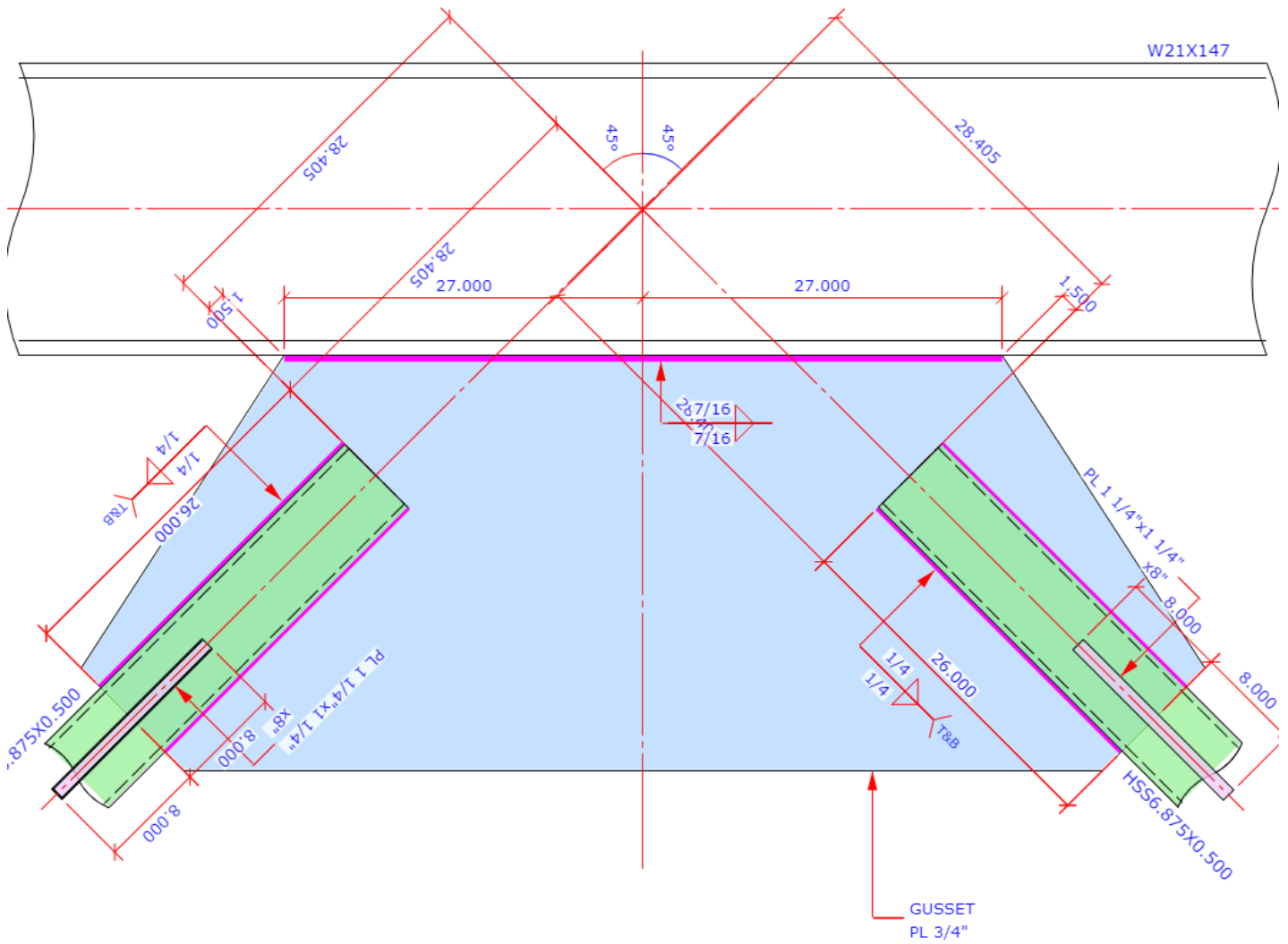
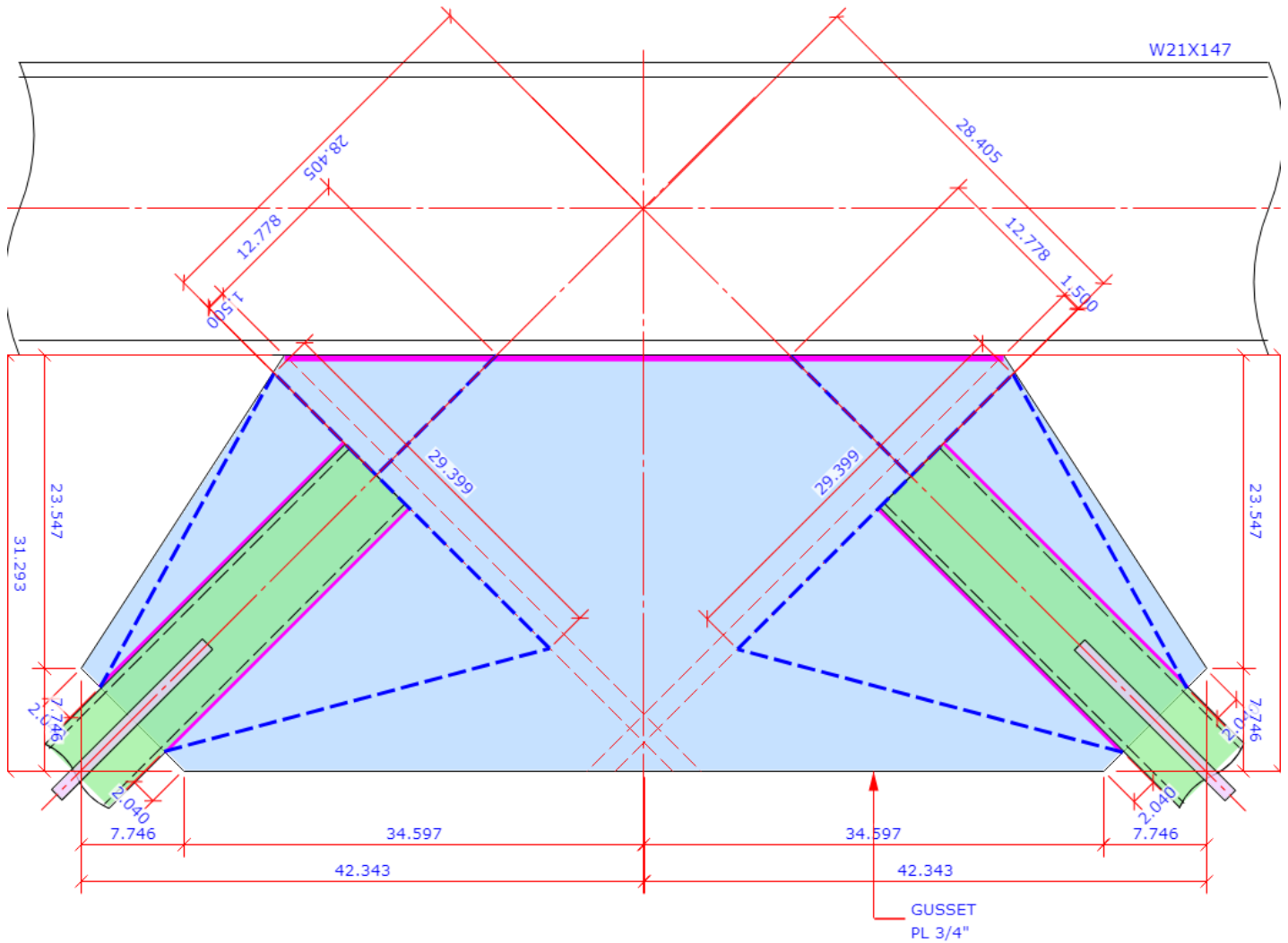


Sketch

Vertical Brace Connection

Code=AISC 360-16 LRFD





Result Summary - Overall	Chevron Brace Connection	Code=AISC 360-16 LRFD
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Result Summary - Overall	geometries & weld limitations = PASS	limit states max ratio = 1.26 FAIL
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Seismic - SCBF Load Case LC1 & LC2

Right Brace - Brace to Gusset	geometries & weld limitations = PASS	limit states max ratio = 0.97 PASS
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Left Brace - Brace to Gusset	geometries & weld limitations = PASS	limit states max ratio = 0.97 PASS
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Gusset to Beam	geometries & weld limitations = PASS	limit states max ratio = 1.26 FAIL
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Seismic - SCBF Load Case LC3 & LC4

Gusset to Beam	geometries & weld limitations = PASS	limit states max ratio = 1.08 FAIL
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Seismic Calculation	Brace Seismic System = SCBF	Code=AISC 360-16 LRFD
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Seismic Brace Axial Forces Calc & Design Cases Summary**Right Brace Section Properties & Member Data**

Brace sect HSS6.875X0.500	Grade = A500 Gr.C Round	F _y = 46.0 [ksi]
Ratio of expected F _y to specified min F _y	R _y = 1.30	AISC 341-16 Table A3.1
	A _g = 9.360 [in ²]	r _y = 2.272 [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	= 559.7 [kips] AISC 341-16 F2.6c (1)
Right Brace seismic design force in tension	P _{s,t} = P _{et}	= -559.7 [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 = 2.272 [in]	E = 29000 [ksi]
Member slenderness ratio	KL/r = K x L / r	= 63.37
Elastic buckling stress	$F_e = \frac{\pi^2 E}{(KL/r)^2}$	= 71.27 [ksi] AISC 15 th Eq E3-4
	when $\frac{KL}{r} \leq 4.71 \left(\frac{E}{R_y F_y} \right)^{0.5} = 103.72$	AISC 15 th E3
Critical stress	F _{cr} = 0.658 (R _y F _y / F _e) R _y F _y	= 42.09 [ksi] AISC 15 th Eq E3-2
Brace expected yield strength in compression	P _{ec} = min (R _y F _y A _g , 1.14 F _{cr} A _g)	= 449.1 [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	$P_{s_ci} = P_{ec}$	= 449.1 [kips]	AISC 341-16 F2.6c (2)
Right Brace seismic design force in compression - post-buckling	$P_{s_cii} = 0.3 \times P_{ec}$	= 134.7 [kips]	AISC 341-16 F2.3 (ii)

Left Brace Section Properties & Member Data

Brace sect HSS6.875X0.500	Grade = A500 Gr.C Round	$F_y = 46.0$ [ksi]	
Ratio of expected F_y to specified min F_y	$R_y = 1.30$		AISC 341-16 Table A3.1
	$A_g = 9.360$ [in ²]	$r_y = 2.272$ [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	$P_{et} = R_y F_y A_g$	= 559.7 [kips]	AISC 341-16 F2.6c (1)
Left Brace seismic design force in tension	$P_{s_t} = P_{et}$	= -559.7 [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	$r = 2.272$ [in]	$E = 29000$ [ksi]	
Member slenderness ratio	$KL/r = K \times L / r$	= 63.37	
Elastic buckling stress	$F_e = \frac{\pi^2 E}{(KL/r)^2}$	= 71.27 [ksi]	AISC 15 th Eq E3-4
	when $\frac{KL}{r} \leq 4.71 \left(\frac{E}{R_y F_y} \right)^{0.5} = 103.72$		AISC 15 th E3
Critical stress	$F_{cr} = 0.658 \left(R_y F_y / F_e \right) R_y F_y$	= 42.09 [ksi]	AISC 15 th Eq E3-2
Brace expected yield strength in compression	$P_{ec} = \min (R_y F_y A_g, 1.14 F_{cr} A_g)$	= 449.1 [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	$P_{s_ci} = P_{ec}$	= 449.1 [kips]	AISC 341-16 F2.6c (2)
Left Brace seismic design force in compression - post-buckling	$P_{s_cii} = 0.3 \times P_{ec}$	= 134.7 [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	$P_{s_t} = -559.7$ kips (T)	Left Brace	$P_{s_ci} = 449.1$ kips (C)		AISC 341-16 F2.3(i)
LC2	Right Brace	$P_{s_ci} = 449.1$ kips (C)	Left Brace	$P_{s_t} = -559.7$ kips (T)		
LC3	Right Brace	$P_{s_t} = -559.7$ kips (T)	Left Brace	$P_{s_cii} = 134.7$ kips (C)	post-buckling	AISC 341-16 F2.3(ii)
LC4	Right Brace	$P_{s_cii} = 134.7$ kips (C)	Left Brace	$P_{s_t} = -559.7$ kips (T)	post-buckling	

