

Appendix E

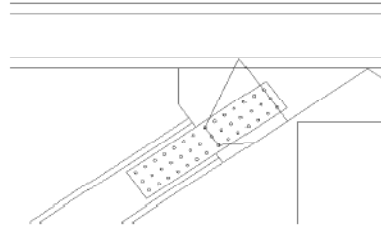
Braced Frame Connection Calculations

Project	AE482
Date	4/8/2008
Engineer	Steve Reichwein

Brace to Girder Connection - LRFD

Fy,beam	50	ksi	Bolt Dia.	0.75	in	Lweld	12	in
Fu,beam	65	ksi	#Rows of Bolts	2		tweld	5	1/16 in
Fy,plate	36	ksi	#Bolts/Row	5		θ	37.5	Deg
Fu,plate	58	ksi	Plate t (ea)	0.5	in	Whitmore		
Brace	W12X53		Plate w	9	in	Section		
Girder	W14X145		Gusset Plate t	0.5	in	Length	18	in

φRn 206.68 kips



Brace Limit States

Tension Yielding	φRn = 0.9 Fy Ag		
	φRn	702.0 kips	
Tension Rupture	φRn = .75 Fu (Ag - Abolts)		
	φRn	232.9396875 kips	
Block Shear	φRn = .75 (.6 x Fu x Anv + Fu x Ant) ≤ .75 (.6 x Fy x Agv + Fu x Ant)		
	φRn	242.19 kips	Anv 6.98625 Ant 0.77625 Agv 9.315

Bolt Limit States

Bolt Shear/Row	φrn	79.6 kips
Bearing on Beam/Row	φrn	60.5475 kips
Bearing on Plates/Row	φrn	156.6 kips
Tearout on Beam/Row		
Edge Bm	φrn	44.14921675 kips
Other Bm	φrn	88.2984375 kips
Tearout on Plates/Row		
Edge Plate	φrn	127.96875 kips
Other Plate	φrn	228.375 kips
	φRn Beam	286.3392188 kips
	φRn Plate	396 kips

Plate Limit States

Tension Yielding	φRn = 0.9 Fy Ag		
	φRn	291.6 kips	
Tension Rupture	φRn = .75 Fu (Ag - Abolts)		
	φRn	315.375 kips	
Block Shear	φRn = .75 (.6 x Fu x Anv + Fu x Ant) ≤ .75 (.6 x Fy x Agv + Fu x Ant)		
	φRn	242.5 kips	Anv 10.125 Ant 0.546875 Agv 13.5

Gusset Plate Limit States

Tension Yielding	φRn = 0.9 Fy Ag		
	φRn	291.6 kips	
Tension Rupture	φRn = .75 Fu (Ag - Abolts)		
	φRn	353.4375 kips	
Block Shear	φRn = .75 (.6 x Fu x Anv + Fu x Ant) ≤ .75 (.6 x Fy x Agv + Fu x Ant)		
	φRn	485.0 kips	Anv 20.25 Ant 1.09375 Agv 27

Weld Limit States

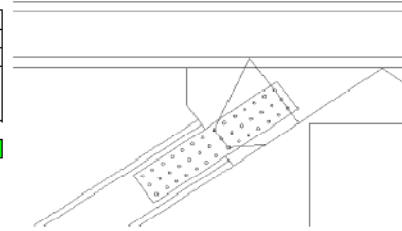
Base Metal	φRn = .75 x .6 x Fu x t x Lweld		
	φRn	765.18 kips	
Weld Rupture	φRn = 1.392 x Lweld x tweld(1/16") x (1 + .5 (sin θ)^1.5)		
	φRn	206.68 kips	

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Brace to Girder Connection - LRFD

Fy,beam	50	ksi	Bolt Dia.	0.75	in	Lweld	24	in
Fu,beam	65	ksi	#Rows of Bolts	2		tweld	5	1/16 in
Fy,plate	36	ksi	#Bolts/Row	6		θ	37.5	Deg
Fu,plate	58	ksi	Plate t (ea)	0.75	in	Whitmore Section Length	18	in
Brace	W12X87		Plate w	9	in			
Girder	W14X145		Gusset Plate t	1.5	in			

