.1**	[kips]	
Beam section	d = 22.100 [in]	t_f = 1.150	[in]	
	t_w = 0.720 [in]	k = 1.650	[in]	
	yield F_y = 50.0 [ksi]	E = 29000	[ksi]	
Length of bearing	l_b = gusset-beam weld length	= 54.000	[in]	
Beam web local crippling strength	$R_n = 0.8\, t_w^2 \; [1+3\frac{l_b}{d}(\frac{t_w}{t_f})^{1.5}] \times (\frac{E F_y t_f}{t_w})^{0.5}$	= 2923.0	[kips]	AISC 15th Eq J10-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th J10.3
	ϕR_n =	= **2192.3**	[kips]	
	ratio = **0.17**	> P_u	OK	

Beam Web Longitudinal Shear Yielding		ratio = 382.2 / 2638.4 = **0.14**		**PASS**
Beam Web Effective Length for Transmitting Shear				
Refer to AISC Design Example v14.2 Page IIC-70 for formula below to calculate beam web effective length in transmitting shear along Sect a-a				
Beam sect W21X147	d = 22.100 [in]	b_f = 12.500	[in]	
	t_f = 1.150 [in]	t_w = 0.720	[in]	
	k = 1.650 [in]	F_y = 50.0	[ksi]	
Gusset edge interface length	L =	= 54.000	[in]	
	ϕ_t = 0.90	ϕ_v = 1.00		
Beam web effective length for transmitting shear	$L_{eff} = L + 5k + \dfrac{2\,\phi_t b_f t_f}{\phi_v 0.6\, t_w}$	= 122.146	[in]	
Gusset edge shear (Sect a-a)	V_u =	= **382.2**	[kips]	
Beam web shear strength	$R_n = 0.6\, F_y t_w L_{eff}$	= 2638.4	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕR_n =	= **2638.4**	[kips]	
	ratio = **0.14**	> V_u	OK	

Beam Web Transverse Section Shear Yielding		ratio = 154.3 / 477.4 = **0.32**		**PASS**
Beam sect W21X147	d = 22.100 [in]	t_w = 0.720	[in]	
Right brace axial force	P_1 = from user input	= 228.3	[kips]	in compression
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
Right brace force ver component	$V_1 = P_1 \sin\theta_1$	= 161.4	[kips]	
Gusset edge shear (Sect b-b)	V' =	= -34.7	[kips]	
Transfer force from chev brace on the other side of beam or column	A_b = from user input	= -27.6	[kips]	
Beam web transverse shear	$V_u = V_1 + V' - A_b$	= **154.3**	[kips]	
Beam web shear strength	$R_n = 0.6\, F_y\, d\, t_w C_v$	= 477.4	[kips]	AISC 15th Eq G2-1
	C_v = 1.00			AISC 15th Eq G2-2
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq G2-1
	ϕR_n =	= **477.4**	[kips]	
	ratio = **0.32**	> V_u	OK	

Seismic - SCBF LC3 & LC4 Gusset Interface Forces Calc

Brace Axial Force LC3

Refer to AISC DG29 Fig. 4-5 ~ Fig. 4-7 for all charts and definitions of variables and symbols shown in calculation below

Right brace axial force	P_1 = from seismic brace force calc	= -312.2	[kips]	in tension
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
	H_1 = -220.8 [kips]	V_1 = -220.8	[kips]	
Left brace axial force	P_2 = from seismic brace force calc	= 68.5	[kips]	in compression
Left brace to hor line angle	θ_2 = from user input	= 45.0	[°]	
	H_2 = 48.4 [kips]	V_2 = 48.4	[kips]	
	L_1 = 27.000 [in]	L_2 = 27.000	[in]	
	$L = L_1 + L_2$	= 54.000	[in]	
	$\Delta = (L_2 - L_1) /2$	= 0.000	[in]	
	e = 11.050 [in]	h = 23.001	[in]	
	M_1 = -203.28 [kip-ft]	M_2 = -44.60	[kip-ft]	
Forces on Section a-a				AISC DG29 Fig. 4-6
Shear	$V = H_1 - H_2$	= **-269.2**	[kips]	
Axial	$N = V_1 + V_2$	= **-172.3**	[kips]	in tension
Moment	$M = M_1 + M_2$	= **-247.88**	[kip-ft]	
Forces on Section b-b				AISC DG29 Fig. 4-7
Shear	$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$	= **24.4**	[kips]	
Axial	$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$	= **-86.2**	[kips]	in tension
Moment	$M' = \frac{L}{8}(V_1+V_2) + \frac{h}{4}(H_1-H_2) + \frac{M}{2} - V_1 \Delta - H_1(e + \frac{h}{2})$	= **64.98**	[kip-ft]	

