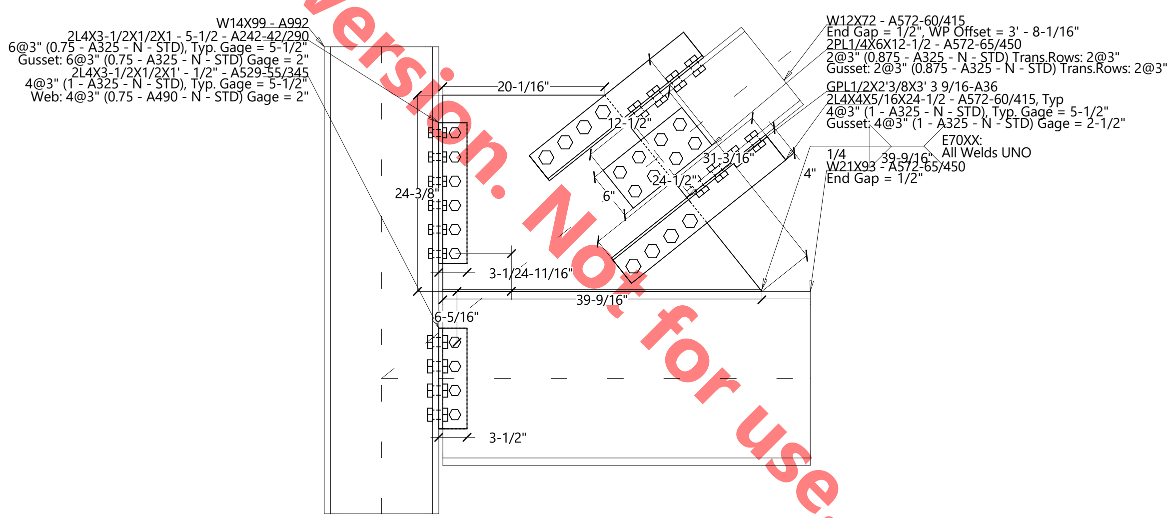
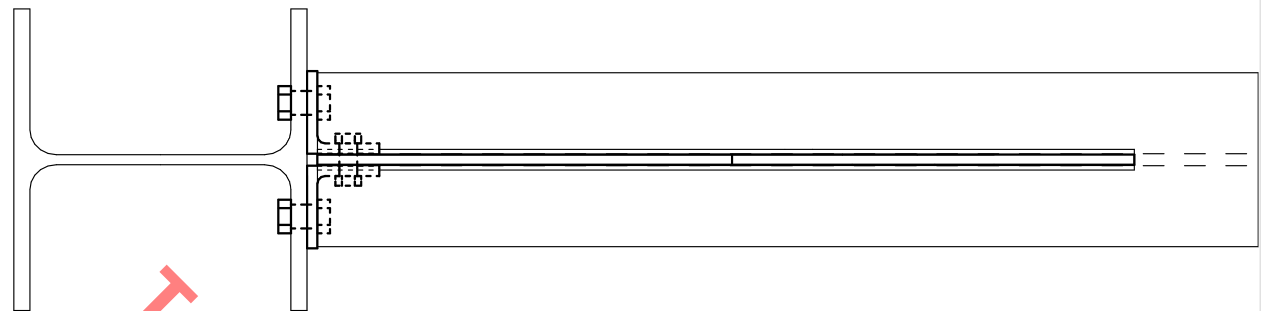
PROJECT NAME	Sample Configuration	**PAGES**	1 / 20
PROJECT NO		**CODE**	AISC13
PROJECT DATE		**METHOD**	ASD
CALC DATE	1/17/2019	**UNITS**	US
CALCULATED BY		**SEISMIC**	No
CHECKED BY		**FILE NAME**	Sample Brace Configuration.dsn
DESCRIPTION			