φRn = 413.37 kips



Brace Limit States

Tension Yielding	φRn = 0.9 Fy Ag		
	φRn	1152.0	kips
Tension Rupture	φRn = .75 Fu (Ag - Abolts)		
	φRn	598.7840625	kips
Block Shear	φRn = .75 (.6 x Fu x Anv + Fu x Ant) ≤ .75 (.6 x Fy x Agv + Fu x Ant)		
	φRn	429.316875	kips
		Anv	12.74625
		Ant	1.15875
		Agv	16.995

Bolt Limit States

Bolt Shear/Row	φrn	79.6	kips
Bearing on Beam/Row	φrn	90.3825	kips
Bearing on Plates/Row	φrn	234.9	kips
Tearout on Beam/Row			
Edge Bm	φrn	65.90390625	kips
Other Bm	φrn	131.8078125	kips
Tearout on Plates/Row			
Edge Plate	φrn	191.953125	kips
Other Plate	φrn	342.5625	kips
	φRn Beam	463.9039063	kips
	φRn Plate	477.6	kips

Plate Limit States

Tension Yielding	φRn = 0.9 Fy Ag		
	φRn	437.4	kips
Tension Rupture	φRn = .75 Fu (Ag - Abolts)		
	φRn	473.0625	kips
Block Shear	φRn = .75 (.6 x Fu x Anv + Fu x Ant) ≤ .75 (.6 x Fy x Agv + Fu x Ant)		
	φRn	472.3	kips
		Anv	18.5625
		Ant	1.640625
		Agv	24.75

Gusset Plate Limit States

Tension Yielding	φRn = 0.9 Fy Ag		
	φRn	874.8	kips
Tension Rupture	φRn = .75 Fu (Ag - Abolts)		
	φRn	1080.3125	kips
Block Shear	φRn = .75 (.6 x Fu x Anv + Fu x Ant) ≤ .75 (.6 x Fy x Agv + Fu x Ant)		
	φRn	472.3	kips
		Anv	18.5625
		Ant	1.640625
		Agv	24.75

Weld Limit States

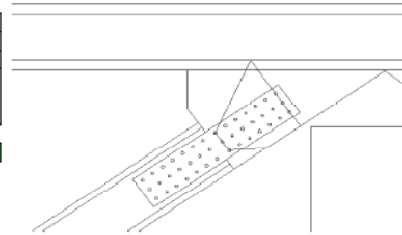
Base Metal	φRn = .75 x .6 x Fu x t x Lweld		
	φRn	1530.36	kips
Weld Rupture	φRn = 1.392 x Lweld x tweld(1/16") x (1 + .5 (sin θ)^1.5)		
	φRn	413.37	kips

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Brace to Girder Connection - LRFD

Fy,beam	50	ksi	Bolt Dia.	0.75	in	Lweld	22	in
Fu,beam	65	ksi	#Rows of Bolts	2		tweld	8	1/16 in
Fy,plate	36	ksi	#Bolts/Row	8		e	37.5	Deg
Fu,plate	58	ksi	Plate t (ea)	1.25	in	Whitmore		
Brace	W12X106		Plate w	9	in	Section		
Girder	W14X145		Gusset Plate t	1.5	in	Length	18	in

ϕR_n 606.27 kips



Brace Limit States

Tension Yielding	$\phi R_n = 0.9 F_y A_g$		
	ϕR_n	1404.0	kips
Tension Rupture	$\phi R_n = .75 F_u (A_g - A_{bolts})$		
	ϕR_n	875.769375	kips
Block Shear	$\phi R_n = .75 (.6 \times F_u \times A_{nv} + F_u \times A_{nt}) \leq .75 (.6 \times F_y \times A_{gv} + F_u \times A_{nt})$		
	ϕR_n	669.09375	kips
		Anv	20.5875
		Ant	1.3725
		Agv	27.45