Brace Axial Force LC4

Refer to AISC DG29 Fig. 4-5 ~ Fig. 4-7 for all charts and definitions of variables and symbols shown in calculation below

Right brace axial force	P_1 = from seismic brace force calc	= 68.5	[kips]	in compression
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
	H_1 = 48.4 [kips]	V_1 = 48.4	[kips]	
Left brace axial force	P_2 = from seismic brace force calc	= -312.2	[kips]	in tension
Left brace to hor line angle	θ_2 = from user input	= 45.0	[°]	
	H_2 = -220.8 [kips]	V_2 = -220.8	[kips]	
	L_1 = 27.000 [in]	L_2 = 27.000	[in]	
	$L = L_1 + L_2$	= 54.000	[in]	
	$\Delta = (L_2 - L_1) /2$	= 0.000	[in]	
	e = 11.050 [in]	h = 23.001	[in]	
	M_1 = 44.60 [kip-ft]	M_2 = 203.28	[kip-ft]	

Forces on Section a-a AISC DG29 Fig. 4-6

Shear	$V = H_1 - H_2$	= **269.2**	[kips]	
Axial	$N = V_1 + V_2$	= **-172.3**	[kips]	in tension
Moment	$M = M_1 + M_2$	= **247.88**	[kip-ft]	

Forces on Section b-b AISC DG29 Fig. 4-7

Shear	$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$	= **-24.4**	[kips]	
Axial	$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$	= **-86.2**	[kips]	in tension
Moment	$M' = \frac{L}{8}(V_1+V_2) + \frac{h}{4}(H_1-H_2) + \frac{M}{2} - V_1\Delta - H_1(e + \frac{h}{2})$	= **64.98**	[kip-ft]	

Gusset to Beam Direct Weld Connection Code=AISC 360-16 LRFD

Result Summary geometries & weld limitations = **PASS** limit states max ratio = **0.90** **PASS**

Weld Limitation Checks - Gusset to Beam **PASS**

Min Fillet Weld Size

Thinner part joined thickness	$t =$	= 0.500	[in]	
Min fillet weld size allowed	$w_{min} =$	= **0.188**	[in]	AISC 15th Table J2.4
Fillet weld size provided	$w =$	= **0.250**	[in]	
		$\geq w_{min}$	OK	

Min Fillet Weld Length

Fillet weld size provided	$w =$	= 0.250	[in]	
Min fillet weld length allowed	$L_{min} = 4 \times w$	= **1.000**	[in]	AISC 15th J2.2b
Min fillet weld length	$L =$	= **68.102**	[in]	
		$\geq L_{min}$	OK	

Brace Force LC3 P_R= -312.2 kips (T) P_L= 68.5 kips (C) ratio = **0.90** **PASS**

Gusset Plate - Shear Yielding (Sect a-a) ratio = 269.2 / 810.0 = **0.33** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 27.000	[in^2]	
Shear force required	$V_u =$	= **269.2**	[kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 810.0	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	$\phi R_n =$	= **810.0**	[kips]	
	ratio = **0.33**	$> V_u$	OK	

Gusset Plate - Shear Rupture (Sect a-a) ratio = 269.2 / 789.8 = **0.34** **PASS**

Plate Shear Rupture Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 27.000	[in^2]	
Shear force in demand	V_u =	= **269.2**	[kips]	
Plate shear rupture strength	$R_n = 0.6\ F_u A_{nv}$	= 1053.0	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	ϕR_n =	= **789.8**	[kips]	
	ratio = **0.34**	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect a-a) ratio = 392.6 / 1215.0 = **0.32** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	N =	= -172.3	[kips]	
Gusset edge moment force	M =	= 247.88	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\ M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 27.000	[in^2]	
Tensile force required	P_u =	= **392.6**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 1350.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th Eq J4-1
	ϕR_n =	= **1215.0**	[kips]	
	ratio = **0.32**	> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect a-a) ratio = 392.6 / 1316.3 = **0.30** PASS

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -172.3	[kips]	
Gusset edge moment force	$M =$	= 247.88	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in tension	$A_{nt} = b_p\, t_p$	= 27.000	[in^2]	
Tensile force required	$P_u =$	= **392.6**	[kips]	
Plate tensile rupture strength	$R_n = F_u\, A_{nt}$	= 1755.0	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-2
	$\phi\, R_n =$	= **1316.3**	[kips]	AISC 15th Eq J4-2
	ratio = **0.30**	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a) ratio = = **0.21** PASS