Right brace $P_1 = S_{CH} = 559.7$ kips (C) Left brace $P_2 = S_{LT} = 449.1$ kips (C) Post Seismic

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	$= -559.7$ [kips]	in tension
Right brace to hor line angle	$\theta_1 =$ from user input	$= 45.0$ [°]	
	$H_1 = -395.8$ [kips]	$V_1 = -395.8$ [kips]	
Left brace axial force	$P_2 =$ from seismic brace force calc	$= 449.1$ [kips]	in compression
Left brace to hor line angle	$\theta_2 =$ from user input	$= 45.0$ [°]	
	$H_2 = 317.6$ [kips]	$V_2 = 317.6$ [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]	$h = 31.294$ [in]	
	$M_1 = -364.44$ [kip-ft]	$M_2 = -292.42$ [kip-ft]	

Forces on Section a-a

AISC DG29 Fig. 4-6

Shear	$V = H_1 - H_2$	$= -713.3$ [kips]	
Axial	$N = V_1 + V_2$	$= -78.2$ [kips]	in tension
Moment	$M = M_1 + M_2$	$= -656.86$ [kip-ft]	

Forces on Section b-b

AISC DG29 Fig. 4-7

Shear	$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$	$= 64.7$ [kips]	
Axial	$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$	$= -39.1$ [kips]	in tension
Moment	$M' = \frac{L}{8}(V_1 + V_2) + \frac{h}{4}(H_1 - H_2) + \frac{M}{2} - V_1 \Delta - H_1(e + \frac{h}{2})$	$= 43.00$ [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	$= 449.1$ [kips]	in compression
Right brace to hor line angle	$\theta_1 =$ from user input	$= 45.0$ [°]	
	$H_1 = 317.6$ [kips]	$V_1 = 317.6$ [kips]	
Left brace axial force	$P_2 =$ from seismic brace force calc	$= -559.7$ [kips]	in tension
Left brace to hor line angle	$\theta_2 =$ from user input	$= 45.0$ [°]	
	$H_2 = -395.8$ [kips]	$V_2 = -395.8$ [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]	$h = 31.294$ [in]	

$$e = 11.030 \text{ [in]}$$

$$h = 51.294 \text{ [in]}$$

$$M_1 = 292.42 \text{ [kip-ft]}$$

$$M_2 = 364.44 \text{ [kip-ft]}$$

Forces on Section a-a

AISC DG29 Fig. 4-6

Shear

$$V = H_1 - H_2 = \mathbf{713.3} \text{ [kips]}$$

Axial

$$N = V_1 + V_2 = \mathbf{-78.2} \text{ [kips]} \text{ in tension}$$

Moment

$$M = M_1 + M_2 = \mathbf{656.86} \text{ [kip-ft]}$$

Forces on Section b-b

AISC DG29 Fig. 4-7

Shear

$$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5X_L} - V_1 = \mathbf{-64.7} \text{ [kips]}$$

Axial

$$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1 = \mathbf{-39.1} \text{ [kips]} \text{ in tension}$$

Moment

$$M' = \frac{L}{8}(V_1 + V_2) + \frac{h}{4}(H_1 - H_2) + \frac{M}{2} - V_1 \Delta - H_1 \left(e + \frac{h}{2}\right) = \mathbf{43.00} \text{ [kip-ft]}$$

Right Brace - Brace to Gusset Sect=HSS 6.875 x 0.500 $P_1 = -559.7$ kips (T) $P_2 = 449.1$ kips (C) Code=AISC 360-16 LRFD

Result Summary

geometries & weld limitations = **PASS**

limit states max ratio = **0.97** **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 HSS6.875X0.500

$$D = 6.875 \text{ [in]}$$

$$t = 0.465 \text{ [in]}$$

HSS sect HSS6.875X0.500

$$F_y = \text{A500 Gr.C Round}$$

$$= 46.0 \text{ [ksi]}$$

$$E = 29000 \text{ [ksi]}$$

Ratio of expected F_y to specified min F_y

$$R_y = 1.30$$

AISC 341-16 Table A3.1

CHS width-to-thickness ratio limit

$$\lambda_{hd} = 0.053 \frac{E}{R_y F_y}$$

$$= \mathbf{25.70}$$

AISC SDM 3rd Table 1-D

CHS width-to-thickness ratio actual

$$D/t = D/t$$

$$= \mathbf{14.78}$$

$$\leq \lambda_{hd}$$

OK

Brace Slot Effective Net Area Check			PASS
HSS With Reinforcing Plates Effective Net Area			
CHS sect HSS6.875X0.500	D = 6.875 [in] A _g = 9.360 [in ²]	t = 0.465 [in]	
Gusset plate thickness	t _{gp} = from user input	= 0.750 [in]	
HSS cut slot width	w = t _{gp} + 1/8"	= 0.875 [in]	
HSS brace net area	A _{nb} = A _g - 2 w t	= 8.546 [in ²]	
Reinforcing plate	w _r = 1.250 [in]	t _r = 1.250 [in]	
Reinforcing plate area	A _r = w _r x t _r	= 1.563 [in ²]	
CHS 1/2 net area A ₁ = 0.5A _{nb}	A ₁ = 4.273 [in ²]	r ₁ = 2.040 [in]	
Reinforce plate	A ₂ = 1.563 [in ²]	r ₂ = 4.063 [in]	
Dist to centroid of comb sect	$\bar{x} = \frac{A_1 r_1 + A_2 r_2}{A_1 + A_2}$	= 2.582 [in]	
Length of connection	L =	= 26.000 [in]	
Shear lag factor	U = 1 - $\bar{x} / L$	= 0.901	AISC 15 th Table D3.1
Total net area	A _n = A _{nb} + 2 x A _r	= 11.671 [in ²]	
Total effective net area	A _e = U A _n	= 10.512 [in ²]	
The brace effective net area shall not be less than the brace gross area			AISC 341-16 F2.5b (3)
HSS sect HSS6.875X0.500	A _g = brace gross area	= 9.360 [in ²]	
Total brace effective net area	A _e = U A _n	= 10.512 [in ²]	
		≥ 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 HSS6.875X0.500	F _y = A500 Gr.C Round	= 46.0 [ksi]	
Reinforce plate	F _{yp} = A992	= 50.0 [ksi]	
		≥ 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 =	= 0.465 [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]	
		≥ 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 15 th J2.2b
Min fillet weld length	L =	= 26.000 [in]	
		≥ L _{min}	OK

Seismic SCBF LC1

Sect=HSS 6.875 x 0.500

P =-559.7 kips (T)

ratio = **0.97**

PASS

HSS Brace Wall - Gusset PL - Shear Yield		ratio = 559.7 / 1735.2		= 0.32	PASS
HSS Brace Wall-Gusset Plate Shear Yielding					
HSS sect HSS6.875X0.500 wall thick	t = 0.465	[in]	F _y = 46.0	[ksi]	
HSS brace wall-gusset overlap length	L = 26.000	[in]			
Ratio of expected F _y to specified min F _y	R _y = 1.30				AISC 341-16 Table A3.1
Beam axial load	P _u = from seismic load calc		= 559.7	[kips]	
HSS brace wall-gusset shear yielding	R _n = 0.6 R _y F _y t L x 4 walls		= 1735.2	[kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	φ = 1.00				AISC 15 th Eq J4-3
	φ R _n =		= 1735.2	[kips]	
	ratio = 0.32		> P _u	OK	

HSS Brace Wall - Gusset PL - Shear Rupture		ratio = 559.7 / 1619.1		= 0.35	PASS
HSS Brace Wall-Gusset Plate Shear Yielding					
HSS sect HSS6.875X0.500 wall thick	t = 0.465	[in]	F _u = 62.0	[ksi]	
HSS brace wall-gusset overlap length	L = 26.000	[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		= 559.7	[kips]	
HSS brace wall-gusset shear rupture	R _n = 0.6 R _t F _u t L x 4 walls		= 2158.8	[kips]	AISC 15 th Eq J4-4
Resistance factor-LRFD	φ = 0.75				AISC 15 th Eq J4-4
	φ R _n =		= 1619.1	[kips]	
	ratio = 0.35		> P _u	OK	

Gusset Plate - Block Shear Rupture		ratio = 559.7 / 1128.9		= 0.50	PASS
Plate Block Shear - Center Strip					
Plate thickness	$t_p = 0.750$	[in]			
Plate strength	$F_y = 50.0$	[ksi]	$F_u = 65.0$	[ksi]	
C shape weld group size	width $b = 26.000$	[in]	depth $d = 6.875$	[in]	
Gross area subject to shear	$A_{gv} = b t_p \times 2$		$= 39.000$	[in ²]	
Net area subject to shear	$A_{nv} = A_{gvb}$		$= 39.000$	[in ²]	
Net area subject to tension	$A_{nt} = d t_p$		$= 5.156$	[in ²]	
Block shear strength required	$V_u =$		$= 559.7$	[kips]	
Uniform tension stress factor	$U_{bs} = 1.00$				AISC 15 th Fig C-J4.2
Bolt shear resistance provided	$R_n = \min (0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$		$= 1505.2$	[kips]	AISC 15 th Eq J4-5
Resistance factor-LRFD	$\phi = 0.75$				AISC 15 th Eq J4-5
	$\phi R_n =$		$= 1128.9$	[kips]	
	ratio = 0.50		$> V_u$	OK	

Gusset Plate - Tensile Yield (Whitmore)		ratio = 559.7 / 992.6	= 0.56	PASS
Plate Tensile Yielding Check				
Plate size	width $b_p = 29.411$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 22.058 [in ²]		
Tensile force required	$P_u =$	= 559.7 [kips]		
Plate tensile yielding strength	$R_n = F_y A_g$	= 1102.9 [kips]	AISC 15 th Eq J4-1	
Resistance factor-LRFD	$\phi = 0.90$	AISC 15 th Eq J4-1		
	$\phi R_n =$	= 992.6 [kips]		
	ratio = 0.56	> P_u	OK	

Gusset Plate - Tensile Rupture (Whitmore)		ratio = 559.7 / 1075.3		= 0.52	PASS
Plate Tensile Rupture Check					
Plate size	width $b_p = 29.411$ [in]	thickness $t_p = 0.750$ [in]			
Plate tensile strength	$F_u = 65.0$ [ksi]				
Plate net area in tension	$A_{nt} = b_p t_p$	= 22.058 [in ²]			
Tensile force required	$P_u =$	= 559.7 [kips]			
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 1433.8 [kips]	AISC 15 th Eq J4-2		
Resistance factor-LRFD	$\phi = 0.75$	AISC 15 th Eq J4-2			
	$\phi R_n =$	= 1075.3 [kips]	AISC 15 th Eq J4-2		
	ratio = 0.52	> P_u	OK		

