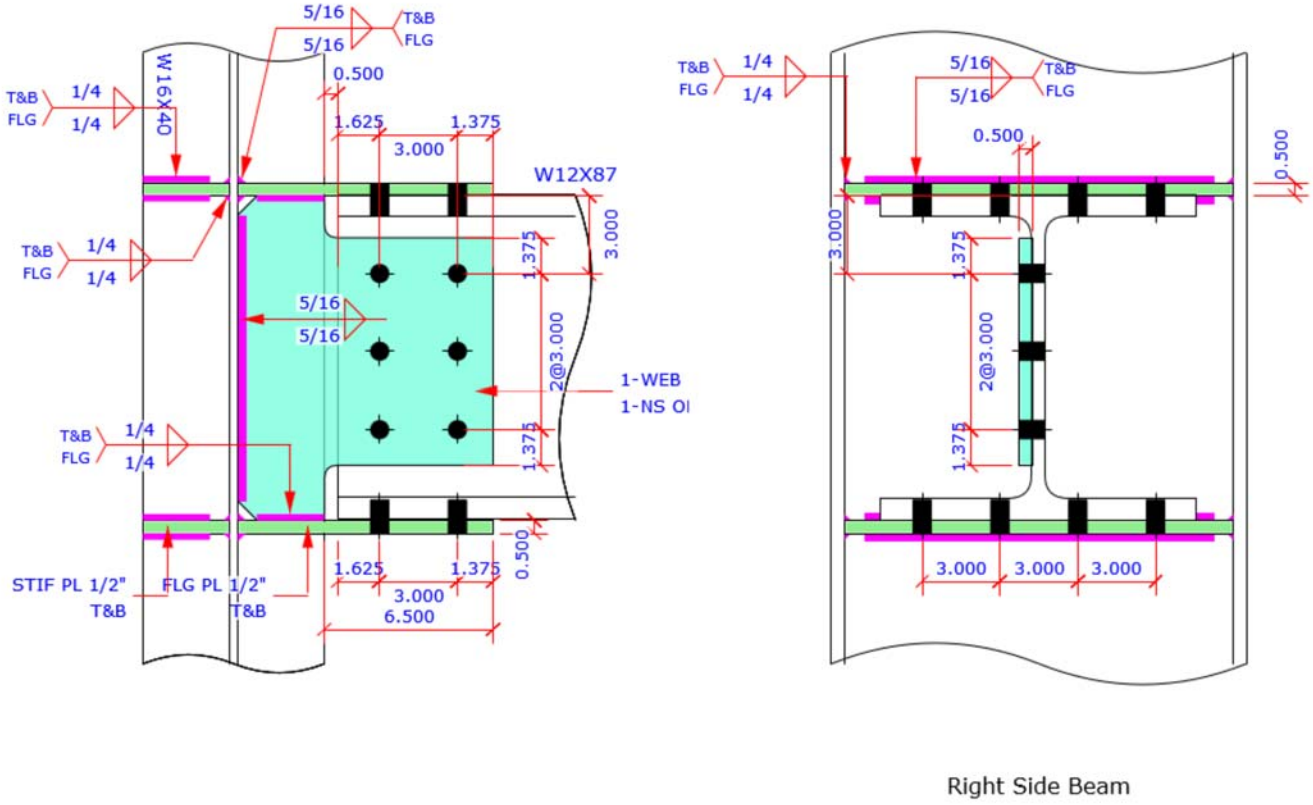
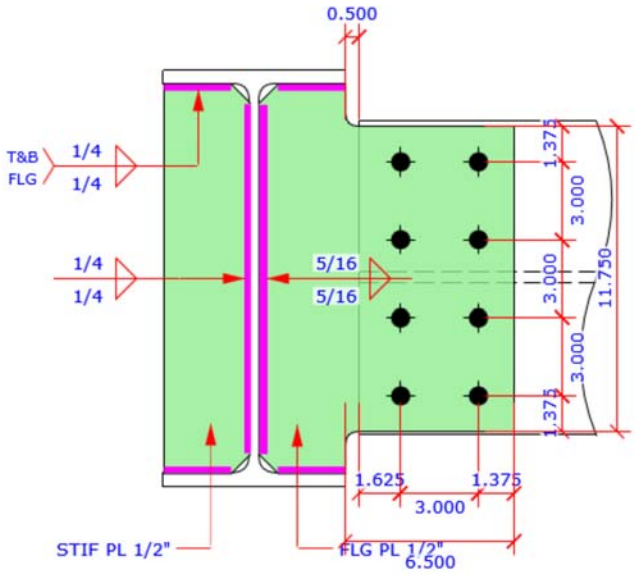
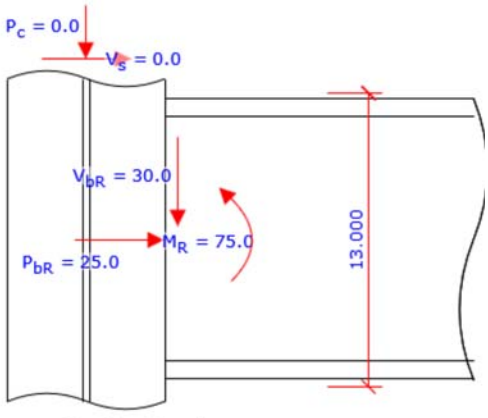
Result Summary - Overall	Moment Connection - Beam to Column	Code=AISC 360-10 LRFD

Result Summary - Overall	geometries & weld limitations = **PASS**	limit states max ratio = **0.71**	**PASS**
Right Beam to Column	geometries & weld limitations = **PASS**	limit states max ratio = **0.71**	**PASS**