Gusset plate	width b_p = 54.000 [in]	thick t_p = 0.500	[in]	
	yield F_y = 50.0 [ksi]			
Shear plate - gross area	$A_g = b_p \times t_p$	= 27.000	[in^2]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 364.50	[in^3]	
Flexural strength available	$M_c = \phi\, F_y\, Z_p$ ϕ=0.90	= 1366.88	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 247.88	[kip-ft]	
Axial strength available	P_c = from axial tensile yield check	= 1215.0	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -172.3	[kips]	
Shear strength available	V_c = from shear yielding check	= 810.0	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 269.2	[kips]	
Flexural yield interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.21**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a) ratio = = **0.21** **PASS**

Gusset plate	width b_p = 54.000 [in]	thick t_p = 0.500 [in]		
	tensile F_u = 65.0 [ksi]			
Net area of plate	$A_n = b_p \times t_p$	= 27.000	[in^2]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 364.50	[in^3]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 1480.78	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 247.88	[kip-ft]	
Axial strength available	P_c = from axial tensile rupture check	= 1316.3	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -172.3	[kips]	
Shear strength available	V_c = from shear rupture check	= 789.8	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 269.2	[kips]	
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.21**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset Plate - Shear Yielding (Sect b-b) ratio = 24.4 / 345.0 = **0.07** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 11.501	[in^2]	
Shear force required	V_u =	= **24.4**	[kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 345.0	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕR_n =	= **345.0**	[kips]	
	ratio = **0.07**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect b-b) ratio = 24.4 / 336.4 = **0.07** **PASS**

Plate Shear Rupture Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 11.501	[in^2]	
Shear force in demand	V_u =	= **24.4**	[kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 448.5	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	ϕR_n =	= **336.4**	[kips]	
	ratio = **0.07**	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect b-b)		ratio = 221.8 / 517.5	= **0.43**	**PASS**	
Gusset Edge Equivalent Normal Force					
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force					
Gusset edge axial force	$N =$		= -86.2	[kips]	
Gusset edge moment force	$M =$		= 64.98	[kip-ft]	
Gusset edge interface length	$L =$		= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$		= -221.8	[kips]	AISC DG29 Fig B-1
Plate Tensile Yielding Check					
Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500		[in]	
Plate yield strength	F_y = 50.0 [ksi]				
Plate gross area in shear	$A_g = b_p t_p$		= 11.501	[in^2]	
Tensile force required	$P_u =$		= **221.8**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$		= 575.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90				AISC 15th Eq J4-1
	$\phi R_n =$		= **517.5**	[kips]	
	ratio = **0.43**		$> P_u$	OK	

Gusset Plate - Axial Tensile Rupture (Sect b-b)		ratio = 221.8 / 560.6	= **0.40**	**PASS**	
Gusset Edge Equivalent Normal Force					
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force					
Gusset edge axial force	$N =$		= -86.2	[kips]	
Gusset edge moment force	$M =$		= 64.98	[kip-ft]	
Gusset edge interface length	$L =$		= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$		= -221.8	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check					
Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500		[in]	
Plate tensile strength	F_u = 65.0 [ksi]				
Plate net area in tension	$A_{nt} = b_p t_p$		= 11.501	[in^2]	
Tensile force required	$P_u =$		= **221.8**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 747.5	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75				AISC 15th Eq J4-2
	$\phi R_n =$		= **560.6**	[kips]	AISC 15th Eq J4-2
	ratio = **0.40**		$> P_u$	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)	ratio =	= **0.19**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500 [in]	
	yield F_y = 50.0 [ksi]		
Shear plate - gross area	$A_g = b_p \times t_p$	= 11.501 [in^2]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 66.13 [in^3]	
Flexural strength available	$M_c = \phi F_y Z_p$ ϕ=0.90	= 247.99 [kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 64.98 [kip-ft]	
Axial strength available	P_c = from axial tensile yield check	= 517.5 [kips]	
Axial strength required	P_r = from gusset interface forces calc	= -86.2 [kips]	
Shear strength available	V_c = from shear yielding check	= 345.0 [kips]	
Shear strength required	V_r = from gusset interface forces calc	= 24.4 [kips]	
Flexural yield interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.19**	AISC 15th Eq 10-5
		< 1.0	OK