Brace Slot to Gusset Plate Weld Strength		ratio = 559.7 / 574.4 = 0.97 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 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} θ)	= 1.00	AISC 15 th Page 8-9
Fillet weld shear strength	R _{n-w} = 0.6 (C ₁ x 70 ksi) 0.707 w n C ₂	= 14.847 [kip/in]	AISC 15 th Eq 8-1
Base metal - brace	thickness t = 0.750 [in]	tensile F _u = 65.0 [ksi]	
Base metal - brace is in shear, <u>shear</u> 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	= 29.250 [kip/in]	AISC 15 th Eq J4-4
Double fillet linear shear strength	R _n = min (R _{n-w} , R _{n-b})	= 14.847 [kip/in]	AISC 15 th Eq 9-2
Resistance factor-LRFD	φ = 0.75		AISC 15 th Eq 8-1
	φ R _n =	= 11.135 [kip/in]	
Shear resistance required	V _u =	= 559.7 [kips]	
Fillet weld leg size	w = 1/4 [in]	max L = 26.000 [in]	
	when L/w = 104.0 > 100 , weld length reduction applied		AISC 15 th J2.2b
Weld length reduction factor	β = 1.2 - 0.002 (L/w) ≤ 1.0	= 0.99	AISC 15 th Eq J2-1
Weld length used for design	L = β x L	= 51.584 [in]	
Fillet weld length - double fillet	L =	= 51.584 [in]	
Shear resistance provided	φ F _n = φ R _n x L	= 574.4 [kips]	
	ratio = 0.97	> V _u	OK

Reinforce Plate to Brace Wall Weld Strength		ratio = 85.9 / 96.0	= 0.89	PASS
Reinforcing plate	$w_r = 1.250$ [in]	$t_r = 1.250$ [in]		
	$F_y = 50.0$ [ksi]			
Ratio of expected F_y to specified min F_y	$R_y = 1.10$			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.563 [in ²]		
Required strength of weld	$P_u = R_y F_y A_r$	= 85.9 [kips]		
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	$L_L = \text{reinforce plate length}$	= 8.000 [in]		
Transverse weld length	$L_T = \text{reinforce plate width}$	= 1.250 [in]		
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 17.250 [in]		AISC 15 th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 15.475 [in]		AISC 15 th Eq J2-10b
	$L = \max (L_1, L_2)$	= 17.250 [in]		AISC 15 th J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = 1/4$ [in]	load angle $\theta = 0.0$ [°]		
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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$	= 7.424 [kip/in]		AISC 15 th Eq 8-1
Base metal - reinforce plate	thickness $t = 1.250$ [in]	tensile $F_u = 65.0$ [ksi]		
Base metal - reinforce plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$	= 48.750 [kip/in]		AISC 15 th Eq J4-4
Single fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$	= 7.424 [kip/in]		AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$	= 5.568 [kip/in]		
Shear resistance required	$P_u =$	= 85.9 [kips]		
Fillet weld length - single fillet	$L =$	= 17.250 [in]		
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= 96.0 [kips]		
	ratio = 0.89	> P_u	OK	

Seismic SCBF LC2

Sect=HSS 6.875 x 0.500

P =449.1 kips (C)

ratio = **0.89** **PASS**

Gusset Plate - Compression (Whitmore)		ratio = 449.1 / 891.4		= 0.50		PASS	
Plate Compression Check							
Plate size	width $b_p = 29.411$ [in]	thickness $t_p = 0.750$ [in]					
	$F_y = 50.0$ [ksi]	$E = 29000$ [ksi]					
Plate gross area in compression	$A_g = b_p t_p$	$= 22.058$ [in ²]					
Plate radius of gyration	$r = t_p / \sqrt{12}$	$= 0.217$ [in]					
Plate effective length factor	$K =$	$= 0.65$					
Plate unbraced length	$L_u =$	$= 12.778$ [in]					
Plate slenderness	$KL/r = 0.65 \times L_u / r$	$= 38.36$					
	when $\frac{KL}{r} > 25$, use Chapter E					AISC 15 th J4.4 (b)	
Elastic buckling stress	$F_e = \frac{\pi^2 E}{(KL/r)^2}$	$= 194.49$ [ksi]				AISC 15 th Eq E3-4	
	when $\frac{KL}{r} \leq 4.71 \left(\frac{E}{F_y} \right)^{0.5} = 113.43$					AISC 15 th E3 (a)	
Critical stress	$F_{cr} = 0.658^{(F_y/F_e)} F_y$	$= 44.90$ [ksi]				AISC 15 th Eq E3-2	
Plate compression required	$P_u = P_c = 449.1$	$= 449.1$ [kips]					
Plate compression provided	$R_n = F_{cr} \times A_g$	$= 990.4$ [kips]				AISC 15 th Eq E3-1	
Resistance factor-LRFD	$\phi = 0.90$					AISC 15 th E1	
	$\phi R_n =$	$= 891.4$ [kips]					
	ratio = 0.50	$> P_u$				OK	

Brace Slot to Gusset Plate Weld Strength		ratio = 449.1 / 574.4	= 0.78	PASS
Fillet Weld Strength Check				
Fillet weld leg size	$w = 1/4$ [in]	load angle $\theta = 0.0$ [°]		
Electrode strength	$F_{EXX} = 70.0$ [ksi]	strength coeff $C_1 = 1.00$		AISC 15 th Table 8-3
Number of weld line	$n = 2$ for double 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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$	= 14.847 [kip/in]		AISC 15 th Eq 8-1
Base metal - brace	thickness $t = 0.750$ [in]	tensile $F_u = 65.0$ [ksi]		
Base metal - brace is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$	= 29.250 [kip/in]		AISC 15 th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$	= 14.847 [kip/in]		AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$	= 11.135 [kip/in]		
Shear resistance required	$V_u =$	= 449.1 [kips]		
Fillet weld leg size	$w = 1/4$ [in]	max $L = 26.000$ [in]		
	when $L/w = 104.0 > 100$, weld length reduction applied			AISC 15 th J2.2b
Weld length reduction factor	$\beta = 1.2 - 0.002 (L/w) \leq 1.0$	= 0.99		AISC 15 th Eq J2-1
Weld length used for design	$L = \beta \times L$	= 51.584 [in]		
Fillet weld length - double fillet	$L =$	= 51.584 [in]		
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= 574.4 [kips]		
	ratio = 0.78	> V_u	OK	

Reinforce Plate to Brace Wall Weld Strength		ratio = 85.9 / 96.0	= 0.89	PASS
Reinforcing plate	$w_r = 1.250$ [in]	$t_r = 1.250$ [in]		
	$F_y = 50.0$ [ksi]			
Ratio of expected F_y to specified min F_y	$R_y = 1.10$			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.563 [in ²]		
Required strength of weld	$P_u = R_y F_y A_r$	= 85.9 [kips]		
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	$L_L = \text{reinforce plate length}$	= 8.000 [in]		
Transverse weld length	$L_T = \text{reinforce plate width}$	= 1.250 [in]		
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 17.250 [in]		AISC 15 th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 15.475 [in]		AISC 15 th Eq J2-10b
	$L = \max (L_1, L_2)$	= 17.250 [in]		AISC 15 th J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = 1/4$ [in]	load angle $\theta = 0.0$ [°]		
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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$	= 7.424 [kip/in]		AISC 15 th Eq 8-1
Base metal - reinforce plate	thickness $t = 1.250$ [in]	tensile $F_u = 65.0$ [ksi]		
Base metal - reinforce plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$	= 48.750 [kip/in]		AISC 15 th Eq J4-4
Single fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$	= 7.424 [kip/in]		AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$	= 5.568 [kip/in]		
Shear resistance required	$P_u =$	= 85.9 [kips]		
Fillet weld length - single fillet	$L =$	= 17.250 [in]		
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= 96.0 [kips]		
	ratio = 0.89	> P_u	OK	

Left Brace - Brace to Gusset Sect=HSS 6.875 x 0.500 $P_1 = 449.1$ kips (C) $P_2 = -559.7$ kips (T) Code=AISC 360-16 LRFD

Result Summary geometries & weld limitations = **PASS** limit states max ratio = **0.97** **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 HSS6.875X0.500	D = 6.875 [in]	t = 0.465 [in]
HSS sect HSS6.875X0.500	$F_y = A500$ Gr.C Round	= 46.0 [ksi]
	E = 29000 [ksi]	

Ratio of expected F_y to specified min F_y	$R_y = 1.30$	AISC 341-16 Table A3.1
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CHS width-to-thickness ratio limit	$\lambda_{hd} = 0.053 \frac{E}{R_y F_y}$	= 25.70	AISC SDM 3 rd Table 1-D
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CHS width-to-thickness ratio actual	D/t = D/t	= 14.78	
		$\leq \lambda_{hd}$	OK

Brace Slot Effective Net Area Check			PASS
HSS With Reinforcing Plates Effective Net Area			
CHS sect HSS6.875X0.500	D = 6.875 [in] $A_g = 9.360$ [in ²]	t = 0.465 [in]	
Gusset plate thickness	$t_{gp} =$ from user input	= 0.750 [in]	
HSS cut slot width	$w = t_{gp} + 1/8"$	= 0.875 [in]	
HSS brace net area	$A_{nb} = A_g - 2 w t$	= 8.546 [in ²]	
Reinforcing plate	$w_r = 1.250$ [in]	$t_r = 1.250$ [in]	
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.563 [in ²]	
CHS 1/2 net area $A_1 = 0.5A_{nb}$	$A_1 = 4.273$ [in ²]	$r_1 = 2.040$ [in]	
Reinforce plate	$A_2 = 1.563$ [in ²]	$r_2 = 4.063$ [in]	
Dist to centroid of comb sect	$\bar{x} = \frac{A_1 r_1 + A_2 r_2}{A_1 + A_2}$	= 2.582 [in]	
Length of connection	L =	= 26.000 [in]	
Shear lag factor	$U = 1 - \bar{x} / L$	= 0.901	AISC 15 th Table D3.1
Total net area	$A_n = A_{nb} + 2 \times A_r$	= 11.671 [in ²]	
Total effective net area	$A_e = U A_n$	= 10.512 [in ²]	
The brace effective net area shall not be less than the brace gross area			AISC 341-16 F2.5b (3)
HSS sect HSS6.875X0.500	$A_g =$ brace gross area	= 9.360 [in ²]	
Total brace effective net area	$A_e = U A_n$	= 10.512 [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 HSS6.875X0.500	$F_y =$ 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 =	= 0.465 [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 =	= 26.000 [in]	
	$\geq L_{min}$	OK	

Seismic SCBF LC1

Sect=HSS 6.875 x 0.500

P =449.1 kips (C)

ratio = **0.89**

PASS

Gusset Plate - Compression (Whitmore)		ratio = 449.1 / 891.4 = 0.50 PASS	
Plate Compression Check			
Plate size	width $b_p = 29.411$ [in] $F_y = 50.0$ [ksi]	thickness $t_p = 0.750$ [in] $E = 29000$ [ksi]	
Plate gross area in compression	$A_g = b_p t_p$	$= 22.058$ [in ²]	
Plate radius of gyration	$r = t_p / \sqrt{12}$	$= 0.217$ [in]	
Plate effective length factor	$K =$	$= 0.65$	
Plate unbraced length	$L_u =$	$= 12.778$ [in]	
Plate slenderness	$KL/r = 0.65 \times L_u / r$	$= 38.36$	
	when $\frac{KL}{r} > 25$, use Chapter E		AISC 15 th J4.4 (b)
Elastic buckling stress	$F_e = \frac{\pi^2 E}{(KL/r)^2}$	$= 194.49$ [ksi]	AISC 15 th Eq E3-4
	when $\frac{KL}{r} \leq 4.71 \left(\frac{E}{F_y} \right)^{0.5} = 113.43$		AISC 15 th E3 (a)
Critical stress	$F_{cr} = 0.658^{(F_y/F_e)} F_y$	$= 44.90$ [ksi]	AISC 15 th Eq E3-2
Plate compression required	$P_u = P_c = 449.1$	$= \mathbf{449.1}$ [kips]	
Plate compression provided	$R_n = F_{cr} \times A_g$	$= 990.4$ [kips]	AISC 15 th Eq E3-1
Resistance factor-LRFD	$\phi = 0.90$		AISC 15 th E1
	$\phi R_n =$	$= \mathbf{891.4}$ [kips]	
	ratio = 0.50	$> P_u$	OK