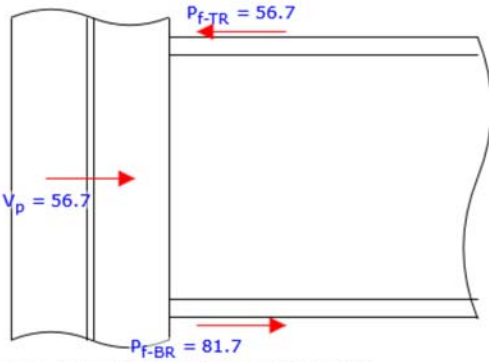
Sketch	Moment Connection - Beam to Column	Code=AISC 360-10 LRFD







Design Load



Beam Flange Force & Panel Zone Shear Vp

Members & Components Summary

Member	Moment Connection				Code=AISC 360-10 LRFD
Column Section					
W16X40	d = 16.000	[in]	b_f = 7.000	[in]	
	t_f = 0.505	[in]	t_w = 0.305	[in]	
	k_{des} = 0.907	[in]	k_{det} = 1.188	[in]	
	k_1 = 0.813	[in]	A = 11.800	[in^2]	
	S_x = 64.70	[in^3]	Z_x = 73.00	[in^3]	
Steel Grade A992	F_y = 50.0	[ksi]	F_u = 65.0	[ksi]	
Right Side Beam Section					
W12X87	d = 12.500	[in]	b_f = 12.100	[in]	
	t_f = 0.810	[in]	t_w = 0.515	[in]	
	k_{des} = 1.410	[in]	k_{det} = 1.688	[in]	
	k_1 = 1.063	[in]	A = 25.600	[in^2]	
	S_x = 118.00	[in^3]	Z_x = 132.00	[in^3]	
Steel Grade A992	F_y = 50.0	[ksi]	F_u = 65.0	[ksi]	

Beam Flange Force Calc

Beam Flange Force - Right Side Beam

Beam section	d_b = 12.500	[in]	t_{fb} = 0.810	[in]
Flange plate thickness	t_{fp} = 0.500	[in]		
Flange force moment arm	$d_m = d_b + t_{fp}$		= 13.000	[in]
User input load	axial P_{bR} = -25.00	[kips]	moment M_R = 75.00	[kip-ft]
	in tension			
Beam flange force - top	$P_{f\text{-}TR} = P_{bR}/2 + M_R/d_m$		= **56.73**	[kips]
Beam flange force - bottom	$P_{f\text{-}BR} = P_{bR}/2 - M_R/d_m$		= **-81.73**	[kips]

Panel Zone Shear Force Calc

Column story shear	V_s = from user input	= 0.00	[kips]
Panel zone shear force	$V_p = P_{f\text{-}TR} - P_{f\text{-}TL} - V_s$	= **56.73**	[kips]

Right Beam to Column	MC Connection	Code=AISC 360-10 LRFD

Result Summary	geometries & weld limitations = **PASS**	limit states max ratio = **0.71** **PASS**

Geometry Restriction Checks - Flange Plate				PASS
Min Bolt Edge Distance - Flange Plate				
Bolt diameter	d_b =	= 0.750	[in]	
Min edge distance allowed	$L_{e\text{-}min}$ =	= **1.000**	[in]	AISC 14th Table J3.4
Min edge distance in Flange Plate	L_e =	= **1.375**	[in]	
		> $L_{e\text{-}min}$	OK	
Min Bolt Spacing - Flange Plate				
Bolt diameter	d_b =	= 0.750	[in]	
Min bolt spacing allowed	$L_{s\text{-}min}$ = 2.667 d_b	= **2.000**	[in]	AISC 14th J3.3
Min Bolt spacing in Flange Plate	L_s =	= **3.000**	[in]	
		> $L_{s\text{-}min}$	OK	

Geometry Restriction Checks - Web Plate				PASS
Min Bolt Edge Distance - Web Plate				
Bolt diameter	d_b =	= 0.750	[in]	
Min edge distance allowed	$L_{e\text{-}min}$ =	= **1.000**	[in]	AISC 14th Table J3.4
Min edge distance in Web Plate	L_e =	= **1.375**	[in]	
		> $L_{e\text{-}min}$	OK	
Min Bolt Spacing - Web Plate				
Bolt diameter	d_b =	= 0.750	[in]	
Min bolt spacing allowed	$L_{s\text{-}min}$ = 2.667 d_b	= **2.000**	[in]	AISC 14th J3.3
Min Bolt spacing in Web Plate	L_s =	= **3.000**	[in]	
		> $L_{s\text{-}min}$	OK	

Fillet Weld Limitation Checks - Flange Plate				PASS
Min Fillet Weld Size				
Thinner part joined thickness	t =	= 0.500	[in]	
Min fillet weld size allowed	w_{min} =	= **0.188**	[in]	AISC 14th 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 14th J2.2b
Min fillet weld length	L =	= **2.598**	[in]	
		> L_{min}	OK	

Fillet Weld Limitation Checks - Web Plate				PASS
Min Fillet Weld Size				
Thinner part joined thickness	t =	= 0.500	[in]	
Min fillet weld size allowed	w_{min} =	= **0.188**	[in]	AISC 14th Table J2.4
Fillet weld size provided	w =	= **0.313**	[in]	
		> w_{min}	OK	
Min Fillet Weld Length				
Fillet weld size provided	w =	= 0.313	[in]	
Min fillet weld length allowed	L_{min} = 4 x w	= **1.250**	[in]	AISC 14th J2.2b
Min fillet weld length	L =	= **9.380**	[in]	
		> L_{min}	OK	