Gusset Plate - Flexural Rupture Interact (Sect b-b)	ratio =	= **0.16**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500 [in]	
	tensile F_u = 65.0 [ksi]		
Net area of plate	$A_n = b_p \times t_p$	= 11.501 [in^2]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 66.13 [in^3]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 268.66 [kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 64.98 [kip-ft]	
Axial strength available	P_c = from axial tensile rupture check	= 560.6 [kips]	
Axial strength required	P_r = from gusset interface forces calc	= -86.2 [kips]	
Shear strength available	V_c = from shear rupture check	= 336.4 [kips]	
Shear strength required	V_r = from gusset interface forces calc	= 24.4 [kips]	
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.16**	AISC 15th Eq 10-5
		< 1.0	OK

Gusset to Beam Weld Strength

ratio = 10.56 / 11.70 = **0.90** **PASS**

Gusset to Beam Interface - Forces

shear V = 269.2 [kips] axial N = -172.3 [kips] in tension

moment M = 247.88 [kip-ft]

Gusset to Beam Interface - Weld Length

Gusset-beam fillet weld length	L_w =	= 54.000	[in]	

Gusset to Beam Interface - Combined Weld Stress

Weld stress from axial force	$f_a = N / L_w$	= -3.191	[kip/in]	in tension
Weld stress from shear force	$f_v = V / L_w$	= 4.985	[kip/in]	
Weld stress from moment force	$f_b = \dfrac{M}{L^2 / 6}$	= 6.120	[kip/in]	
Weld stress combined - max	$f_{max} = [(f_a - f_b)^2 + f_v^2]^{0.5}$	= **10.562**	[kip/in]	AISC 15^{th} Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$	= 61.8	[°]	

Fillet Weld Strength Calc

Fillet weld leg size	$w = {}^1/_4$	[in]	load angle θ = 61.8	[°]		
Electrode strength	F_{EXX} = 70.0	[ksi]	strength coeff C_1 = 1.00			AISC 15^{th} Table 8-3
Number of weld line	n = 2 for double fillet					
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$		= 1.41			AISC 15^{th} Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) \, 0.707 \, w \, n \, C_2$		= 20.992	[kip/in]		AISC 15^{th} Eq 8-1

Base metal - gusset plate thickness t = 0.500 [in] tensile F_u = 65.0 [ksi]

Base metal - gusset plate is in shear, shear rupture as per AISC 15^{th} Eq J4-4 is checked — AISC 15^{th} J2.4

Base metal shear rupture	$R_{n-b} = 0.6 \, F_u \, t$	= 19.500	[kip/in]	AISC 15^{th} Eq J4-4

Double fillet linear shear strength	$R_n = \min (R_{n-w} , R_{n-b})$	= **19.500**	[kip/in]	AISC 15^{th} Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15^{th} Eq 8-1
	ϕR_n =	= 14.625	[kip/in]	

When gusset plate is directly welded to beam or column, apply 1.25 ductility factor to allow adequate force redistribution in the weld group — AISC 15^{th} Page 13-11

Weld strength used for design after applying ductility factor	$\phi R_n = \phi R_n \times (1/1.25)$	= **11.700**	[kip/in]	
	ratio = **0.90**	> f_{max}	OK	

Column Web Local Yielding ratio = 392.6 / 2241.0 = **0.18** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -172.3	[kips]	
Gusset edge moment force	$M =$	= 247.88	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1

Concentrated force from gusset	$P_u =$	= **392.6**	[kips]	
Beam section	d = 22.100 [in]	t_f = 1.150	[in]	
	t_w = 0.720 [in]	k = 1.650	[in]	
	yield F_y = 50.0 [ksi]			

Length of bearing	l_b = gusset-beam weld length	= 54.000	[in]	
Beam web local yielding strength	$R_n = F_y t_w (5\,k + l_b)$	= 2241.0	[kips]	AISC 15th Eq J10-2
Resistance factor-LRFD	ϕ = 1.00			
	$\phi\,R_n =$	= **2241.0**	[kips]	
	ratio = **0.18**	> P_u	OK	

Column Web Local Crippling ratio = 392.6 / 2192.3 = **0.18** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -172.3	[kips]	
Gusset edge moment force	$M =$	= 247.88	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\,M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1

Concentrated force from gusset	$P_u =$	= **392.6**	[kips]	
Beam section	d = 22.100 [in]	t_f = 1.150	[in]	
	t_w = 0.720 [in]	k = 1.650	[in]	
	yield F_y = 50.0 [ksi]	E = 29000	[ksi]	