Brace Slot to Gusset Plate Weld Strength		ratio = 449.1 / 574.4	= 0.78	PASS
Fillet Weld Strength Check				
Fillet weld leg size	$w = 1/4$ [in]	load angle $\theta = 0.0$ [°]		
Electrode strength	$F_{EXX} = 70.0$ [ksi]	strength coeff $C_1 = 1.00$		AISC 15 th Table 8-3
Number of weld line	$n = 2$ for double 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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$	= 14.847 [kip/in]		AISC 15 th Eq 8-1
Base metal - brace	thickness $t = 0.750$ [in]	tensile $F_u = 65.0$ [ksi]		
Base metal - brace is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$	= 29.250 [kip/in]		AISC 15 th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$	= 14.847 [kip/in]		AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$	= 11.135 [kip/in]		
Shear resistance required	$V_u =$	= 449.1 [kips]		
Fillet weld leg size	$w = 1/4$ [in]	max $L = 26.000$ [in]		
	when $L/w = 104.0 > 100$, weld length reduction applied			AISC 15 th J2.2b
Weld length reduction factor	$\beta = 1.2 - 0.002 (L/w) \leq 1.0$	= 0.99		AISC 15 th Eq J2-1
Weld length used for design	$L = \beta \times L$	= 51.584 [in]		
Fillet weld length - double fillet	$L =$	= 51.584 [in]		
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= 574.4 [kips]		
	ratio = 0.78	> V_u	OK	

Reinforce Plate to Brace Wall Weld Strength		ratio = 85.9 / 96.0	= 0.89	PASS
Reinforcing plate	$w_r = 1.250$ [in]	$t_r = 1.250$ [in]		
	$F_y = 50.0$ [ksi]			
Ratio of expected F_y to specified min F_y	$R_y = 1.10$			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.563 [in ²]		
Required strength of weld	$P_u = R_y F_y A_r$	= 85.9 [kips]		
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	$L_L = \text{reinforce plate length}$	= 8.000 [in]		
Transverse weld length	$L_T = \text{reinforce plate width}$	= 1.250 [in]		
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 17.250 [in]		AISC 15 th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 15.475 [in]		AISC 15 th Eq J2-10b
	$L = \max (L_1, L_2)$	= 17.250 [in]		AISC 15 th J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = 1/4$ [in]	load angle $\theta = 0.0$ [°]		
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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$	= 7.424 [kip/in]		AISC 15 th Eq 8-1
Base metal - reinforce plate	thickness $t = 1.250$ [in]	tensile $F_u = 65.0$ [ksi]		
Base metal - reinforce plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$	= 48.750 [kip/in]		AISC 15 th Eq J4-4
Single fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$	= 7.424 [kip/in]		AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$	= 5.568 [kip/in]		
Shear resistance required	$P_u =$	= 85.9 [kips]		
Fillet weld length - single fillet	$L =$	= 17.250 [in]		
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= 96.0 [kips]		
	ratio = 0.89	> P_u	OK	

Seismic SCBF LC2

Sect=HSS 6.875 x 0.500

P =-559.7 kips (T)

ratio = **0.97** **PASS**

HSS Brace Wall - Gusset PL - Shear Yield		ratio = 559.7 / 1735.2		= 0.32	PASS
HSS Brace Wall-Gusset Plate Shear Yielding					
HSS sect HSS6.875X0.500 wall thick	t = 0.465	[in]	F _y = 46.0	[ksi]	
HSS brace wall-gusset overlap length	L = 26.000	[in]			
Ratio of expected F _y to specified min F _y	R _y = 1.30				AISC 341-16 Table A3.1
Beam axial load	P _u = from seismic load calc		= 559.7	[kips]	
HSS brace wall-gusset shear yielding	R _n = 0.6 R _y F _y t L x 4 walls		= 1735.2	[kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	φ = 1.00				AISC 15 th Eq J4-3
	φ R _n =		= 1735.2	[kips]	
	ratio = 0.32		> P _u	OK	

HSS Brace Wall - Gusset PL - Shear Rupture		ratio = 559.7 / 1619.1 = 0.35		PASS
HSS Brace Wall-Gusset Plate Shear Yielding				
HSS sect HSS6.875X0.500 wall thick	t = 0.465 [in]	F _u = 62.0 [ksi]		
HSS brace wall-gusset overlap length	L = 26.000 [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	= 559.7 [kips]		
HSS brace wall-gusset shear rupture	R _n = 0.6 R _t F _u t L x 4 walls	= 2158.8 [kips]		AISC 15 th Eq J4-4
Resistance factor-LRFD	φ = 0.75			AISC 15 th Eq J4-4
	φ R _n =	= 1619.1 [kips]		
	ratio = 0.35	> P _u	OK	

Gusset Plate - Block Shear Rupture		ratio = 559.7 / 1128.9 = 0.50 PASS	
Plate Block Shear - Center Strip			
Plate thickness	$t_p = 0.750$ [in]		
Plate strength	$F_y = 50.0$ [ksi]	$F_u = 65.0$ [ksi]	
C shape weld group size	width $b = 26.000$ [in]	depth $d = 6.875$ [in]	
Gross area subject to shear	$A_{gv} = b t_p \times 2$	$= 39.000$ [in ²]	
Net area subject to shear	$A_{nv} = A_{gvb}$	$= 39.000$ [in ²]	
Net area subject to tension	$A_{nt} = d t_p$	$= 5.156$ [in ²]	
Block shear strength required	$V_u =$	$= 559.7$ [kips]	
Uniform tension stress factor	$U_{bs} = 1.00$		AISC 15 th Fig C-J4.2
Bolt shear resistance provided	$R_n = \min (0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$	$= 1505.2$ [kips]	AISC 15 th Eq J4-5
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th Eq J4-5
	$\phi R_n =$	$= 1128.9$ [kips]	
	ratio = 0.50	$> V_u$	OK

Gusset Plate - Tensile Yield (Whitmore)		ratio = 559.7 / 992.6	= 0.56	PASS
Plate Tensile Yielding Check				
Plate size	width $b_p = 29.411$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 22.058 [in ²]		
Tensile force required	$P_u =$	= 559.7 [kips]		
Plate tensile yielding strength	$R_n = F_y A_g$	= 1102.9 [kips]		AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$			AISC 15 th Eq J4-1
	$\phi R_n =$	= 992.6 [kips]		
	ratio = 0.56	> P_u	OK	

Gusset Plate - Tensile Rupture (Whitmore)		ratio = 559.7 / 1075.3	= 0.52	PASS
Plate Tensile Rupture Check				
Plate size	width $b_p = 29.411$ [in]	thickness $t_p = 0.750$ [in]		
Plate tensile strength	$F_u = 65.0$ [ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$	= 22.058 [in ²]		
Tensile force required	$P_u =$	= 559.7 [kips]		
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 1433.8 [kips]		AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-2
	$\phi R_n =$	= 1075.3 [kips]		AISC 15 th Eq J4-2
	ratio = 0.52	> P_u	OK	

Brace Slot to Gusset Plate Weld Strength		ratio = 559.7 / 574.4		= 0.97	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 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} θ)		= 1.00		AISC 15 th Page 8-9
Fillet weld shear strength	R _{n-w} = 0.6 (C ₁ x 70 ksi) 0.707 w n C ₂		= 14.847	[kip/in]	AISC 15 th Eq 8-1
Base metal - brace	thickness t = 0.750	[in]	tensile F _u = 65.0	[ksi]	
Base metal - brace is in shear, <u>shear</u> 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		= 29.250	[kip/in]	AISC 15 th Eq J4-4
Double fillet linear shear strength	R _n = min (R _{n-w} , R _{n-b})		= 14.847	[kip/in]	AISC 15 th Eq 9-2
Resistance factor-LRFD	φ = 0.75				AISC 15 th Eq 8-1
	φ R _n =		= 11.135	[kip/in]	
Shear resistance required	V _u =		= 559.7	[kips]	
Fillet weld leg size	w = 1/4	[in]	max L = 26.000	[in]	
	when L/w = 104.0 >100 , weld length reduction applied				AISC 15 th J2.2b
Weld length reduction factor	β = 1.2 - 0.002 (L/w) ≤ 1.0		= 0.99		AISC 15 th Eq J2-1
Weld length used for design	L = β x L		= 51.584	[in]	
Fillet weld length - double fillet	L =		= 51.584	[in]	
Shear resistance provided	φ F _n = φ R _n x L		= 574.4	[kips]	
	ratio = 0.97		> V _u		OK

Reinforce Plate to Brace Wall Weld Strength		ratio = 85.9 / 96.0	= 0.89	PASS
Reinforcing plate	$w_r = 1.250$ [in]	$t_r = 1.250$ [in]		
	$F_y = 50.0$ [ksi]			
Ratio of expected F_y to specified min F_y	$R_y = 1.10$			AISC 341-16 Table A3.1
Reinforcing plate area	$A_r = w_r \times t_r$	= 1.563 [in ²]		
Required strength of weld	$P_u = R_y F_y A_r$	= 85.9 [kips]		
Reinforce Plate to Brace Wall Fillet Weld Length				
Longitudinal weld length	$L_L = \text{reinforce plate length}$	= 8.000 [in]		
Transverse weld length	$L_T = \text{reinforce plate width}$	= 1.250 [in]		
Total weld length - single fillet weld	$L_1 = 2 \times L_L + L_T$	= 17.250 [in]		AISC 15 th Eq J2-10a
	$L_2 = 0.85 \times 2 \times L_L + 1.5 \times L_T$	= 15.475 [in]		AISC 15 th Eq J2-10b
	$L = \max (L_1, L_2)$	= 17.250 [in]		AISC 15 th J2.4 (c)
Fillet Weld Strength Check				
Fillet weld leg size	$w = 1/4$ [in]	load angle $\theta = 0.0$ [°]		
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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$	= 7.424 [kip/in]		AISC 15 th Eq 8-1
Base metal - reinforce plate	thickness $t = 1.250$ [in]	tensile $F_u = 65.0$ [ksi]		
Base metal - reinforce plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$	= 48.750 [kip/in]		AISC 15 th Eq J4-4
Single fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$	= 7.424 [kip/in]		AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$	= 5.568 [kip/in]		
Shear resistance required	$P_u =$	= 85.9 [kips]		
Fillet weld length - single fillet	$L =$	= 17.250 [in]		
Shear resistance provided	$\phi F_n = \phi R_n \times L$	= 96.0 [kips]		
	ratio = 0.89	> P_u		OK

Gusset to Beam

Direct Weld Connection

Code=AISC 360-16 LRFD

Result Summarygeometries & weld limitations = **PASS**limit states max ratio = **1.26** **FAIL****Weld Limitation Checks - Gusset to Beam****PASS****Min Fillet Weld Size**

Thinner part joined thickness	$t =$	$= 0.750$ [in]	
Min fillet weld size allowed	$w_{min} =$	$= 0.250$ [in]	AISC 15 th Table J2.4
Fillet weld size provided	$w =$	$= 0.438$ [in]	
		$\geq w_{min}$	OK