Bolt Limit States

Bolt Shear/Row	ϕR_n	79.6	kips
Bearing on Beam/Row	ϕR_n	107.055	kips
Bearing on Plates/Row	ϕR_n	391.5	kips
Tearout on Beam/Row			
Edge Bm	ϕR_n	78.0609375	kips
Other Bm	ϕR_n	156.121875	kips
Tearout on Plates/Row			
Edge Plate	ϕR_n	319.921875	kips
Other Plate	ϕR_n	570.9375	kips
	ϕR_n Beam	635.2609375	kips
	ϕR_n Plate	636.8	kips

Plate Limit States

Tension Yielding	$\phi R_n = 0.9 F_y A_g$		
	ϕR_n	729	kips
Tension Rupture	$\phi R_n = .75 F_u (A_g - A_{bolts})$		
	ϕR_n	788.4375	kips
Block Shear	$\phi R_n = .75 (.6 \times F_u \times A_{nv} + F_u \times A_{nt}) \leq .75 (.6 \times F_y \times A_{gv} + F_u \times A_{nt})$		
	ϕR_n	1160.6	kips
		Anv	42.1875
		Ant	1.367188
		Agv	112.5

Gusset Plate Limit States

Tension Yielding	$\phi R_n = 0.9 F_y A_g$		
	ϕR_n	874.8	kips
Tension Rupture	$\phi R_n = .75 F_u (A_g - A_{bolts})$		
	ϕR_n	1060.3125	kips
Block Shear	$\phi R_n = .75 (.6 \times F_u \times A_{nv} + F_u \times A_{nt}) \leq .75 (.6 \times F_y \times A_{gv} + F_u \times A_{nt})$		
	ϕR_n	618.1	kips
		Anv	25.3125
		Ant	1.640625
		Agv	33.75

Weld Limit States

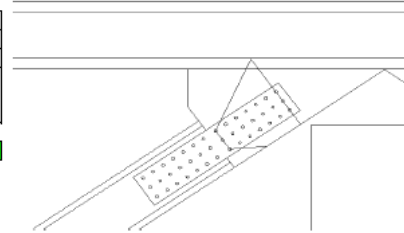
Base Metal	$\phi R_n = .75 \times .6 \times F_u \times t \times L_{weld}$		
	ϕR_n	1402.83	kips
Weld Rupture	$\phi R_n = 1.392 \times L_{weld} \times t_{weld} / (1/16") \times (1 + .5 (\sin \theta)^{1.5})$		
	ϕR_n	606.27	kips

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Brace to Girder Connection - LRFD

Fy,beam	50	ksi	Bolt Dia.	0.75	in	Lweld	30	in
Fu,beam	65	ksi	#Rows of Bolts	3		tweld	8	1/16 in
Fy,plate	36	ksi	#Bolts/Row	7		θ	37.5	Deg
Fu,plate	58	ksi	Plate t (ea)	2	in	Whitmore		
Brace	W12X136		Plate w	9	in	Section		
Girder	W14X145		Gusset Plate t	2.5	in	Length	18	in

ΦR_n 826.74 kips



Brace Limit States

Tension Yielding	$\Phi R_n = 0.9 F_y A_g$		
	ΦR_n	1795.5	kips
Tension Rupture	$\Phi R_n = .75 F_u (A_g - A_{bolts})$		
	ΦR_n	1435.553438	kips
Block Shear	$\Phi R_n = .75 (.6 F_u x A_{nv} + F_u x A_{nt}) \leq .75 (.6 F_y x A_{gv} + F_u x A_{nt})$		
	ΦR_n	844.3865625	kips
	Anv	23.1075	
	Ant	3.45625	
	Agv	30.81	

Bolt Limit States

Bolt Shear/Row	ΦR_n	119.4	kips
Bearing on Beam/Row	ΦR_n	207.9675	kips
Bearing on Plates/Row	ΦR_n	939.6	kips
Tearout on Beam/Row			
Edge Bm	ΦR_n	151.6429688	kips
Other Bm	ΦR_n	303.2859375	kips
Tearout on Plates/Row			
Edge Plate	ΦR_n	767.8125	kips
Other Plate	ΦR_n	1370.25	kips
	ΦR_n Beam	835.8	kips
	ΦR_n Plate	835.8	kips