Length of bearing	l_b = gusset-beam weld length	= 54.000	[in]	
Beam web local crippling strength	$R_n = 0.8\,t_w^2\,[1+3\frac{l_b}{d}(\frac{t_w}{t_f})^{1.5}]\times(\frac{E\,F_y t_f}{t_w})^{0.5}$	= 2923.0	[kips]	AISC 15th Eq J10-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th J10.3
	$\phi R_n =$	= **2192.3**	[kips]	
	ratio = **0.18**	> P_u	OK	

Beam Web Longitudinal Shear Yielding ratio = 269.2 / 2638.4 = **0.10** **PASS**

Beam Web Effective Length for Transmitting Shear

Refer to AISC Design Example v14.2 Page IIC-70 for formula below to calculate beam web effective length in transmitting shear along Sect a-a

Beam sect W21X147	d = 22.100 [in]	b_f = 12.500 [in]		
	t_f = 1.150 [in]	t_w = 0.720 [in]		
	k = 1.650 [in]	F_y = 50.0 [ksi]		
Gusset edge interface length	L =	= 54.000	[in]	
	ϕ_t = 0.90	ϕ_v = 1.00		
Beam web effective length for transmitting shear	$L_{eff} = L + 5k + \frac{2\ \phi_t b_f t_f}{\phi_v 0.6\ t_w}$	= 122.146	[in]	
Gusset edge shear (Sect a-a)	V_u =	= **269.2**	[kips]	
Beam web shear strength	$R_n = 0.6\ F_y t_w L_{eff}$	= 2638.4	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	$\phi\ R_n$ =	= **2638.4**	[kips]	
	ratio = **0.10**	> V_u	OK	

Beam Web Transverse Section Shear Yielding ratio = 150.4 / 477.4 = **0.31** **PASS**

Beam sect W21X147	d = 22.100 [in]	t_w = 0.720 [in]		
Right brace axial force	P_1 = from user input	= -312.2	[kips]	in tension
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
Right brace force ver component	$V_1 = P_1 \sin\theta_1$	= -220.8	[kips]	
Gusset edge shear (Sect b-b)	V' =	= 24.4	[kips]	
Transfer force from chev brace on the other side of beam or column	A_b = from user input	= -46.0	[kips]	in compression
Beam web transverse shear	$V_u = V_1 + V' - A_b$	= **150.4**	[kips]	
Beam web shear strength	$R_n = 0.6\ F_y\ d\ t_w C_v$	= 477.4	[kips]	AISC 15th Eq G2-1
	C_v = 1.00			AISC 15th Eq G2-2
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq G2-1
	$\phi\ R_n$ =	= **477.4**	[kips]	
	ratio = **0.31**	> V_u	OK	

Brace Force LC4 P_R= 68.5 kips (C) P_L= -312.2 kips (T) ratio = **0.90** **PASS**

Gusset Plate - Shear Yielding (Sect a-a) ratio = 269.2 / 810.0 = **0.33** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500 [in]		
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 27.000	[in^2]	
Shear force required	V_u =	= **269.2**	[kips]	
Plate shear yielding strength	$R_n = 0.6\ F_y A_{gv}$	= 810.0	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	$\phi\ R_n$ =	= **810.0**	[kips]	
	ratio = **0.33**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect a-a) ratio = 269.2 / 789.8 = **0.34** **PASS**