Min Fillet Weld Length

Fillet weld size provided	$w =$	$= 0.438$ [in]	
Min fillet weld length allowed	$L_{min} = 4 \times w$	$= 1.750$ [in]	AISC 15 th J2.2b
Min fillet weld length	$L =$	$= 84.686$ [in]	
		$\geq L_{min}$	OK

Brace Force LC1 $P_R = -559.7$ kips (T) $P_L = 449.1$ kips (C)ratio = **1.26** **FAIL****Gusset Plate - Shear Yielding (Sect a-a)**ratio = $713.3 / 1215.0 = 0.59$ **PASS****Plate Shear Yielding Check**

Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]	
Plate yield strength	$F_y = 50.0$ [ksi]		
Plate gross area in shear	$A_{gv} = b_p t_p$	$= 40.500$ [in ²]	
Shear force required	$V_u =$	$= 713.3$ [kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	$= 1215.0$ [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	$\phi = 1.00$		AISC 15 th Eq J4-3
	$\phi R_n =$	$= 1215.0$ [kips]	
	ratio = 0.59	$> V_u$	OK

Gusset Plate - Shear Rupture (Sect a-a)ratio = $713.3 / 1184.6 = 0.60$ **PASS****Plate Shear Rupture Check**

Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]	
Plate tensile strength	$F_u = 65.0$ [ksi]		
Plate net area in shear	$A_{nv} = b_p t_p$	$= 40.500$ [in ²]	
Shear force in demand	$V_u =$	$= 713.3$ [kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	$= 1579.5$ [kips]	AISC 15 th Eq J4-4
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th Eq J4-4
	$\phi R_n =$	$= 1184.6$ [kips]	
	ratio = 0.60	$> V_u$	OK

Gusset Plate - Axial Tensile Yield (Sect a-a)

ratio = 662.1 / 1822.5 = **0.36** **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 =	= -78.2 [kips]	
Gusset edge moment force	M =	= 656.86 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -662.1 [kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]	
Plate yield strength	$F_y = 50.0$ [ksi]		
Plate gross area in shear	$A_g = b_p t_p$	= 40.500 [in ²]	
Tensile force required	$P_u =$	= 662.1 [kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 2025.0 [kips]	AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$		AISC 15 th Eq J4-1
	$\phi R_n =$	= 1822.5 [kips]	
	ratio = 0.36	> P_u	OK

Gusset Plate - Axial Tensile Rupture (Sect a-a)

ratio = 662.1 / 1974.4 = **0.34** **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 =	= -78.2 [kips]	
Gusset edge moment force	M =	= 656.86 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -662.1 [kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]	
Plate tensile strength	$F_u = 65.0$ [ksi]		
Plate net area in tension	$A_{nt} = b_p t_p$	= 40.500 [in ²]	
Tensile force required	$P_u =$	= 662.1 [kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 2632.5 [kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th Eq J4-2
	$\phi R_n =$	= 1974.4 [kips]	AISC 15 th Eq J4-2
	ratio = 0.34	> P_u	OK

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= 0.48	PASS
Gusset plate	width $b_p = 54.000$ [in] yield $F_y = 50.0$ [ksi]	thick $t_p = 0.750$ [in]		
Shear plate - gross area	$A_g = b_p \times t_p$		= 40.500 [in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$		= 546.75 [in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$		= 2050.31 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 656.86 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check		= 1822.5 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -78.2 [kips]	
Shear strength available	$V_c =$ from shear yielding check		= 1215.0 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 713.3 [kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.48	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Flexural Rupture Interact (Sect a-a)		ratio =	= 0.48	PASS
Gusset plate	width $b_p = 54.000$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 40.500 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 546.75 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 2221.17 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 656.86 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1974.4 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -78.2 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 1184.6 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 713.3 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.48	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Shear Yielding (Sect b-b)		ratio = 64.7 / 704.1	= 0.09	PASS
Plate Shear Yielding Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$		= 23.471 [in ²]	
Shear force required	$V_u =$		= 64.7 [kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$		= 704.1 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	$\phi = 1.00$			AISC 15 th Eq J4-3
	$\phi R_n =$		= 704.1 [kips]	
	ratio = 0.09		> V_u	OK

Gusset Plate - Shear Rupture (Sect b-b)		ratio = 64.7 / 686.5	= 0.09	PASS
Plate Shear Rupture Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate tensile strength	$F_u = 65.0$ [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 23.471 [in ²]		
Shear force in demand	$V_u =$	= 64.7 [kips]		
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 915.3 [kips]		AISC 15 th Eq J4-4
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-4
	$\phi R_n =$	= 686.5 [kips]		
	ratio = 0.09	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect b-b)		ratio = 105.1 / 1056.2	= 0.10	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	$N =$	= -39.1 [kips]		
Gusset edge moment force	$M =$	= 43.00 [kip-ft]		
Gusset edge interface length	$L =$	= 31.294 [in]		
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -105.1 [kips]		AISC DG29 Fig B-1
Plate Tensile Yielding Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_g = b_p t_p$	= 23.471 [in ²]		
Tensile force required	$P_u =$	= 105.1 [kips]		
Plate tensile yielding strength	$R_n = F_y A_g$	= 1173.5 [kips]		AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$			AISC 15 th Eq J4-1
	$\phi R_n =$	= 1056.2 [kips]		
	ratio = 0.10	> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect b-b)		ratio = 105.1 / 1144.2	= 0.09	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 =	= -39.1	[kips]	
Gusset edge moment force	M =	= 43.00	[kip-ft]	
Gusset edge interface length	L =	= 31.294	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -105.1	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]		
Plate net area in tension	$A_{nt} = b_p t_p$	= 23.471	[in ²]	
Tensile force required	$P_u =$	= 105.1	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 1525.6	[kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-2
	$\phi R_n =$	= 1144.2	[kips]	AISC 15 th Eq J4-2
	ratio = 0.09	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)		ratio =	= 0.02	PASS
Gusset plate	width $b_p = 31.294$ [in]	thick $t_p = 0.750$	[in]	
	yield $F_y = 50.0$	[ksi]		
Shear plate - gross area	$A_g = b_p \times t_p$	= 23.471	[in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 183.62	[in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$	= 688.58	[kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc	= 43.00	[kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check	= 1056.2	[kips]	
Axial strength required	$P_r =$ from gusset interface forces calc	= -39.1	[kips]	
Shear strength available	$V_c =$ from shear yielding check	= 704.1	[kips]	
Shear strength required	$V_r =$ from gusset interface forces calc	= 64.7	[kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$	= 0.02		AISC 15 th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect b-b)		ratio =	= 0.02	PASS
Gusset plate	width $b_p = 31.294$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 23.471 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 745.96 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 43.00 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1144.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -39.1 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 686.5 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 64.7 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.02	AISC 15 th Eq 10-5
		< 1.0	OK	

Gusset to Beam Weld Strength		ratio = 22.06 / 17.55	= 1.26	FAIL
Gusset to Beam Interface - Forces				
shear V = 713.3	[kips]	axial N = -78.2	[kips]	in tension
moment M = 656.86	[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	$f_a = N / L_w$		= -1.448	[kip/in] in tension
Weld stress from shear force	$f_v = V / L_w$		= 13.209	[kip/in]
Weld stress from moment force	$f_b = \frac{M}{L^2 / 6}$		= 16.219	[kip/in]
Weld stress combined - max	$f_{max} = [(f_a - f_b)^2 + f_v^2]^{0.5}$		= 22.059	[kip/in] AISC 15 th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$		= 53.2	[°]
Fillet Weld Strength Calc				
Fillet weld leg size	$w = 7/16$	[in]	load angle $\theta = 53.2$	[°]
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	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$		= 1.36	AISC 15 th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$		= 35.293	[kip/in] AISC 15 th Eq 8-1
Base metal - gusset plate	thickness $t = 0.750$	[in]	tensile $F_u = 65.0$	[ksi]
Base metal - gusset plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$		= 29.250	[kip/in] AISC 15 th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$		= 29.250	[kip/in] AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$		= 21.938	[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	$\phi R_n = \phi R_n \times (1/1.25)$		= 17.550	[kip/in]
	ratio = 1.26		< 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 = 662.1 / 2241.0 = 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 =	= -78.2 [kips]	
Gusset edge moment force	M =	= 656.86 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -662.1 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 662.1 [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 15 th Eq J10-2
Resistance factor-LRFD	$\phi = 1.00$		
	$\phi R_n =$	= 2241.0 [kips]	
	ratio = 0.30	> P_u OK	

Column Web Local Crippling		ratio = 662.1 / 2192.3 = 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 =	= -78.2 [kips]	
Gusset edge moment force	M =	= 656.86 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -662.1 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 662.1 [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 15 th Eq J10-4
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th J10.3
	$\phi R_n =$	= 2192.3 [kips]	
	ratio = 0.30	> P_u OK	

Beam Web Longitudinal Shear Yielding		ratio = 713.3 / 2638.4 = 0.27		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 =	= 713.3 [kips]		
Beam web shear strength	R _n = 0.6 F _y t _w L _{eff}	= 2638.4 [kips]	AISC 15 th Eq J4-3	
Resistance factor-LRFD	ϕ = 1.00		AISC 15 th Eq J4-3	
	ϕ R _n =	= 2638.4 [kips]		
	ratio = 0.27	> V _u	OK	

Beam Web Transverse Section Shear Yielding		ratio = 285.1 / 477.4 = 0.60 PASS	
Beam sect W21X147	d = 22.100 [in]	t _w = 0.720 [in]	
Right brace axial force	P ₁ = from user input	= -559.7 [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 θ ₁	= -395.8 [kips]	
Gusset edge shear (Sect b-b)	V' =	= 64.7 [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	= 285.1 [kips]	
Beam web shear strength	R _n = 0.6 F _y d t _w C _v	= 477.4 [kips]	AISC 15 th Eq G2-1
	C _v = 1.00		AISC 15 th Eq G2-2
Resistance factor-LRFD	φ = 1.00		AISC 15 th Eq G2-1
	φ R _n =	= 477.4 [kips]	
	ratio = 0.60	> V _u	OK

Brace Force LC2P_R = 449.1 kips (C)P_L = -559.7 kips (T)ratio = **1.26** **FAIL**

Gusset Plate - Shear Yielding (Sect a-a)		ratio = 713.3 / 1215.0	= 0.59	PASS
Plate Shear Yielding Check				
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$	= 40.500 [in ²]		
Shear force required	$V_u =$	= 713.3 [kips]		
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 1215.0 [kips]	AISC 15 th Eq J4-3	
Resistance factor-LRFD	$\phi = 1.00$		AISC 15 th Eq J4-3	
	$\phi R_n =$	= 1215.0 [kips]		
	ratio = 0.59	> V_u	OK	

Gusset Plate - Shear Rupture (Sect a-a)		ratio = 713.3 / 1184.6		= 0.60	PASS
Plate Shear Rupture Check					
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]			
Plate tensile strength	$F_u = 65.0$ [ksi]				
Plate net area in shear	$A_{nv} = b_p t_p$	= 40.500 [in ²]			
Shear force in demand	$V_u =$	= 713.3 [kips]			
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 1579.5 [kips]	AISC 15 th Eq J4-4		
Resistance factor-LRFD	$\phi = 0.75$	AISC 15 th Eq J4-4			
	$\phi R_n =$	= 1184.6 [kips]			
	ratio = 0.60	> V_u	OK		