Fillet Weld Limitation Checks - Web Plate to Flange Plate				PASS
Min Fillet Weld Size				
Thinner part joined thickness	t =	= 0.500	[in]	
Min fillet weld size allowed	w_{min} =	= **0.188**	[in]	AISC 14th 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 14th J2.2b
Min fillet weld length	L =	= **2.598**	[in]	
		> L_{min}	OK	

Flange Plate Weld Strength						ratio = 81.73 / 115.70	= **0.71**	**PASS**
Flange force required in tension	$P_{uf\_t} = P_u / 2 - M_u / d_m$					= **81.73**	[kips]	
Refer to AISC Modern Steel Construction paper *Moment Connections to Column Webs* by M. Thomas Ferrell, the program assumes that only the welds at the column flange resist the flange force, the weld at the column web does not contribute to the flange force resistance.								
Column section	b_f = 7.000	[in]			t_w = 0.305	[in]		
Flange/stiff plate to column clip	clip = 0.750	[in]						
Flange/stiff plate to column flange one side weld length	$L_{st} = 0.5(b_f - t_w)$ - clip					= 2.598	[in]	
Total fillet weld length - double fillet	$L = 4 \times L_{st}$					= **10.390**	[in]	
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 14th 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 14th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70$ ksi$) 0.707$ w n C_2					= 14.847	[kip/in]	AISC 14th Eq 8-1
Base metal - flange_plate	thickness t = 0.500	[in]		tensile F_u = 65.0		[ksi]		
Base metal - flange_plate is in shear, shear rupture as per AISC 14th Eq J4-4 is checked								AISC 14th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$					= 19.500	[kip/in]	AISC 14th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$					= **14.847**	[kip/in]	AISC 14th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75							AISC 14th Eq 8-1
	ϕR_n =					= **11.135**	[kip/in]	
Shear resistance required	P_{uf_t} =					= **81.73**	[kips]	
Fillet weld length - double fillet	L =					= 10.390	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$					= **115.70**	[kips]	
	ratio = **0.71**					> P_{uf_t}	OK	

Web Plate Weld Strength						ratio = 30.00 / 130.56	= **0.23**	**PASS**
Shear force in demand	V_u =					= **30.00**	[kips]	
Fillet weld length - double fillet	L =					= 9.380	[in]	
Fillet Weld Strength Check								
Fillet weld leg size	w = $^5/_{16}$	[in]		load angle θ = 0.0	[°]			
Electrode strength	F_{EXX} = 70.0	[ksi]		strength coeff C_1 = 1.00				AISC 14th 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 14th Page 8-9
Fillet weld shear strength	$R_{n-w} = 0.6 (C_1 \times 70 \text{ ksi}) 0.707 \text{ w n } C_2$					= 18.559	[kip/in]	AISC 14th Eq 8-1
Base metal - web plate	thickness t = 0.500	[in]		tensile F_u = 65.0	[ksi]			
Base metal - web plate is in shear, shear rupture as per AISC 14th Eq J4-4 is checked								AISC 14th J2.4
Base metal shear rupture	$R_{n-b} = 0.6 F_u t$					= 19.500	[kip/in]	AISC 14th Eq J4-4
Double fillet linear shear strength	$R_n = \min (R_{n-w}, R_{n-b})$					= **18.559**	[kip/in]	AISC 14th Eq 9-2
Resistance factor-LRFD	ϕ = 0.75							AISC 14th Eq 8-1
	ϕR_n =					= **13.919**	[kip/in]	
Shear resistance required	V_u =					= **30.00**	[kips]	
Fillet weld length - double fillet	L =					= 9.380	[in]	
Shear resistance provided	$\phi F_n = \phi R_n \times L$					= **130.56**	[kips]	
	ratio = **0.23**					> V_u	OK	

Web Plate to Flange Plate Weld Strength					ratio = 8.70 / 28.92	= **0.30**	**PASS**	
Beam end shear force	V = from user input				= 30.00	[kips]		
Shear force ecc - web plate bolt group CG to column flange face	e =				= 3.625	[in]		
Beam depth	d = 12.500	[in]						
Req'd shear at web plate to flange plate welds	V_u = (V x e) / d				= **8.70**	[in]		
Fillet weld length - double fillet	L =				= 2.598	[in]		
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 14th	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 14th	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 14th	Eq 8-1
Base metal - web plate	thickness t = 0.500	[in]	tensile F_u = 65.0			[ksi]		
Base metal - web plate is in shear, shear rupture as per AISC 14th Eq J4-4 is checked							AISC 14th	J2.4
Base metal shear rupture	R_{n-b} = 0.6 F_u t				= 19.500	[kip/in]	AISC 14th	Eq J4-4
Double fillet linear shear strength	R_n = min (R_{n-w} , R_{n-b})				= **14.847**	[kip/in]	AISC 14th	Eq 9-2
Resistance factor-LRFD	ϕ = 0.75						AISC 14th	Eq 8-1
	ϕ R_n =				= **11.135**	[kip/in]		
Shear resistance required	sym_V =				= **8.70**	[kips]		
Fillet weld length - double fillet	L =				= 2.598	[in]		
Shear resistance provided	ϕ F_n = ϕ R_n x L				= **28.92**	[kips]		
	ratio = **0.30**				> sym_V	OK		