Plate Limit States

Tension Yielding	$\Phi R_n = 0.9 F_y A_g$		
	ΦR_n	1166.4	kips
Tension Rupture	$\Phi R_n = .75 F_u (A_g - A_{bolts})$		
	ΦR_n	1109.25	kips
Block Shear	$\Phi R_n = .75 (.6 F_u x A_{nv} + F_u x A_{nt}) \leq .75 (.6 F_y x A_{gv} + F_u x A_{nt})$		
	ΦR_n	1698.4	kips
	Anv	73.125	
	Ant	2.734375	
	Agv	97.5	

Gusset Plate Limit States

Tension Yielding	$\Phi R_n = 0.9 F_y A_g$		
	ΦR_n	1458	kips
Tension Rupture	$\Phi R_n = .75 F_u (A_g - A_{bolts})$		
	ΦR_n	1672.03125	kips
Block Shear	$\Phi R_n = .75 (.6 F_u x A_{nv} + F_u x A_{nt}) \leq .75 (.6 F_y x A_{gv} + F_u x A_{nt})$		
	ΦR_n	908.7	kips
	Anv	36.5625	
	Ant	2.734375	
	Agv	48.75	

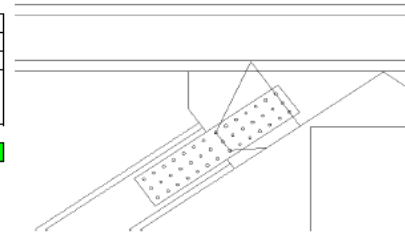
Weld Limit States

Base Metal	$\Phi R_n = .75 x .6 x F_u x t x L_{weld}$		
	ΦR_n	1912.95	kips
Weld Rupture	$\Phi R_n = 1.392 x L_{weld} x tweld(1/16") x (1 + .5 (sin \theta)^{1.5})$		
	ΦR_n	826.74	kips

Project	AE482
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Brace to Girder Connection - LRFD

Fy,beam	50	ksi	Bolt Dia.	0.75	in	Lweld	38	in
Fu,beam	65	ksi	#Rows of Bolts	4		tweld	8	1/16 in
Fy,plate	36	ksi	#Bolts/Row	7		θ	37.5	Deg
Fu,plate	58	ksi	Plate t (ea)	2.25	in	Whitmore		
Brace	W12X170		Plate w	9	in	Section		
Girder	W14X145		Gusset Plate t	3	in	Length	18	in



BoE $\Phi R_n = 1047.20$ kips

Brace Limit States

Tension Yielding	$\Phi R_n = 0.9 F_y A_g$		
	ΦR_n	2250.0	kips
Tension Rupture	$\Phi R_n = .75 F_u (A_g - A_{bolts})$		
	ΦR_n	2176.2	kips
Block Shear	$\Phi R_n = .75 (.6 F_u A_{nv} + F_u A_{nt}) \leq .75 (.6 F_y A_{gv} + F_u A_{nt})$		
	ΦR_n	1125.54	kips
	Anv	28.08	
	Ant	6.24	
	Agv	37.44	

Bolt Limit States

Bolt Shear/Row	ΦR_n	159.2	kips
Bearing on Beam/Row	ΦR_n	336.96	kips
Bearing on Plates/Row	ΦR_n	1409.4	kips
Tearout on Beam/Row			
Edge Bm	ΦR_n	245.7	kips
Other Bm	ΦR_n	491.4	kips
Tearout on Plates/Row			
Edge Plate	ΦR_n	1151.71875	kips
Other Plate	ΦR_n	2055.375	kips
	ΦR_n Beam	1114.4	kips
	ΦR_n Plate	1114.4	kips