Plate Shear Rupture Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 27.000	[in^2]	
Shear force in demand	V_u =	= **269.2**	[kips]	
Plate shear rupture strength	$R_n = 0.6\ F_u A_{nv}$	= 1053.0	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	ϕR_n =	= **789.8**	[kips]	
	ratio = **0.34**	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect a-a) ratio = 392.6 / 1215.0 = **0.32** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	N =	= -172.3	[kips]	
Gusset edge moment force	M =	= 247.88	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4\ M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width b_p = 54.000 [in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 27.000	[in^2]	
Tensile force required	P_u =	= **392.6**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 1350.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90			AISC 15th Eq J4-1
	ϕR_n =	= **1215.0**	[kips]	
	ratio = **0.32**	> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect a-a)		ratio = 392.6 / 1316.3	= **0.30**		**PASS**
Gusset Edge Equivalent Normal Force					
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force					
Gusset edge axial force	$N =$		= -172.3	[kips]	
Gusset edge moment force	$M =$		= 247.88	[kip-ft]	
Gusset edge interface length	$L =$		= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$		= -392.6	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check					
Plate size	width b_p = 54.000 [in]	thickness t_p =	0.500	[in]	
Plate tensile strength	F_u = 65.0 [ksi]				
Plate net area in tension	$A_{nt} = b_p t_p$		= 27.000	[in^2]	
Tensile force required	$P_u =$		= **392.6**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 1755.0	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75				AISC 15th Eq J4-2
	$\phi R_n =$		= **1316.3**	[kips]	AISC 15th Eq J4-2
	ratio = **0.30**		> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= **0.21**		**PASS**
Gusset plate	width b_p = 54.000 [in]	thick t_p =	0.500	[in]	
	yield F_y = 50.0 [ksi]				
Shear plate - gross area	$A_g = b_p \times t_p$		= 27.000	[in^2]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$		= 364.50	[in^3]	
Flexural strength available	$M_c = \phi F_y Z_p$ ϕ=0.90		= 1366.88	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc		= 247.88	[kip-ft]	
Axial strength available	P_c = from axial tensile yield check		= 1215.0	[kips]	
Axial strength required	P_r = from gusset interface forces calc		= -172.3	[kips]	
Shear strength available	V_c = from shear yielding check		= 810.0	[kips]	
Shear strength required	V_r = from gusset interface forces calc		= 269.2	[kips]	
Flexural yield interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$		= **0.21**		AISC 15th Eq 10-5
			< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a) ratio = = **0.21** **PASS**

Gusset plate	width b_p = 54.000 [in]	thick t_p = 0.500 [in]		
	tensile F_u = 65.0 [ksi]			
Net area of plate	$A_n = b_p \times t_p$	= 27.000	[in^2]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 364.50	[in^3]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 1480.78	[kip-ft]	
Flexural strength required	M_r = from gusset interface forces calc	= 247.88	[kip-ft]	
Axial strength available	P_c = from axial tensile rupture check	= 1316.3	[kips]	
Axial strength required	P_r = from gusset interface forces calc	= -172.3	[kips]	
Shear strength available	V_c = from shear rupture check	= 789.8	[kips]	
Shear strength required	V_r = from gusset interface forces calc	= 269.2	[kips]	
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.21**		AISC 15th Eq 10-5
		< 1.0	OK	

Gusset Plate - Shear Yielding (Sect b-b) ratio = 24.4 / 345.0 = **0.07** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate yield strength	F_y = 50.0 [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 11.501	[in^2]	
Shear force required	V_u =	= **24.4**	[kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 345.0	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕR_n =	= **345.0**	[kips]	
	ratio = **0.07**	> V_u	OK	

Gusset Plate - Shear Rupture (Sect b-b) ratio = 24.4 / 336.4 = **0.07** **PASS**

Plate Shear Rupture Check

Plate size	width b_p = 23.001 [in]	thickness t_p = 0.500 [in]		
Plate tensile strength	F_u = 65.0 [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 11.501	[in^2]	
Shear force in demand	V_u =	= **24.4**	[kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 448.5	[kips]	AISC 15th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq J4-4
	ϕR_n =	= **336.4**	[kips]	
	ratio = **0.07**	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect b-b) ratio = 221.8 / 517.5 = **0.43** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -86.2	[kips]	
Gusset edge moment force	$M =$	= 64.98	[kip-ft]	
Gusset edge interface length	$L =$	= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -221.8	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width b_p = 23.001	[in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0	[ksi]			
Plate gross area in shear	$A_g = b_p t_p$		= 11.501	[in^2]	
Tensile force required	$P_u =$		= **221.8**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$		= 575.0	[kips]	AISC 15th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90				AISC 15th Eq J4-1
	$\phi R_n =$		= **517.5**	[kips]	
	ratio = **0.43**		> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect b-b) ratio = 221.8 / 560.6 = **0.40** **PASS**