Flange Plate - Bolt Shear					ratio = 84.50 / 143.14	= **0.59**	**PASS**	
Flange force moment arm	d_m = d_b				= 12.500	[in]		
Beam flange force as shear	V_u = P_b / 2 + M / d_m				= **84.50**	[kips]		
Bolt shear stress	bolt grade = A325-N				F_{nv} = 54.0	[ksi]	AISC 14th	Table J3.2
	bolt dia d_b = 0.750	[in]	bolt area A_b = 0.442			[in^2]		
Number of bolt carried shear	n_s = 8.0		shear plane m = 1					
Required shear strength	V_u =				= **84.50**	[kips]		
Bolt shear strength	R_n = F_{nv} A_b n_s m C_{ec}				= 190.85	[kips]	AISC 14th	Eq J3-1
Bolt resistance factor-LRFD	ϕ = 0.75						AISC 14th	Eq J3-1
	ϕ R_n =				= **143.14**	[kips]		
	ratio = **0.59**				> V_u	OK		

Flange Plate - Bolt Bearing					ratio = 81.73 / 143.14	= **0.57**	**PASS**
Flange force moment arm	$d_m = d_b + t_p$				= 13.000	[in]	
Beam flange force as shear	$V_u = P_b / 2 + M / d_m$				= **81.73**	[kips]	
Single Bolt Shear Strength							
Bolt shear stress	bolt grade = A325-N				F_{nv} = 54.0	[ksi]	AISC 14th Table J3.2
	bolt dia d_b = 0.750	[in]			bolt area A_b = 0.442	[in^2]	
Single bolt shear strength	$R_{n\text{-}bolt} = F_{nv} A_b$				= 23.86	[kips]	AISC 14th Eq J3-1
Bolt Bearing / TearOut Strength on Plate							
Bolt hole diameter	bolt dia d_b = $^3/_4$	[in]			bolt hole dia d_h = $^{13}/_{16}$	[in]	AISC 14th Table J3.3
Bolt spacing & edge distance	spacing L_s = 3.000	[in]			edge distance L_e = 1.375	[in]	
Plate tensile strength	F_u = 65.0	[ksi]					
Plate thickness	t = 0.500	[in]					
Interior Bolt							
Bolt hole edge clear distance	$L_c = L_s - d_h$				= 2.188	[in]	
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}in} = 1.5\, L_c\, t\, F_u \le 3.0\, d_b\, t\, F_u$						AISC 14th Eq J3-6b
	= 106.64 ≤ 73.13				= 73.13	[kips]	
Bolt strength at interior	$R_{n\text{-}in} = \min(R_{n\text{-}t\&b\text{-}in}, R_{n\text{-}bolt})$				= 23.86	[kips]	
Edge Bolt							
Bolt hole edge clear distance	$L_c = L_e - d_h / 2$				= 0.969	[in]	
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}ed} = 1.5\, L_c\, t\, F_u \le 3.0\, d_b\, t\, F_u$						AISC 14th Eq J3-6b
	= 47.23 ≤ 73.13				= 47.23	[kips]	
Bolt strength at edge	$R_{n\text{-}ed} = \min(R_{n\text{-}t\&b\text{-}ed}, R_{n\text{-}bolt})$				= 23.86	[kips]	
Number of bolt	interior n_{in} = 4				edge n_{ed} = 4		
Bolt bearing strength for all bolts	$R_n = n_{in} R_{n\text{-}in} + n_{ed} R_{n\text{-}ed}$				= 190.85	[kips]	
Required shear strength	V_u =				= **81.73**	[kips]	
Bolt resistance factor-LRFD	ϕ = 0.75						AISC 14th J3-10
	ϕR_n =				= **143.14**	[kips]	
	ratio = **0.57**				> V_u	OK	

Flange Plate - Block Shear - 2 Side Strips			ratio = 81.73 / 135.28	= **0.60**	**PASS**
Flange force moment arm	$d_m = d_b + t_p$		= 13.000	[in]	
Flange force - tension	$P_u = P_b / 2 + M / d_m$		= **81.73**	[kips]	
Plate Block Shear - 2 Side Strips					
Bolt hole diameter	bolt dia d_b = $^3/_4$	[in]	bolt hole dia d_h = $^7/_8$	[in]	AISC 14th B4.3b
Plate thickness	t_p = 0.500	[in]			
Plate strength	F_y = 50.0	[ksi]	F_u = 65.0	[ksi]	
Bolt no in ver & hor dir	n_v = 4		n_h = 2		
Bolt spacing in ver & hor dir	s_v = 3.000	[in]	s_h = 3.000	[in]	
Bolt edge dist in ver & hor dir	e_v = 1.375	[in]	e_h = 1.375	[in]	
Gross area subject to shear	$A_{gv} = [(n_h - 1) s_h + e_h] t_p$ x 2		= 4.375	[in^2]	
Net area subject to shear	$A_{nv} = A_{gv} - [(n_h - 1) + 0.5] d_h t_p$ x2		= 3.063	[in^2]	
Net area subject to tension when sheared out by 2 side strips	$A_{nt} = (e_v - 0.5 d_h) t_p$ x 2		= 0.938	[in^2]	
Block shear strength required	V_u =		= **81.73**	[kips]	
Uniform tension stress factor	U_{bs} = 1.00				AISC 14th Fig C-J4.2
Bolt shear resistance provided	$R_n = \min(0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$		= 180.38	[kips]	AISC 14th Eq J4-5
Resistance factor-LRFD	ϕ = 0.75				AISC 14th Eq J4-5
	ϕR_n =		= **135.28**	[kips]	
	ratio = **0.60**		> V_u	OK	