Plate Limit States

Tension Yielding	$\Phi R_n = 0.9 F_y A_g$		
	ΦR_n	1312.2	kips
Tension Rupture	$\Phi R_n = .75 F_u (A_g - A_{bolts})$		
	ΦR_n	1076.625	kips
Block Shear	$\Phi R_n = .75 (.6 F_u A_{nv} + F_u A_{nt}) \leq .75 (.6 F_y A_{gv} + F_u A_{nt})$		
	ΦR_n	1635.7	kips
	Anv	65.8125	
	Ant	4.921875	
	Agv	87.75	

Gusset Plate Limit States

Tension Yielding	$\Phi R_n = 0.9 F_y A_g$		
	ΦR_n	1749.6	kips
Tension Rupture	$\Phi R_n = .75 F_u (A_g - A_{bolts})$		
	ΦR_n	1892.25	kips
Block Shear	$\Phi R_n = .75 (.6 F_u A_{nv} + F_u A_{nt}) \leq .75 (.6 F_y A_{gv} + F_u A_{nt})$		
	ΦR_n	1090.4	kips
	Anv	43.875	
	Ant	3.28125	
	Agv	58.5	

Weld Limit States

Base Metal	$\Phi R_n = .75 F_u t L_{weld}$		
	ΦR_n	2423.07	kips
Weld Rupture	$\Phi R_n = 1.392 L_{weld} t_{weld} (1/16") \times (1 + .5 (\sin \theta)^{1.5})$		
	ΦR_n	1047.20	kips

Project: AE 482
 Date: 4/8/2008
 Engineer: STEVE REICHWEIN

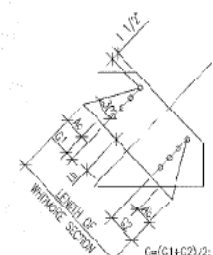
GUSSET PLATE CAPACITY (LRFD)

Fy = 36 ksi
 Bolt Diameter = 0.75 in
 # of Rows of Bolts = 1
 G = 6 in
 Lb = 18 in

Gusset pl (in)	Brace Size	ϕR_n PL (k)	ϕR_n yld (k)	ϕR_n rpt (k)	ϕR_n b.s. (k)	ϕP_n (k)
0.625	W14	427.3	607.5	757.85	664.11	427.29
	W12	313.3	445.5	540.35	446.61	313.34
	W10	284.9	405	485.98	392.24	284.86
0.75	W14	448.9	583.2	713.67	601.19	448.85
	W12	411.4	534.6	648.42	535.94	411.45
	W10	374.0	486	583.17	470.69	374.04
1	W14	654.5	777.6	951.56	801.58	654.53
	W12	600.0	712.8	864.56	714.58	599.99
	W10	545.4	648	777.56	627.58	545.44
1.25	W14	852.8	972	1189.45	1001.98	852.79
	W12	781.7	891	1080.70	893.23	781.72
	W10	710.7	810	971.95	784.48	710.66
1.5	W14	1046.6	1166.4	1427.34	1202.37	1046.65
	W12	959.4	1069.2	1296.84	1071.87	959.43
	W10	872.2	972	1166.34	941.37	872.21
1.75	W14	1237.8	1360.8	1665.23	1402.77	1237.78
	W12	1134.6	1247.4	1512.98	1250.52	1134.63
	W10	1031.5	1134	1360.73	1098.27	1031.48
2	W14	1427.1	1555.2	1903.13	1603.16	1427.13
	W12	1308.2	1425.6	1729.13	1429.16	1308.20
	W10	1189.3	1296	1555.13	1255.16	1189.27
2.25	W14	1615.2	1749.6	2141.02	1803.56	1615.24
	W12	1480.6	1603.8	1945.27	1607.81	1480.64
	W10	1346.0	1458	1749.52	1412.06	1346.04
2.5	W14	1802.5	1944	2378.91	2003.95	1802.49
	W12	1652.3	1782	2161.41	1786.45	1652.28
	W10	1502.1	1620	1943.91	1568.95	1502.07
2.75	W14	1989.1	2138.4	2616.80	2204.35	1989.09
	W12	1823.3	1960.2	2377.55	1965.10	1823.33
	W10	1657.6	1782	2138.30	1725.85	1657.57
3	W14	2175.2	2332.8	2854.69	2404.74	2175.19
	W12	1993.9	2138.4	2593.69	2143.74	1993.93
	W10	1812.7	1944	2382.69	1882.74	1812.66