Gusset Edge Equivalent Normal Force

Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force

Gusset edge axial force	$N =$	= -86.2	[kips]	
Gusset edge moment force	$M =$	= 64.98	[kip-ft]	
Gusset edge interface length	$L =$	= 23.001	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -221.8	[kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width b_p = 23.001	[in]	thickness t_p = 0.500	[in]	
Plate tensile strength	F_u = 65.0	[ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$		= 11.501	[in^2]	
Tensile force required	$P_u =$		= **221.8**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 747.5	[kips]	AISC 15th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75				AISC 15th Eq J4-2
	$\phi R_n =$		= **560.6**	[kips]	AISC 15th Eq J4-2
	ratio = **0.40**		> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)	ratio =	= **0.19**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500	[in]
	yield F_y = 50.0 [ksi]		
Shear plate - gross area	$A_g = b_p \times t_p$	= 11.501	[in^2]
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 66.13	[in^3]
Flexural strength available	$M_c = \phi F_y Z_p$ ϕ=0.90	= 247.99	[kip-ft]
Flexural strength required	M_r = from gusset interface forces calc	= 64.98	[kip-ft]
Axial strength available	P_c = from axial tensile yield check	= 517.5	[kips]
Axial strength required	P_r = from gusset interface forces calc	= -86.2	[kips]
Shear strength available	V_c = from shear yielding check	= 345.0	[kips]
Shear strength required	V_r = from gusset interface forces calc	= 24.4	[kips]
Flexural yield interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.19**	AISC 15th Eq 10-5
		< 1.0	OK

Gusset Plate - Flexural Rupture Interact (Sect b-b)	ratio =	= **0.16**	**PASS**
Gusset plate	width b_p = 23.001 [in]	thick t_p = 0.500	[in]
	tensile F_u = 65.0 [ksi]		
Net area of plate	$A_n = b_p \times t_p$	= 11.501	[in^2]
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$	= 66.13	[in^3]
Flexural strength available	$M_c = \phi F_u Z_{net}$ ϕ=0.75	= 268.66	[kip-ft]
Flexural strength required	M_r = from gusset interface forces calc	= 64.98	[kip-ft]
Axial strength available	P_c = from axial tensile rupture check	= 560.6	[kips]
Axial strength required	P_r = from gusset interface forces calc	= -86.2	[kips]
Shear strength available	V_c = from shear rupture check	= 336.4	[kips]
Shear strength required	V_r = from gusset interface forces calc	= 24.4	[kips]
Flexural rupture interaction	ratio = $\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{P_r}{P_c} + \frac{M_r}{M_c}\right)^2$	= **0.16**	AISC 15th Eq 10-5
		< 1.0	OK

Gusset to Beam Weld Strength		ratio = 10.56 / 11.70	= **0.90**	**PASS**

Gusset to Beam Interface - Forces

	shear V = 269.2 [kips]	axial N = -172.3	[kips]	in tension
	moment M = 247.88 [kip-ft]			

Gusset to Beam Interface - Weld Length

Gusset-beam fillet weld length	L_w =	= 54.000	[in]	

Gusset to Beam Interface - Combined Weld Stress

Weld stress from axial force	$f_a = N / L_w$	= -3.191	[kip/in]	in tension
Weld stress from shear force	$f_v = V / L_w$	= 4.985	[kip/in]	
Weld stress from moment force	$f_b = \dfrac{M}{L^2 / 6}$	= 6.120	[kip/in]	
Weld stress combined - max	$f_{max} = [(f_a - f_b)^2 + f_v^2]^{0.5}$	= **10.562**	[kip/in]	AISC 15th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$	= 61.8	[°]	

Fillet Weld Strength Calc

Fillet weld leg size	$w = {}^1/_4$ [in]	load angle θ = 61.8	[°]	
Electrode strength	F_{EXX} = 70.0 [ksi]	strength coeff C_1 = 1.00		AISC 15th Table 8-3
Number of weld line	n = 2 for double fillet			
Load angle coefficient	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$	= 1.41		AISC 15th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707\ w\ n\ C_2$	= 20.992	[kip/in]	AISC 15th Eq 8-1

Base metal - gusset plate	thickness t = 0.500 [in]	tensile F_u = 65.0	[ksi]	

Base metal - gusset plate is in shear, shear rupture as per AISC 15th Eq J4-4 is checked — AISC 15th J2.4

Base metal shear rupture	$R_{n-b} = 0.6\ F_u\ t$	= 19.500	[kip/in]	AISC 15th Eq J4-4

Double fillet linear shear strength	$R_n = \min (R_{n-w} , R_{n-b})$	= **19.500**	[kip/in]	AISC 15th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75			AISC 15th Eq 8-1
	ϕR_n =	= 14.625	[kip/in]	

When gusset plate is directly welded to beam or column, apply 1.25 ductility factor to allow adequate force redistribution in the weld group — AISC 15th Page 13-11

Weld strength used for design after applying ductility factor	$\phi R_n = \phi R_n \times (1/1.25)$	= **11.700**	[kip/in]	
	ratio = **0.90**	$> f_{max}$	OK	