Flange Plate - Block Shear - Center Strip			ratio = 81.73 / 167.27	= **0.49**	**PASS**
Flange force moment arm	$d_m = d_b + t_p$		= 13.000	[in]	
Flange force - tension	$P_u = P_b / 2 + M / d_m$		= **81.73**	[kips]	
Plate Block Shear - Center Strip					
Bolt hole diameter	bolt dia d_b = $^3/_4$	[in]	bolt hole dia d_h = $^7/_8$	[in]	AISC 14th B4.3b
Plate thickness	t_p = 0.500	[in]			
Plate strength	F_y = 50.0	[ksi]	F_u = 65.0	[ksi]	
Bolt no in ver & hor dir	n_v = 4		n_h = 2		
Bolt spacing in ver & hor dir	s_v = 3.000	[in]	s_h = 3.000	[in]	
Bolt edge dist in ver & hor dir	e_v = 1.375	[in]	e_h = 1.375	[in]	
Gross area subject to shear	$A_{gv} = [(n_h - 1) s_h + e_h] t_p$ x 2		= 4.375	[in^2]	
Net area subject to shear	$A_{nv} = A_{gv} - [(n_h - 1) + 0.5] d_h t_p$ x2		= 3.063	[in^2]	
Net area subject to tension when sheared out by center strip	$A_{nt} = (n_v - 1) (s_v - d_h) t_p$		= 3.188	[in^2]	
Block shear strength required	V_u =		= **81.73**	[kips]	
Uniform tension stress factor	U_{bs} = 0.50				AISC 14th Fig C-J4.2
Bolt shear resistance provided	$R_n = \min(0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$		= 223.03	[kips]	AISC 14th Eq J4-5
Resistance factor-LRFD	ϕ = 0.75				AISC 14th Eq J4-5
	ϕR_n =		= **167.27**	[kips]	
	ratio = **0.49**		> V_u	OK	

Flange Plate - Tensile Yielding				ratio = 81.73 / 264.38	= **0.31**	**PASS**
Flange force moment arm	$d_m = d_b + t_p$			= 13.000	[in]	
Flange force - tension	$P_u = P_b / 2 + M / d_m$			= **81.73**	[kips]	
Plate Tensile Yielding Check						
Plate size	width b_p = 11.750	[in]	thickness t_p = 0.500		[in]	
Plate yield strength	F_y = 50.0	[ksi]				
Plate gross area in shear	$A_g = b_p t_p$			= 5.875	[in^2]	
Tensile force required	P_u =			= **81.73**	[kips]	
Plate tensile yielding strength	$R_n = F_y A_g$			= 293.75	[kips]	AISC 14th Eq J4-1
Resistance factor-LRFD	ϕ = 0.90					AISC 14th Eq J4-1
	ϕR_n =			= **264.38**	[kips]	
	ratio = **0.31**			> P_u	OK	

Flange Plate - Tensile Rupture				ratio = 81.73 / 201.09	= **0.41**	**PASS**
Flange force moment arm	$d_m = d_b + t_p$			= 13.000	[in]	
Flange force - tension	$P_u = P_b / 2 + M / d_m$			= **81.73**	[kips]	
Plate Tensile Rupture Check						
Bolt hole diameter	bolt dia d_b = 3/4	[in]	bolt hole dia d_h = 7/8		[in]	AISC 14th B4.3b
Number of bolt	n = 4					
Plate size	width b_p = 11.750	[in]	thickness t_p = 0.500		[in]	
Plate tensile strength	F_u = 65.0	[ksi]				
Plate net area in tension	$A_{nt} = (b_p - n d_h) t_p$			= 4.125	[in^2]	
Tensile force required	P_u =			= **81.73**	[kips]	
Plate tensile rupture strength	$R_n = F_u A_{nt}$			= 268.13	[kips]	AISC 14th Eq J4-2
Resistance factor-LRFD	ϕ = 0.75					AISC 14th Eq J4-2
	ϕR_n =			= **201.09**	[kips]	AISC 14th Eq J4-2
	ratio = **0.41**			> P_u	OK	

Flange Plate - Compression					ratio = 56.73 / 264.38	= **0.21**	**PASS**
Flange force moment arm	$d_m = d_b + t_p$				= 13.000	[in]	
Flange force - compression	$P_u = P_b / 2 + M / d_m$				= **56.73**	[kips]	
Plate Compression Check							
Plate size	width b_p = 11.750	[in]	thickness t_p = 0.500	[in]			
	F_y = 50.0	[ksi]	E = 29000	[ksi]			
Plate gross area in compression	$A_g = b_p t_p$				= 5.875	[in^2]	
Plate radius of gyration	$r = t_p / \sqrt{12}$				= 0.144	[in]	
Plate effective length factor	K =				= 0.65		
Plate unbraced length	L_u =				= 2.125	[in]	
Plate slenderness	KL/r = 0.65 x L_u / r				= 9.57		
Plate compression required	P_u =				= **56.73**	[kips]	
	when $\frac{KL}{r} \leq 25$						AISC 14th J4.4 (a)
Plate compression provided	$R_n = F_y$ x A_g				= 293.75	[kips]	AISC 14th Eq J4-6
Bolt resistance factor-LRFD	ϕ = 0.90						AISC 14th J4.4 (a)
	ϕR_n =				= **264.38**	[kips]	
	ratio = **0.21**				> P_u	OK	

Web Plate - Bolt Bearing

ratio = 30.00 / 107.35 = **0.28** **PASS**

Single Bolt Shear Strength

Bolt shear stress	bolt grade = A325-N		F_{nv} = 54.0	[ksi]	AISC 14th Table J3.2
	bolt dia d_b = 0.750	[in]	bolt area A_b = 0.442	[in^2]	
Single bolt shear strength	$R_{n\text{-}bolt} = F_{nv} A_b$		= 23.86	[kips]	AISC 14th Eq J3-1