GUSSET PLATE WITH WHITMORE SECTION IN GUSSET



GUSSET PLATE WITH WHITMORE SECTION IN GUSSET AND FRAMING MEMBER

L_u UNBRACED LENGTH FOR BUCKLING CHECK = (L1+L2+L3)/3, CONSERVATIVELY USE L3 FOR SIMPLICITY.
 A_c = AREA OF WHITMORE SECTION THAT IS INTO THE COLUMN.
 A_b = AREA OF WHITMORE SECTION THAT IS INTO THE BEAM.
 FOR DESIGN CHECKS OF THE WHITMORE SECTION, THE AREA OF THE BEAM AND COLUMN CAN BE UTILIZED, AS WELL AS THE FIELD STRESS OF THE BEAM OF COLUMN, I.E. $\phi P_n = \phi [A_c(F_y C) + A_b(F_y C) + A_m(F_y C)]$, WHERE THE COLUMN IS ORIENTED WEAK AXIS TO THE CONNECTION (COLUMN WEB PERPENDICULAR TO GUSSET). THE WHITMORE SECTION MUST BE TRUNCATED, A_c=0.

Project: AE 482
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Engineer: STEVE REICHWEIN

CLAW ANGLE CAPACITY (LRFD)

Fy = 36 ksi
Bolt Diameter = 0.75 in
Angles per Conn = 4

		ϕ Rn Angle Group (k)					
# of Bolts	Angle	3	4	5	6	7	8
L3X3X1/2		356.4	356.4	356.4	356.4	356.4	356.4
L3X3X7/16		314.9	314.9	314.9	314.9	314.9	314.9
L3X3X3/8		273.5	273.5	273.5	273.5	273.5	273.5
L3X3X5/16		230.7	230.7	230.7	230.7	230.7	230.7
L3X3X1/4		186.6	186.6	186.6	186.6	186.6	186.6
L3X3X3/16		141.3	141.3	141.3	141.3	141.3	141.3
L3 1/2x3 1/2x1/2		401.2	423.8	423.8	423.8	423.8	423.8
L3 1/2x3 1/2x7/16		351.1	374.5	374.5	374.5	374.5	374.5
L3 1/2x3 1/2x3/8		300.9	324.0	324.0	324.0	324.0	324.0
L3 1/2x3 1/2x5/16		250.8	272.2	272.2	272.2	272.2	272.2
L3 1/2x3 1/2x1/4		200.6	220.3	220.3	220.3	220.3	220.3
L4X4X3/4		601.8	703.7	703.7	703.7	703.7	703.7
L4X4X5/8		501.5	597.5	597.5	597.5	597.5	597.5
L4X4X1/2		401.2	486.0	486.0	486.0	486.0	486.0
L4X4X7/16		351.1	427.7	427.7	427.7	427.7	427.7
L4X4X3/8		300.9	370.7	370.7	370.7	370.7	370.7
L4X4X5/16		250.8	311.0	311.0	311.0	311.0	311.0
L4X4X1/4		200.6	250.1	250.1	250.1	250.1	250.1
L5X5X7/8		702.1	976.2	1039.4	1039.4	1039.4	1039.4
L5X5X3/4		601.8	836.7	904.6	904.6	904.6	904.6
L5X5X5/8		501.5	697.3	764.6	764.6	764.6	764.6
L5X5X1/2		401.2	557.8	620.8	620.8	620.8	620.8
L5X5X7/16		351.1	488.1	546.9	546.9	546.9	546.9
L5X5X3/8		300.9	418.4	473.0	473.0	473.0	473.0
L5X5X5/16		250.8	348.6	397.9	397.9	397.9	397.9