Column Web Local Yielding		ratio = 392.6 / 2241.0 = **0.18**		**PASS**
Gusset Edge Equivalent Normal Force				
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force				
Gusset edge axial force	$N =$	= -172.3	[kips]	
Gusset edge moment force	$M =$	= 247.88	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= **392.6**	[kips]	
Beam section	$d = 22.100$ [in]	$t_f = 1.150$	[in]	
	$t_w = 0.720$ [in]	$k = 1.650$	[in]	
	yield $F_y = 50.0$ [ksi]			
Length of bearing	$l_b =$ gusset-beam weld length	= 54.000	[in]	
Beam web local yielding strength	$R_n = F_y t_w (5k + l_b)$	= 2241.0	[kips]	AISC 15th Eq J10-2
Resistance factor-LRFD	$\phi = 1.00$			
	$\phi R_n =$	= **2241.0**	[kips]	
	ratio = **0.18**	$> P_u$	OK	

Column Web Local Crippling		ratio = 392.6 / 2192.3 = **0.18**		**PASS**
Gusset Edge Equivalent Normal Force				
Refer to AISC DG29 Fig. B-1 for formula below to calculate gusset edge equivalent normal force				
Gusset edge axial force	$N =$	= -172.3	[kips]	
Gusset edge moment force	$M =$	= 247.88	[kip-ft]	
Gusset edge interface length	$L =$	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -392.6	[kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= **392.6**	[kips]	
Beam section	$d = 22.100$ [in]	$t_f = 1.150$	[in]	
	$t_w = 0.720$ [in]	$k = 1.650$	[in]	
	yield $F_y = 50.0$ [ksi]	$E = 29000$	[ksi]	
Length of bearing	$l_b =$ gusset-beam weld length	= 54.000	[in]	
Beam web local crippling strength	$R_n = 0.8\, t_w^2 \left[1 + 3\frac{l_b}{d}\left(\frac{t_w}{t_f}\right)^{1.5}\right] \times \left(\frac{E F_y t_f}{t_w}\right)^{0.5}$	= 2923.0	[kips]	AISC 15th Eq J10-4
Resistance factor-LRFD	$\phi = 0.75$			AISC 15th J10.3
	$\phi R_n =$	= **2192.3**	[kips]	
	ratio = **0.18**	$> P_u$	OK	

Beam Web Longitudinal Shear Yielding		ratio = 269.2 / 2638.4	= **0.10**	**PASS**

Beam Web Effective Length for Transmitting Shear

Refer to AISC Design Example v14.2 Page IIC-70 for formula below to calculate beam web effective length in transmitting shear along Sect a-a

Beam sect W21X147	d = 22.100 [in]	b_f = 12.500	[in]	
	t_f = 1.150 [in]	t_w = 0.720	[in]	
	k = 1.650 [in]	F_y = 50.0	[ksi]	
Gusset edge interface length	L =	= 54.000	[in]	
	ϕ_t = 0.90	ϕ_v = 1.00		
Beam web effective length for transmitting shear	$L_{eff} = L + 5k + \dfrac{2\,\phi_t b_f t_f}{\phi_v 0.6\, t_w}$	= 122.146	[in]	
Gusset edge shear (Sect a-a)	V_u =	= **269.2**	[kips]	
Beam web shear strength	$R_n = 0.6\, F_y t_w L_{eff}$	= 2638.4	[kips]	AISC 15th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq J4-3
	ϕR_n =	= **2638.4**	[kips]	
	ratio = **0.10**	> V_u	OK	

Beam Web Transverse Section Shear Yielding		ratio = 51.6 / 477.4	= **0.11**	**PASS**

Beam sect W21X147	d = 22.100 [in]	t_w = 0.720	[in]	
Right brace axial force	P_1 = from user input	= 68.5	[kips]	in compression
Right brace to hor line angle	θ_1 = from user input	= 45.0	[°]	
Right brace force ver component	$V_1 = P_1 \sin\theta_1$	= 48.4	[kips]	
Gusset edge shear (Sect b-b)	V' =	= -24.4	[kips]	
Transfer force from chev brace on the other side of beam or column	A_b = from user input	= -27.6	[kips]	
Beam web transverse shear	$V_u = V_1 + V' - A_b$	= **51.6**	[kips]	
Beam web shear strength	$R_n = 0.6\, F_y d\, t_w C_v$	= 477.4	[kips]	AISC 15th Eq G2-1
	C_v = 1.00			AISC 15th Eq G2-2
Resistance factor-LRFD	ϕ = 1.00			AISC 15th Eq G2-1
	ϕR_n =	= **477.4**	[kips]	
	ratio = **0.11**	> V_u	OK	