Bolt Bearing / TearOut Strength on Plate

Bolt hole diameter	bolt dia d_b = 3/4	[in]	bolt hole dia d_h = 13/16	[in]	AISC 14th Table J3.3
Bolt spacing & edge distance	spacing L_s = 3.000	[in]	edge distance L_e = 1.375	[in]	
Plate tensile strength	F_u = 65.0	[ksi]			
Plate thickness	t = 0.500	[in]			

Interior Bolt

Bolt hole edge clear distance	$L_c = L_s - d_h$		= 2.188	[in]	
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}in} = 1.5\, L_c\, t\, F_u \le 3.0\, d_b\, t\, F_u$				AISC 14th Eq J3-6b
	= 106.64 ≤ 73.13		= 73.13	[kips]	
Bolt strength at interior	$R_{n\text{-}in} = \min(R_{n\text{-}t\&b\text{-}in}, R_{n\text{-}bolt})$		= 23.86	[kips]	

Edge Bolt

Bolt hole edge clear distance	$L_c = L_e - d_h / 2$		= 0.969	[in]	
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}ed} = 1.5\, L_c\, t\, F_u \le 3.0\, d_b\, t\, F_u$				AISC 14th Eq J3-6b
	= 47.23 ≤ 73.13		= 47.23	[kips]	
Bolt strength at edge	$R_{n\text{-}ed} = \min(R_{n\text{-}t\&b\text{-}ed}, R_{n\text{-}bolt})$		= 23.86	[kips]	

Number of bolt	interior n_{in} = 4		edge n_{ed} = 2		
Bolt bearing strength for all bolts	$R_n = n_{in} R_{n\text{-}in} + n_{ed} R_{n\text{-}ed}$		= 143.14	[kips]	
Required shear strength	V_u =		= **30.00**	[kips]	
Bolt resistance factor-LRFD	ϕ = 0.75				AISC 14th J3-10
	ϕ R_n =		= **107.35**	[kips]	
	ratio = **0.28**		> V_u	OK	

Web Plate - Shear Yielding

ratio = 30.00 / 131.25 = **0.23** **PASS**

Plate Shear Yielding Check

Plate size	width b_p = 8.750	[in]	thickness t_p = 0.500	[in]	
Plate yield strength	F_y = 50.0	[ksi]			
Plate gross area in shear	$A_{gv} = b_p t_p$		= 4.375	[in^2]	
Shear force required	V_u =		= **30.00**	[kips]	
Plate shear yielding strength	$R_n = 0.6\, F_y A_{gv}$		= 131.25	[kips]	AISC 14th Eq J4-3
Resistance factor-LRFD	ϕ = 1.00				AISC 14th Eq J4-3
	ϕ R_n =		= **131.25**	[kips]	
	ratio = **0.23**		> V_u	OK	

Web Plate - Shear Rupture ratio = 30.00 / 89.58 = **0.33** **PASS**

Plate Shear Rupture Check

Bolt hole diameter	bolt dia d_b = $^3/_4$ [in]	bolt hole dia d_h = $^7/_8$ [in]		AISC 14th	B4.3b
Number of bolt	n = 3				
Plate size	width b_p = 8.750 [in]	thickness t_p = 0.500 [in]			
Plate tensile strength	F_u = 65.0 [ksi]				
Plate net area in shear	$A_{nv} = (b_p - n\, d_h)\, t_p$	= 3.063	[in^2]		
Shear force required	V_u =	= **30.00**	[kips]		
Plate shear rupture strength	$R_n = 0.6\, F_u\, A_{nv}$	= 119.44	[kips]	AISC 14th	Eq J4-4
Resistance factor-LRFD	ϕ = 0.75			AISC 14th	Eq J4-4
	$\phi\, R_n$ =	= **89.58**	[kips]		
	ratio = **0.33**	> V_u	OK		

Web Plate - Block Shear - 1-Side Strip ratio = 30.00 / 113.19 = **0.27** **PASS**

Plate Block Shear - Side Strip

Bolt hole diameter	bolt dia d_b = $^3/_4$ [in]	bolt hole dia d_h = $^7/_8$ [in]		AISC 14th	B4.3b
Plate thickness	t_p = 0.500 [in]				
Plate strength	F_y = 50.0 [ksi]	F_u = 65.0	[ksi]		
Bolt no in ver & hor dir	n_v = 2	n_h = 3			
Bolt spacing in ver & hor dir	s_v = 3.000 [in]	s_h = 3.000	[in]		
Bolt edge dist in ver & hor dir	e_v = 1.375 [in]	e_h = 1.375	[in]		
Gross area subject to shear	$A_{gv} = [(n_h - 1)\, s_h + e_h]\, t_p$	= 3.688	[in^2]		
Net area subject to shear	$A_{nv} = A_{gv} - [(n_h - 1) + 0.5]\, d_h\, t_p$	= 2.594	[in^2]		
Net area subject to tension when sheared out by side strip	$A_{nt} = [(n_v - 1)s_v + e_v - ((n_v - 1) + 0.5)d_h]\, t_p$	= 1.531	[in^2]		
Block shear strength required	V_u =	= **30.00**	[kips]		
Uniform tension stress factor	U_{bs} = 0.50			AISC 14th	Fig C-J4.2
Bolt shear resistance provided	$R_n = \min(0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$	= 150.92	[kips]	AISC 14th	Eq J4-5
Resistance factor-LRFD	ϕ = 0.75			AISC 14th	Eq J4-5
	$\phi\, R_n$ =	= **113.19**	[kips]		
	ratio = **0.27**	> V_u	OK		