Gusset Plate - Axial Tensile Yield (Sect a-a)		ratio = 662.1 / 1822.5 = 0.36		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 =	= -78.2	[kips]	
Gusset edge moment force	M =	= 656.86	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -662.1	[kips]	AISC DG29 Fig B-1
Plate Tensile Yielding Check				
Plate size	width $b_p = 54.000$	[in]	thickness $t_p = 0.750$	[in]
Plate yield strength	$F_y = 50.0$	[ksi]		
Plate gross area in shear	$A_g = b_p t_p$		= 40.500	[in ²]
Tensile force required	$P_u =$		= 662.1	[kips]
Plate tensile yielding strength	$R_n = F_y A_g$		= 2025.0	[kips] AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$			AISC 15 th Eq J4-1
	$\phi R_n =$		= 1822.5	[kips]
	ratio = 0.36		> P_u	OK

Gusset Plate - Axial Tensile Rupture (Sect a-a)		ratio = 662.1 / 1974.4	= 0.34	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 =	= -78.2	[kips]	
Gusset edge moment force	M =	= 656.86	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -662.1	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check				
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]		
Plate net area in tension	$A_{nt} = b_p t_p$	= 40.500	[in ²]	
Tensile force required	$P_u =$	= 662.1	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 2632.5	[kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-2
	$\phi R_n =$	= 1974.4	[kips]	AISC 15 th Eq J4-2
	ratio = 0.34	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= 0.48	PASS
Gusset plate	width $b_p = 54.000$ [in]	thick $t_p = 0.750$	[in]	
	yield $F_y = 50.0$	[ksi]		
Shear plate - gross area	$A_g = b_p \times t_p$	= 40.500	[in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 546.75	[in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$	= 2050.31	[kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc	= 656.86	[kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check	= 1822.5	[kips]	
Axial strength required	$P_r =$ from gusset interface forces calc	= -78.2	[kips]	
Shear strength available	$V_c =$ from shear yielding check	= 1215.0	[kips]	
Shear strength required	$V_r =$ from gusset interface forces calc	= 713.3	[kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$	= 0.48		AISC 15 th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a)		ratio =	= 0.48	PASS
Gusset plate	width $b_p = 54.000$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 40.500 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 546.75 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 2221.17 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 656.86 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1974.4 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -78.2 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 1184.6 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 713.3 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.48	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Shear Yielding (Sect b-b)		ratio = 64.7 / 704.1	= 0.09	PASS
Plate Shear Yielding Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$		= 23.471 [in ²]	
Shear force required	$V_u =$		= 64.7 [kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$		= 704.1 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	$\phi = 1.00$			AISC 15 th Eq J4-3
	$\phi R_n =$		= 704.1 [kips]	
	ratio = 0.09		> V_u	OK

Gusset Plate - Shear Rupture (Sect b-b)		ratio = 64.7 / 686.5	= 0.09	PASS
Plate Shear Rupture Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate tensile strength	$F_u = 65.0$ [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$		= 23.471 [in ²]	
Shear force in demand	$V_u =$		= 64.7 [kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$		= 915.3 [kips]	AISC 15 th Eq J4-4
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-4
	$\phi R_n =$		= 686.5 [kips]	
	ratio = 0.09		> V_u	OK

Gusset Plate - Axial Tensile Yield (Sect b-b)

ratio = 105.1 / 1056.2 = **0.10** **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 =	= -39.1	[kips]	
Gusset edge moment force	M =	= 43.00	[kip-ft]	
Gusset edge interface length	L =	= 31.294	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -105.1	[kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width $b_p = 31.294$	[in]	thickness $t_p = 0.750$	[in]	
Plate yield strength	$F_y = 50.0$	[ksi]			
Plate gross area in shear	$A_g = b_p t_p$		= 23.471	[in ²]	
Tensile force required	$P_u =$		= 105.1	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$		= 1173.5	[kips]	AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$				AISC 15 th Eq J4-1
	$\phi R_n =$		= 1056.2	[kips]	
	ratio = 0.10		> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect b-b)

ratio = 105.1 / 1144.2 = **0.09** **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 =	= -39.1	[kips]	
Gusset edge moment force	M =	= 43.00	[kip-ft]	
Gusset edge interface length	L =	= 31.294	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -105.1	[kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width $b_p = 31.294$	[in]	thickness $t_p = 0.750$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$		= 23.471	[in ²]	
Tensile force required	$P_u =$		= 105.1	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 1525.6	[kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$				AISC 15 th Eq J4-2
	$\phi R_n =$		= 1144.2	[kips]	AISC 15 th Eq J4-2
	ratio = 0.09		> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)		ratio =	= 0.02	PASS
Gusset plate	width $b_p = 31.294$ [in] yield $F_y = 50.0$ [ksi]	thick $t_p = 0.750$ [in]		
Shear plate - gross area	$A_g = b_p \times t_p$		= 23.471 [in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$		= 688.58 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 43.00 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check		= 1056.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -39.1 [kips]	
Shear strength available	$V_c =$ from shear yielding check		= 704.1 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 64.7 [kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.02	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Flexural Rupture Interact (Sect b-b)		ratio =	= 0.02	PASS
Gusset plate	width $b_p = 31.294$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 23.471 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 745.96 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 43.00 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1144.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -39.1 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 686.5 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 64.7 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.02	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset to Beam Weld Strength		ratio = 22.06 / 17.55	= 1.26	FAIL
Gusset to Beam Interface - Forces				
shear V = 713.3	[kips]	axial N = -78.2	[kips]	in tension
moment M = 656.86	[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	$f_a = N / L_w$		= -1.448	[kip/in] in tension
Weld stress from shear force	$f_v = V / L_w$		= 13.209	[kip/in]
Weld stress from moment force	$f_b = \frac{M}{L^2 / 6}$		= 16.219	[kip/in]
Weld stress combined - max	$f_{max} = [(f_a - f_b)^2 + f_v^2]^{0.5}$		= 22.059	[kip/in] AISC 15 th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$		= 53.2	[°]
Fillet Weld Strength Calc				
Fillet weld leg size	$w = 7/16$	[in]	load angle $\theta = 53.2$	[°]
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	$C_2 = (1 + 0.5 \sin^{1.5} \theta)$		= 1.36	AISC 15 th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$		= 35.293	[kip/in] AISC 15 th Eq 8-1
Base metal - gusset plate	thickness $t = 0.750$	[in]	tensile $F_u = 65.0$	[ksi]
Base metal - gusset plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$		= 29.250	[kip/in] AISC 15 th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$		= 29.250	[kip/in] AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$		= 21.938	[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	$\phi R_n = \phi R_n \times (1/1.25)$		= 17.550	[kip/in]
	ratio = 1.26		< 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 = 662.1 / 2241.0 = 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 =	= -78.2 [kips]	
Gusset edge moment force	M =	= 656.86 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -662.1 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 662.1 [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 15 th Eq J10-2
Resistance factor-LRFD	$\phi = 1.00$		
	$\phi R_n =$	= 2241.0 [kips]	
	ratio = 0.30	> P_u	OK

Column Web Local Crippling		ratio = 662.1 / 2192.3 = 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 =	= -78.2 [kips]	
Gusset edge moment force	M =	= 656.86 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -662.1 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 662.1 [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 15 th Eq J10-4
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th J10.3
	$\phi R_n =$	= 2192.3 [kips]	
	ratio = 0.30	> P_u OK	

Beam Web Longitudinal Shear Yielding		ratio = 713.3 / 2638.4 = 0.27 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 =	= 713.3 [kips]	
Beam web shear strength	R _n = 0.6 F _y t _w L _{eff}	= 2638.4 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00		AISC 15 th Eq J4-3
	ϕ R _n =	= 2638.4 [kips]	
	ratio = 0.27	> V _u	OK

Beam Web Transverse Section Shear Yielding		ratio = 280.5 / 477.4 = 0.59 PASS	
Beam sect W21X147	d = 22.100 [in]	t _w = 0.720 [in]	
Right brace axial force	P ₁ = from user input	= 449.1 [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 θ ₁	= 317.6 [kips]	
Gusset edge shear (Sect b-b)	V' =	= -64.7 [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	= 280.5 [kips]	
Beam web shear strength	R _n = 0.6 F _y d t _w C _v	= 477.4 [kips]	AISC 15 th Eq G2-1
	C _v = 1.00		AISC 15 th Eq G2-2
Resistance factor-LRFD	φ = 1.00		AISC 15 th Eq G2-1
	φ R _n =	= 477.4 [kips]	
	ratio = 0.59	> 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	$= -559.7$ [kips]	in tension
Right brace to hor line angle	$\theta_1 =$ from user input	$= 45.0$ [°]	
	$H_1 = -395.8$ [kips]	$V_1 = -395.8$ [kips]	
Left brace axial force	$P_2 =$ from seismic brace force calc	$= 134.7$ [kips]	in compression
Left brace to hor line angle	$\theta_2 =$ from user input	$= 45.0$ [°]	
	$H_2 = 95.2$ [kips]	$V_2 = 95.2$ [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]	$h = 31.294$ [in]	
	$M_1 = -364.44$ [kip-ft]	$M_2 = -87.71$ [kip-ft]	

Forces on Section a-a

AISC DG29 Fig. 4-6

Shear	$V = H_1 - H_2$	$= -491.0$ [kips]	
Axial	$N = V_1 + V_2$	$= -300.5$ [kips]	in tension
Moment	$M = M_1 + M_2$	$= -452.14$ [kip-ft]	

Forces on Section b-b

AISC DG29 Fig. 4-7

Shear	$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$	$= 44.6$ [kips]	
Axial	$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$	$= -150.3$ [kips]	in tension
Moment	$M' = \frac{L}{8}(V_1 + V_2) + \frac{h}{4}(H_1 - H_2) + \frac{M}{2} - V_1 \Delta - H_1(e + \frac{h}{2})$	$= 165.25$ [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	$= 134.7$ [kips]	in compression
Right brace to hor line angle	$\theta_1 =$ from user input	$= 45.0$ [°]	
	$H_1 = 95.2$ [kips]	$V_1 = 95.2$ [kips]	
Left brace axial force	$P_2 =$ from seismic brace force calc	$= -559.7$ [kips]	in tension
Left brace to hor line angle	$\theta_2 =$ from user input	$= 45.0$ [°]	
	$H_2 = -395.8$ [kips]	$V_2 = -395.8$ [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]	$h = 31.294$ [in]	
	$M_1 = 87.71$ [kip-ft]	$M_2 = 364.44$ [kip-ft]	

Forces on Section a-a

AISC DG29 Fig. 4-6

Shear	$V = H_1 - H_2$	= 491.0 [kips]	
Axial	$N = V_1 + V_2$	= -300.5 [kips]	in tension
Moment	$M = M_1 + M_2$	= 452.14 [kip-ft]	

Forces on Section b-b

AISC DG29 Fig. 4-7

Shear	$V' = \frac{1}{2}(V_1 + V_2) + \frac{M}{0.5XL} - V_1$	= -44.6 [kips]	
Axial	$N' = \frac{1}{2}(H_1 - H_2) \times -1 + H_1$	= -150.3 [kips]	in tension
Moment	$M' = \frac{L}{8}(V_1 + V_2) + \frac{h}{4}(H_1 - H_2) + \frac{M}{2} - V_1 \Delta - H_1(e + \frac{h}{2})$	= 165.25 [kip-ft]	

Gusset to Beam

Direct Weld Connection

Code=AISC 360-16 LRFD

Result Summarygeometries & weld limitations = **PASS**limit states max ratio = **1.08** **FAIL****Weld Limitation Checks - Gusset to Beam****PASS****Min Fillet Weld Size**

Thinner part joined thickness	$t =$	= 0.750 [in]	
Min fillet weld size allowed	$w_{min} =$	= 0.250 [in]	AISC 15 th Table J2.4
Fillet weld size provided	$w =$	= 0.438 [in]	
		$\geq w_{min}$	OK

Min Fillet Weld Length

Fillet weld size provided	$w =$	= 0.438 [in]	
Min fillet weld length allowed	$L_{min} = 4 \times w$	= 1.750 [in]	AISC 15 th J2.2b
Min fillet weld length	$L =$	= 84.686 [in]	
		$\geq L_{min}$	OK