Beam Flange - Bolt Shear					ratio = 84.50 / 143.14	= **0.59**	**PASS**
Flange force moment arm	$d_m = d_b$				= 12.500	[in]	
Beam flange force as shear	$V_u = P_b / 2 + M / d_m$				= **84.50**	[kips]	
Bolt shear stress	bolt grade = A325-N				F_{nv} = 54.0	[ksi]	AISC 14th Table J3.2
	bolt dia d_b = 0.750	[in]			bolt area A_b = 0.442	[in^2]	
Number of bolt carried shear	n_s = 8.0				shear plane m = 1		
Required shear strength	V_u =				= **84.50**	[kips]	
Bolt shear strength	$R_n = F_{nv} A_b n_s m C_{ec}$				= 190.85	[kips]	AISC 14th Eq J3-1
Bolt resistance factor-LRFD	ϕ = 0.75						AISC 14th Eq J3-1
	ϕR_n =				= **143.14**	[kips]	
	ratio = **0.59**				> V_u	OK	

Beam Flange - Bolt Bearing					ratio = 89.49 / 143.14	= **0.63**	**PASS**
Flange force moment arm	$d_m = d_b - t_{fb}$				= 11.690	[in]	
Beam flange force as shear	$V_u = P_b / 2 + M / d_m$				= **89.49**	[kips]	
Single Bolt Shear Strength							
Bolt shear stress	bolt grade = A325-N				F_{nv} = 54.0	[ksi]	AISC 14th Table J3.2
	bolt dia d_b = 0.750	[in]			bolt area A_b = 0.442	[in^2]	
Single bolt shear strength	$R_{n\text{-}bolt} = F_{nv} A_b$				= 23.86	[kips]	AISC 14th Eq J3-1
Bolt Bearing / TearOut Strength on Plate							
Bolt hole diameter	bolt dia d_b = 3/4	[in]			bolt hole dia d_h = 13/16	[in]	AISC 14th Table J3.3
Bolt spacing & edge distance	spacing L_s = 3.000	[in]			edge distance L_e = 1.625	[in]	
Plate tensile strength	F_u = 65.0	[ksi]					
Plate thickness	t = 0.810	[in]					
Interior Bolt							
Bolt hole edge clear distance	$L_c = L_s - d_h$				= 2.188	[in]	
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}in} = 1.5 L_c t F_u \le 3.0 d_b t F_u$						AISC 14th Eq J3-6b
	= 172.76 ≤ 118.46				= 118.46	[kips]	
Bolt strength at interior	$R_{n\text{-}in} = \min(R_{n\text{-}t\&b\text{-}in}, R_{n\text{-}bolt})$				= 23.86	[kips]	
Edge Bolt							
Bolt hole edge clear distance	$L_c = L_e - d_h / 2$				= 1.219	[in]	
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}ed} = 1.5 L_c t F_u \le 3.0 d_b t F_u$						AISC 14th Eq J3-6b
	= 96.25 ≤ 118.46				= 96.25	[kips]	
Bolt strength at edge	$R_{n\text{-}ed} = \min(R_{n\text{-}t\&b\text{-}ed}, R_{n\text{-}bolt})$				= 23.86	[kips]	
Number of bolt	interior n_{in} = 4				edge n_{ed} = 4		
Bolt bearing strength for all bolts	$R_n = n_{in} R_{n\text{-}in} + n_{ed} R_{n\text{-}ed}$				= 190.85	[kips]	
Required shear strength	V_u =				= **89.49**	[kips]	
Bolt resistance factor-LRFD	ϕ = 0.75						AISC 14th J3-10
	ϕR_n =				= **143.14**	[kips]	
	ratio = **0.63**				> V_u	OK	

Beam Flange - Block Shear - 2 Side Strips					ratio = 89.49 / 244.82	= **0.37**	**PASS**
Flange force moment arm	$d_m = d_b - t_{fb}$				= 11.690	[in]	
Beam flange force - tension	$V_u = P_b / 2 + M / d_m$				= **89.49**	[kips]	
Plate Block Shear - 2 Side Strips							
Bolt hole diameter	bolt dia d_b = $^3/_4$	[in]	bolt hole dia d_h =	$^7/_8$	[in]	AISC 14th B4.3b	
Plate thickness	t_p = 0.810	[in]					
Plate strength	F_y = 50.0	[ksi]	F_u = 65.0		[ksi]		
Bolt no in ver & hor dir	n_v = 4		n_h = 2				
Bolt spacing in ver & hor dir	s_v = 3.000	[in]	s_h = 3.000		[in]		
Bolt edge dist in ver & hor dir	e_v = 1.550	[in]	e_h = 1.625		[in]		
Gross area subject to shear	$A_{gv} = [(n_h - 1) s_h + e_h] t_p \times 2$				= 7.493	[in^2]	
Net area subject to shear	$A_{nv} = A_{gv} - [(n_h - 1) + 0.5] d_h t_p \times 2$				= 5.366	[in^2]	
Net area subject to tension when sheared out by 2 side strips	$A_{nt} = (e_v - 0.5 d_h) t_p \times 2$				= 1.802	[in^2]	
Block shear strength required	V_u =				= **89.49**	[kips]	
Uniform tension stress factor	U_{bs} = 1.00					AISC 14th Fig C-J4.2	
Bolt shear resistance provided	$R_n = \min(0.6F_u A_{nv}, 0.6F_y A_{gv}) + U_{bs} F_u A_{nt}$				= 326.43	[kips]	AISC 14th Eq J4-5
Resistance factor-LRFD	ϕ = 0.75					AISC 14th Eq J4-5	
	ϕR_n =				= **244.82**	[kips]	
	ratio = **0.37**				> V_u	OK	