Brace Force LC3 $P_R = -559.7$ kips (T) $P_L = 134.7$ kips (C)ratio = **1.08** **FAIL****Gusset Plate - Shear Yielding (Sect a-a)**ratio = 491.0 / 1215.0 = **0.40** **PASS****Plate Shear Yielding Check**

Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]	
Plate yield strength	$F_y = 50.0$ [ksi]		
Plate gross area in shear	$A_{gv} = b_p t_p$	= 40.500 [in ²]	
Shear force required	$V_u =$	= 491.0 [kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$	= 1215.0 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	$\phi = 1.00$		AISC 15 th Eq J4-3
	$\phi R_n =$	= 1215.0 [kips]	
	ratio = 0.40	$> V_u$	OK

Gusset Plate - Shear Rupture (Sect a-a)		ratio = 491.0 / 1184.6		= 0.41	PASS
Plate Shear Rupture Check					
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]			
Plate tensile strength	$F_u = 65.0$ [ksi]				
Plate net area in shear	$A_{nv} = b_p t_p$	= 40.500 [in ²]			
Shear force in demand	$V_u =$	= 491.0 [kips]			
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 1579.5 [kips]	AISC 15 th Eq J4-4		
Resistance factor-LRFD	$\phi = 0.75$	AISC 15 th Eq J4-4			
	$\phi R_n =$	= 1184.6 [kips]			
	ratio = 0.41	> V_u	OK		

Gusset Plate - Axial Tensile Yield (Sect a-a)		ratio = 702.4 / 1822.5 = 0.39		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 =	= -300.5	[kips]	
Gusset edge moment force	M =	= 452.14	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -702.4	[kips]	AISC DG29 Fig B-1
Plate Tensile Yielding Check				
Plate size	width $b_p = 54.000$	[in]	thickness $t_p = 0.750$	[in]
Plate yield strength	$F_y = 50.0$	[ksi]		
Plate gross area in shear	$A_g = b_p t_p$		= 40.500	[in ²]
Tensile force required	$P_u =$		= 702.4	[kips]
Plate tensile yielding strength	$R_n = F_y A_g$		= 2025.0	[kips] AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$			AISC 15 th Eq J4-1
	$\phi R_n =$		= 1822.5	[kips]
	ratio = 0.39		> P_u	OK

Gusset Plate - Axial Tensile Rupture (Sect a-a)		ratio = 702.4 / 1974.4	= 0.36	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 =	= -300.5	[kips]	
Gusset edge moment force	M =	= 452.14	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -702.4	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check				
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]		
Plate net area in tension	$A_{nt} = b_p t_p$	= 40.500	[in ²]	
Tensile force required	$P_u =$	= 702.4	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 2632.5	[kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-2
	$\phi R_n =$	= 1974.4	[kips]	AISC 15 th Eq J4-2
	ratio = 0.36	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= 0.31	PASS
Gusset plate	width $b_p = 54.000$ [in]	thick $t_p = 0.750$	[in]	
	yield $F_y = 50.0$	[ksi]		
Shear plate - gross area	$A_g = b_p \times t_p$	= 40.500	[in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 546.75	[in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$	= 2050.31	[kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc	= 452.14	[kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check	= 1822.5	[kips]	
Axial strength required	$P_r =$ from gusset interface forces calc	= -300.5	[kips]	
Shear strength available	$V_c =$ from shear yielding check	= 1215.0	[kips]	
Shear strength required	$V_r =$ from gusset interface forces calc	= 491.0	[kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$	= 0.31		AISC 15 th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a)		ratio =	= 0.30	PASS
Gusset plate	width $b_p = 54.000$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 40.500 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 546.75 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 2221.17 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 452.14 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1974.4 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -300.5 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 1184.6 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 491.0 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.30	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Shear Yielding (Sect b-b)		ratio = 44.6 / 704.1	= 0.06	PASS
Plate Shear Yielding Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$		= 23.471 [in ²]	
Shear force required	$V_u =$		= 44.6 [kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$		= 704.1 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	$\phi = 1.00$			AISC 15 th Eq J4-3
	$\phi R_n =$		= 704.1 [kips]	
	ratio = 0.06		> V_u	OK

Gusset Plate - Shear Rupture (Sect b-b)		ratio = 44.6 / 686.5	= 0.06	PASS
Plate Shear Rupture Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate tensile strength	$F_u = 65.0$ [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$		= 23.471 [in ²]	
Shear force in demand	$V_u =$		= 44.6 [kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$		= 915.3 [kips]	AISC 15 th Eq J4-4
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-4
	$\phi R_n =$		= 686.5 [kips]	
	ratio = 0.06		> V_u	OK

Gusset Plate - Axial Tensile Yield (Sect b-b)

ratio = 403.8 / 1056.2 = **0.38** **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 =	= -150.3 [kips]	
Gusset edge moment force	M =	= 165.25 [kip-ft]	
Gusset edge interface length	L =	= 31.294 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -403.8 [kips]	AISC DG29 Fig B-1

Plate Tensile Yielding Check

Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]	
Plate yield strength	$F_y = 50.0$ [ksi]		
Plate gross area in shear	$A_g = b_p t_p$	= 23.471 [in ²]	
Tensile force required	$P_u =$	= 403.8 [kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 1173.5 [kips]	AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$		AISC 15 th Eq J4-1
	$\phi R_n =$	= 1056.2 [kips]	
	ratio = 0.38	> P_u	OK

Gusset Plate - Axial Tensile Rupture (Sect b-b)

ratio = 403.8 / 1144.2 = **0.35** **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 =	= -150.3 [kips]	
Gusset edge moment force	M =	= 165.25 [kip-ft]	
Gusset edge interface length	L =	= 31.294 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -403.8 [kips]	AISC DG29 Fig B-1

Plate Tensile Rupture Check

Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]	
Plate tensile strength	$F_u = 65.0$ [ksi]		
Plate net area in tension	$A_{nt} = b_p t_p$	= 23.471 [in ²]	
Tensile force required	$P_u =$	= 403.8 [kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 1525.6 [kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th Eq J4-2
	$\phi R_n =$	= 1144.2 [kips]	AISC 15 th Eq J4-2
	ratio = 0.35	> P_u	OK

Gusset Plate - Flexural Yield Interact (Sect b-b)		ratio =	= 0.15	PASS
Gusset plate	width $b_p = 31.294$ [in] yield $F_y = 50.0$ [ksi]	thick $t_p = 0.750$ [in]		
Shear plate - gross area	$A_g = b_p \times t_p$		= 23.471 [in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$		= 688.58 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 165.25 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check		= 1056.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -150.3 [kips]	
Shear strength available	$V_c =$ from shear yielding check		= 704.1 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 44.6 [kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.15	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Flexural Rupture Interact (Sect b-b)		ratio =	= 0.13	PASS
Gusset plate	width $b_p = 31.294$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 23.471 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 745.96 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 165.25 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1144.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -150.3 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 686.5 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 44.6 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.13	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset to Beam Weld Strength		ratio = 19.04 / 17.55	= 1.08	FAIL
Gusset to Beam Interface - Forces				
shear V = 491.0	[kips]	axial N = -300.5	[kips]	in tension
moment M = 452.14	[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	$f_a = N / L_w$		= -5.565	[kip/in] in tension
Weld stress from shear force	$f_v = V / L_w$		= 9.093	[kip/in]
Weld stress from moment force	$f_b = \frac{M}{L^2 / 6}$		= 11.164	[kip/in]
Weld stress combined - max	$f_{max} = [(f_a - f_b)^2 + f_v^2]^{0.5}$		= 19.040	[kip/in] AISC 15 th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$		= 61.5	[°]
Fillet Weld Strength Calc				
Fillet weld leg size	$w = 7/16$	[in]	load angle $\theta = 61.5$	[°]
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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$		= 36.681	[kip/in] AISC 15 th Eq 8-1
Base metal - gusset plate	thickness $t = 0.750$	[in]	tensile $F_u = 65.0$	[ksi]
Base metal - gusset plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$		= 29.250	[kip/in] AISC 15 th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$		= 29.250	[kip/in] AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$		= 21.938	[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	$\phi R_n = \phi R_n \times (1/1.25)$		= 17.550	[kip/in]
	ratio = 1.08		< 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 = 702.4 / 2241.0 = 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 =	= -300.5 [kips]	
Gusset edge moment force	M =	= 452.14 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -702.4 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 702.4 [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 15 th Eq J10-2
Resistance factor-LRFD	$\phi = 1.00$		
	$\phi R_n =$	= 2241.0 [kips]	
	ratio = 0.31	> P_u	OK

Column Web Local Crippling		ratio = 702.4 / 2192.3 = 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 =	= -300.5 [kips]	
Gusset edge moment force	M =	= 452.14 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -702.4 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 702.4 [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 15 th Eq J10-4
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th J10.3
	$\phi R_n =$	= 2192.3 [kips]	
	ratio = 0.32	> P_u OK	

Beam Web Longitudinal Shear Yielding		ratio = 491.0 / 2638.4	= 0.19	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 =	= 491.0 [kips]		
Beam web shear strength	R _n = 0.6 F _y t _w L _{eff}	= 2638.4 [kips]		AISC 15 th Eq J4-3
Resistance factor-LRFD	φ = 1.00			AISC 15 th Eq J4-3
	φ R _n =	= 2638.4 [kips]		
	ratio = 0.19	> V _u	OK	

Beam Web Transverse Section Shear Yielding		ratio = 305.2 / 477.4	= 0.64	PASS
Beam sect W21X147	d = 22.100 [in]	t _w = 0.720 [in]		
Right brace axial force	P ₁ = from user input	= -559.7 [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 θ ₁	= -395.8 [kips]		
Gusset edge shear (Sect b-b)	V' =	= 44.6 [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	= 305.2 [kips]		
Beam web shear strength	R _n = 0.6 F _y d t _w C _v	= 477.4 [kips]		AISC 15 th Eq G2-1
	C _v = 1.00			AISC 15 th Eq G2-2
Resistance factor-LRFD	φ = 1.00			AISC 15 th Eq G2-1
	φ R _n =	= 477.4 [kips]		
	ratio = 0.64	> V _u	OK	

Brace Force LC4P_R = 134.7 kips (C)P_L = -559.7 kips (T)

ratio = 1.08 FAIL

Gusset Plate - Shear Yielding (Sect a-a)		ratio = 491.0 / 1215.0	= 0.40	PASS
Plate Shear Yielding Check				
Plate size	width b _p = 54.000 [in]	thickness t _p = 0.750 [in]		
Plate yield strength	F _y = 50.0 [ksi]			
Plate gross area in shear	A _{gv} = b _p t _p	= 40.500 [in ²]		
Shear force required	V _u =	= 491.0 [kips]		
Plate shear yielding strength	R _n = 0.6 F _y A _{gv}	= 1215.0 [kips]		AISC 15 th Eq J4-3
Resistance factor-LRFD	φ = 1.00			AISC 15 th Eq J4-3
	φ R _n =	= 1215.0 [kips]		
	ratio = 0.40	> V _u	OK	

Gusset Plate - Shear Rupture (Sect a-a)		ratio = 491.0 / 1184.6 = 0.41		PASS
Plate Shear Rupture Check				
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]		
Plate tensile strength	$F_u = 65.0$ [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$	= 40.500 [in ²]		
Shear force in demand	$V_u =$	= 491.0 [kips]		
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$	= 1579.5 [kips]	AISC 15 th Eq J4-4	
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th Eq J4-4	
	$\phi R_n =$	= 1184.6 [kips]		
	ratio = 0.41	> V_u	OK	