Beam Web - Bolt Shear					ratio = 30.00 / 107.35	= **0.28**	**PASS**
Bolt shear stress	bolt grade = A325-N			F_{nv} = 54.0	[ksi]	AISC 14th Table J3.2	
	bolt dia d_b = 0.750	[in]		bolt area A_b = 0.442	[in^2]		
Number of bolt carried shear	n_s = 6.0			shear plane m = 1			
Required shear strength	V_u =			= **30.00**	[kips]		
Bolt shear strength	$R_n = F_{nv} A_b n_s m C_{ec}$			= 143.14	[kips]	AISC 14th Eq J3-1	
Bolt resistance factor-LRFD	ϕ = 0.75					AISC 14th Eq J3-1	
	ϕR_n =			= **107.35**	[kips]		
	ratio = **0.28**			> V_u	OK		

Beam Web - Bolt Bearing					ratio = 30.00 / 107.35	= **0.28**	**PASS**
Single Bolt Shear Strength							
Bolt shear stress	bolt grade = A325-N			F_{nv} = 54.0	[ksi]	AISC 14th Table J3.2	
	bolt dia d_b = 0.750	[in]		bolt area A_b = 0.442	[in^2]		
Single bolt shear strength	$R_{n\text{-}bolt} = F_{nv} A_b$			= 23.86	[kips]	AISC 14th Eq J3-1	
Bolt Bearing / TearOut Strength on Plate							
Bolt hole diameter	bolt dia d_b = 3/4	[in]		bolt hole dia d_h = 13/16	[in]	AISC 14th Table J3.3	
Bolt spacing	spacing L_s = 3.000	[in]					
Plate tensile strength	F_u = 65.0	[ksi]					
Plate thickness	t = 0.515	[in]					
Interior Bolt							
Bolt hole edge clear distance	$L_c = L_s - d_h$			= 2.188	[in]		
Bolt tear out/bearing strength	$R_{n\text{-}t\&b\text{-}in} = 1.5\ L_c\ t\ F_u \le 3.0\ d_b\ t\ m\ F_u$					AISC 14th Eq J3-6b	
	= 109.84 ≤ 75.32			= 75.32	[kips]		
Bolt strength at interior	$R_{n\text{-}in} = \min(R_{n\text{-}t\&b\text{-}in}, R_{n\text{-}bolt})$			= 23.86	[kips]		
Number of bolt	interior n_{in} = 6						
Bolt bearing strength for all bolts	$R_n = n_{in} R_{n\text{-}in}$			= 143.14	[kips]		
Required shear strength	V_u =			= **30.00**	[kips]		
Bolt resistance factor-LRFD	ϕ = 0.75					AISC 14th J3-10	
	ϕ R_n =			= **107.35**	[kips]		
	ratio = **0.28**			> V_u	OK		

Beam Web - Shear Yielding					ratio = 30.00 / 193.13	= **0.16**	**PASS**
Plate Shear Yielding Check							
Plate size	width b_p = 12.500	[in]		thickness t_p = 0.515	[in]		
Plate yield strength	F_y = 50.0	[ksi]					
Plate gross area in shear	$A_{gv} = b_p t_p$			= 6.438	[in^2]		
Shear force required	V_u =			= **30.00**	[kips]		
Plate shear yielding strength	$R_n = 0.6\ F_y\ A_{gv}$			= 193.13	[kips]	AISC 14th Eq J4-3	
Resistance factor-LRFD	ϕ = 1.00					AISC 14th Eq J4-3	
	ϕ R_n =			= **193.13**	[kips]		
	ratio = **0.16**			> V_u	OK		

Beam Web - Shear Rupture			ratio = 30.00 / 148.75	= **0.20**	**PASS**
Plate Shear Rupture Check					
Bolt hole diameter	bolt dia d_b = $^3/_4$	[in]	bolt hole dia d_h = $^7/_8$	[in]	AISC 14th B4.3b
Number of bolt	n = 3				
Plate size	width b_p = 12.500	[in]	thickness t_p = 0.515	[in]	
Plate tensile strength	F_u = 65.0	[ksi]			
Plate net area in shear	$A_{nv} = (b_p - n\, d_h)\, t_p$		= 5.086	[in^2]	
Shear force required	V_u =		= **30.00**	[kips]	
Plate shear rupture strength	$R_n = 0.6\, F_u\, A_{nv}$		= 198.34	[kips]	AISC 14th Eq J4-4
Resistance factor-LRFD	ϕ = 0.75				AISC 14th Eq J4-4
	$\phi\, R_n$ =		= **148.75**	[kips]	
	ratio = **0.20**		> V_u	OK	

Beam Flange With Holes - Beam Flexural Rupture			ratio = 75.00 / 408.86	= **0.18**	**PASS**
Beam sect W12X87	b_f = 12.100	[in]	t_f = 0.810	[in]	
	S_x = 118.000	[in^3]			
	F_y = 50.0	[ksi]	F_u = 65.0	[ksi]	
Gross area of tension flange	$A_{fg} = b_f t_f$		= 9.801	[in^2]	
Bolt hole diameter	bolt dia d_b = $^3/_4$	[in]	bolt hole dia d_h = $^7/_8$	[in]	AISC 14th B4.3b
Number of bolt	n = 4				
Net area of tension flange	$A_{fn} = (b_f - n\, d_h)\, t_f$		= 6.966	[in^2]	
Moment in demand	M_u =		= **75.00**	[kips]	
Beam flexural rupture strength	$M_n = \frac{F_u A_{fn}}{A_{fg}} S_x$		= 454.28	[kip-ft]	AISC 14th Eq F13-1
Resistance factor-LRFD	ϕ = 0.90				AISC 14th F1
	$\phi\, M_n$ =		= **408.86**	[kips]	
	ratio = **0.18**		> M_u	OK	