Gusset Plate - Axial Tensile Yield (Sect a-a)		ratio = 702.4 / 1822.5 = 0.39 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 =	= -300.5 [kips]	
Gusset edge moment force	M =	= 452.14 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -702.4 [kips]	AISC DG29 Fig B-1
Plate Tensile Yielding Check			
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$ [in]	
Plate yield strength	$F_y = 50.0$ [ksi]		
Plate gross area in shear	$A_g = b_p t_p$	= 40.500 [in ²]	
Tensile force required	$P_u =$	= 702.4 [kips]	
Plate tensile yielding strength	$R_n = F_y A_g$	= 2025.0 [kips]	AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$		AISC 15 th Eq J4-1
	$\phi R_n =$	= 1822.5 [kips]	
	ratio = 0.39	> P_u	OK

Gusset Plate - Axial Tensile Rupture (Sect a-a)		ratio = 702.4 / 1974.4	= 0.36	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 =	= -300.5	[kips]	
Gusset edge moment force	M =	= 452.14	[kip-ft]	
Gusset edge interface length	L =	= 54.000	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$	= -702.4	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check				
Plate size	width $b_p = 54.000$ [in]	thickness $t_p = 0.750$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]		
Plate net area in tension	$A_{nt} = b_p t_p$	= 40.500	[in ²]	
Tensile force required	$P_u =$	= 702.4	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$	= 2632.5	[kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-2
	$\phi R_n =$	= 1974.4	[kips]	AISC 15 th Eq J4-2
	ratio = 0.36	> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect a-a)		ratio =	= 0.31	PASS
Gusset plate	width $b_p = 54.000$ [in]	thick $t_p = 0.750$	[in]	
	yield $F_y = 50.0$	[ksi]		
Shear plate - gross area	$A_g = b_p \times t_p$	= 40.500	[in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$	= 546.75	[in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$	= 2050.31	[kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc	= 452.14	[kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check	= 1822.5	[kips]	
Axial strength required	$P_r =$ from gusset interface forces calc	= -300.5	[kips]	
Shear strength available	$V_c =$ from shear yielding check	= 1215.0	[kips]	
Shear strength required	$V_r =$ from gusset interface forces calc	= 491.0	[kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$	= 0.31		AISC 15 th Eq 10-5
		< 1.0	OK	

Gusset Plate - Flexural Rupture Interact (Sect a-a)		ratio =	= 0.30	PASS
Gusset plate	width $b_p = 54.000$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 40.500 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 546.75 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net} \quad \phi=0.75$		= 2221.17 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 452.14 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1974.4 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -300.5 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 1184.6 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 491.0 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.30	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Shear Yielding (Sect b-b)		ratio = 44.6 / 704.1	= 0.06	PASS
Plate Shear Yielding Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate yield strength	$F_y = 50.0$ [ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$		= 23.471 [in ²]	
Shear force required	$V_u =$		= 44.6 [kips]	
Plate shear yielding strength	$R_n = 0.6 F_y A_{gv}$		= 704.1 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	$\phi = 1.00$			AISC 15 th Eq J4-3
	$\phi R_n =$		= 704.1 [kips]	
	ratio = 0.06		> V_u	OK

Gusset Plate - Shear Rupture (Sect b-b)		ratio = 44.6 / 686.5	= 0.06	PASS
Plate Shear Rupture Check				
Plate size	width $b_p = 31.294$ [in]	thickness $t_p = 0.750$ [in]		
Plate tensile strength	$F_u = 65.0$ [ksi]			
Plate net area in shear	$A_{nv} = b_p t_p$		= 23.471 [in ²]	
Shear force in demand	$V_u =$		= 44.6 [kips]	
Plate shear rupture strength	$R_n = 0.6 F_u A_{nv}$		= 915.3 [kips]	AISC 15 th Eq J4-4
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq J4-4
	$\phi R_n =$		= 686.5 [kips]	
	ratio = 0.06		> V_u	OK

Gusset Plate - Axial Tensile Yield (Sect b-b)			ratio = 403.8 / 1056.2	= 0.38	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 =		= -150.3	[kips]	
Gusset edge moment force	M =		= 165.25	[kip-ft]	
Gusset edge interface length	L =		= 31.294	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$		= -403.8	[kips]	AISC DG29 Fig B-1
Plate Tensile Yielding Check					
Plate size	width $b_p = 31.294$	[in]	thickness $t_p = 0.750$	[in]	
Plate yield strength	$F_y = 50.0$	[ksi]			
Plate gross area in shear	$A_g = b_p t_p$		= 23.471	[in ²]	
Tensile force required	$P_u =$		= 403.8	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$		= 1173.5	[kips]	AISC 15 th Eq J4-1
Resistance factor-LRFD	$\phi = 0.90$				AISC 15 th Eq J4-1
	$\phi R_n =$		= 1056.2	[kips]	
	ratio = 0.38		> P_u	OK	

Gusset Plate - Axial Tensile Rupture (Sect b-b)			ratio = 403.8 / 1144.2	= 0.35	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 =		= -150.3	[kips]	
Gusset edge moment force	M =		= 165.25	[kip-ft]	
Gusset edge interface length	L =		= 31.294	[in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4M}{L}$		= -403.8	[kips]	AISC DG29 Fig B-1
Plate Tensile Rupture Check					
Plate size	width $b_p = 31.294$	[in]	thickness $t_p = 0.750$	[in]	
Plate tensile strength	$F_u = 65.0$	[ksi]			
Plate net area in tension	$A_{nt} = b_p t_p$		= 23.471	[in ²]	
Tensile force required	$P_u =$		= 403.8	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$		= 1525.6	[kips]	AISC 15 th Eq J4-2
Resistance factor-LRFD	$\phi = 0.75$				AISC 15 th Eq J4-2
	$\phi R_n =$		= 1144.2	[kips]	AISC 15 th Eq J4-2
	ratio = 0.35		> P_u	OK	

Gusset Plate - Flexural Yield Interact (Sect b-b)		ratio =	= 0.15	PASS
Gusset plate	width $b_p = 31.294$ [in] yield $F_y = 50.0$ [ksi]	thick $t_p = 0.750$ [in]		
Shear plate - gross area	$A_g = b_p \times t_p$		= 23.471 [in ²]	
Shear plate - plastic modulus	$Z_p = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_y Z_p$ $\phi=0.90$		= 688.58 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 165.25 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile yield check		= 1056.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -150.3 [kips]	
Shear strength available	$V_c =$ from shear yielding check		= 704.1 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 44.6 [kips]	
Flexural yield interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.15	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset Plate - Flexural Rupture Interact (Sect b-b)		ratio =	= 0.13	PASS
Gusset plate	width $b_p = 31.294$ [in] tensile $F_u = 65.0$ [ksi]	thick $t_p = 0.750$ [in]		
Net area of plate	$A_n = b_p \times t_p$		= 23.471 [in ²]	
Plastic modulus of net section	$Z_{net} = (b_p \times t_p^2) / 4$		= 183.62 [in ³]	
Flexural strength available	$M_c = \phi F_u Z_{net}$ $\phi=0.75$		= 745.96 [kip-ft]	
Flexural strength required	$M_r =$ from gusset interface forces calc		= 165.25 [kip-ft]	
Axial strength available	$P_c =$ from axial tensile rupture check		= 1144.2 [kips]	
Axial strength required	$P_r =$ from gusset interface forces calc		= -150.3 [kips]	
Shear strength available	$V_c =$ from shear rupture check		= 686.5 [kips]	
Shear strength required	$V_r =$ from gusset interface forces calc		= 44.6 [kips]	
Flexural rupture interaction	ratio = $(\frac{V_r}{V_c})^2 + (\frac{P_r}{P_c} + \frac{M_r}{M_c})^2$		= 0.13	AISC 15 th Eq 10-5
			< 1.0	OK

Gusset to Beam Weld Strength		ratio = 19.04 / 17.55	= 1.08	FAIL
Gusset to Beam Interface - Forces				
shear V = 491.0	[kips]	axial N = -300.5	[kips]	in tension
moment M = 452.14	[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	$f_a = N / L_w$		= -5.565	[kip/in] in tension
Weld stress from shear force	$f_v = V / L_w$		= 9.093	[kip/in]
Weld stress from moment force	$f_b = \frac{M}{L^2 / 6}$		= 11.164	[kip/in]
Weld stress combined - max	$f_{max} = [(f_a - f_b)^2 + f_v^2]^{0.5}$		= 19.040	[kip/in] AISC 15 th Eq 8-11
Weld resultant load angle	$\theta = \tan^{-1} [(f_b - f_a) / f_v]$		= 61.5	[°]
Fillet Weld Strength Calc				
Fillet weld leg size	$w = 7/16$	[in]	load angle $\theta = 61.5$	[°]
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	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 w n C_2$		= 36.681	[kip/in] AISC 15 th Eq 8-1
Base metal - gusset plate	thickness $t = 0.750$	[in]	tensile $F_u = 65.0$	[ksi]
Base metal - gusset plate is in shear, <u>shear</u> rupture as per AISC 15 th Eq J4-4 is checked				AISC 15 th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$		= 29.250	[kip/in] AISC 15 th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$		= 29.250	[kip/in] AISC 15 th Eq 9-2
Resistance factor-LRFD	$\phi = 0.75$			AISC 15 th Eq 8-1
	$\phi R_n =$		= 21.938	[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	$\phi R_n = \phi R_n \times (1/1.25)$		= 17.550	[kip/in]
	ratio = 1.08		< 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 = 702.4 / 2241.0 = 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 =	= -300.5 [kips]	
Gusset edge moment force	M =	= 452.14 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -702.4 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 702.4 [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 15 th Eq J10-2
Resistance factor-LRFD	$\phi = 1.00$		
	$\phi R_n =$	= 2241.0 [kips]	
	ratio = 0.31	> P_u	OK

Column Web Local Crippling		ratio = 702.4 / 2192.3 = 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 =	= -300.5 [kips]	
Gusset edge moment force	M =	= 452.14 [kip-ft]	
Gusset edge interface length	L =	= 54.000 [in]	
Gusset edge equivalent normal force	$N_e = N - \frac{4 M}{L}$	= -702.4 [kips]	AISC DG29 Fig B-1
Concentrated force from gusset	$P_u =$	= 702.4 [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 15 th Eq J10-4
Resistance factor-LRFD	$\phi = 0.75$		AISC 15 th J10.3
	$\phi R_n =$	= 2192.3 [kips]	
	ratio = 0.32	> P_u OK	

Beam Web Longitudinal Shear Yielding		ratio = 491.0 / 2638.4 = 0.19 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 =	= 491.0 [kips]	
Beam web shear strength	R _n = 0.6 F _y t _w L _{eff}	= 2638.4 [kips]	AISC 15 th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00		AISC 15 th Eq J4-3
	ϕ R _n =	= 2638.4 [kips]	
	ratio = 0.19	> V _u	OK

Beam Web Transverse Section Shear Yielding		ratio = 78.2 / 477.4 = 0.16 PASS	
Beam sect W21X147	d = 22.100 [in]	t _w = 0.720 [in]	
Right brace axial force	P ₁ = from user input	= 134.7 [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 θ ₁	= 95.2 [kips]	
Gusset edge shear (Sect b-b)	V' =	= -44.6 [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	= 78.2 [kips]	
Beam web shear strength	R _n = 0.6 F _y d t _w C _v	= 477.4 [kips]	AISC 15 th Eq G2-1
	C _v = 1.00		AISC 15 th Eq G2-2
Resistance factor-LRFD	φ = 1.00		AISC 15 th Eq G2-1
	φ R _n =	= 477.4 [kips]	
	ratio = 0.16	> V _u	OK