Front View

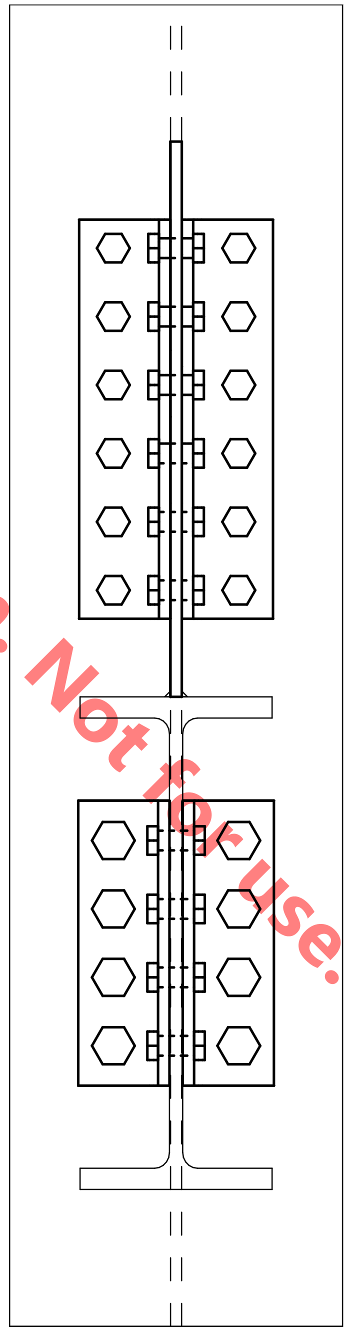


Top View



PROJECT NAME	Sample Configuration	**PAGES**	3 / 20
PROJECT NO		**CODE**	AISC13
PROJECT DATE		**METHOD**	ASD
CALC DATE	1/17/2019	**UNITS**	US
CALCULATED BY		**SEISMIC**	No
CHECKED BY		**FILE NAME**	Sample Brace Configuration.dsn
DESCRIPTION			

Right Side View



BASIC DETAILS OVERVIEW

Joint Configuration: Beam and/or Brace to Column

Member: Column
Section: W14X99
Material: A992

Member: Upper Right Brace
Section: W12X72
Material: A572-60/415

Member: Right Side Beam
Section: W21X93
Material: A572-65/450

DETAILED CALCULATION REPORT

BASIC DESIGN DATA

Non-Seismic Design

Column:
Size: W14X99
Material: A992
Orientation: Web In Plane
Axial Force (Tension): 0 kips
Axial Force (Compression): 0 kips
Shear Force: 0 kips

Upper Right Brace:
Size: W12X72
Length: 15 ft.
Material: A572-60/415
Axial Force (Tension): 300 kips
Axial Force (Compression): 200 kips
Work Point X: 0 in.
Work Point Y: 0 in.
Rise/Run: 1 / 1.25
Bolt Edge Distance: 1.5 in.

Claw Angles:
Length: 24.5 in.
OSL: Short Leg
Material: A572-60/415
Bolts: (1 - A325 - N - STD)
Bolt Spacing: 3 in.
Bolt Edge Distance: 1.5 in.

Splice Plates:
Width: 6 in.
Length: 12.5 in.
Thickness: 0.25 in.
Material: A572-65/450
Bolts: (0.875 - A325 - N - STD)
Bolt Spacing (Transv.): 3 in.
Bolt Spacing (Long.): 3 in.
Bolt Edge Dist.: 1.5 in.
Number of Longitudinal Bolt Lines: 2

Gusset Plate:
Material: A36
Column Side Length: 24.3479 in.
Beam Side Length: 39.5654 in.
Brace Side Length: 24.6377 in.
Column Side Free Edge: x = 20.087 in., y = 0 in.
Beam Side Free Edge: x = -6.797 in., y = 8.4963 in.
Thickness: 0.5 in.
Setback from Column: 0.5 in.
Bolt Edge Distance: 1.5 in.
Gusset-Brace Gap: 0.5 in.

Clip Angles:
Length: 17.5 in.
OSL: Long Leg
Material: A242-42/290
Bolts: (0.75 - A325 - N - STD)
Bolt Spacing: 3 in.
Bolt Edge Distance: 1.25 in.

Right Side Beam:
Size: W21X93
Material: A572-65/450
Axial Force (Wind/Seismic - Right to Left): -156.1737 kips
Axial Force (Wind/Seismic - Left to Right): 234.2606 kips
Shear Force: 15 kips
Work Point X: 0 in.
Work Point Y: 0 in.

Clip Angles:
Length: 12.5 in.
OSL: Long Leg
Bolts: (1 - A325 - N - STD)
Bolt Spacing: 3 in.
Bolt Edge Distance: 1.75 in.

UPPER RIGHT BRACE

1. UPPER RIGHT BRACE TO GUSSET CONNECTION
Flange Area = Af
= tf * bf

= 0.67 * 12 = 8.04 in^2

Web Area = Aw
= A - 2 * Af
= 21.1 - 2 * 8.04 = 5.02 in^2

Flange Force (Each) Tension = Pft
= Af * Fx_T / A
= 8.04 * 300 / 21.1 = 114.3127 kips

Flange Force (Each) Compression = Pfc
= Af * Fx_C / A
= 8.04 * 200 / 21.1 = 76.2085 kips

Web Force Tension = Pwt
= Aw * Fx_T / A
= 5.02 * 300 / 21.1= 71.3744 kips

Web Force Compression = Pwc
= Aw * Fx_C / A
= 5.02 * 200 / 21.1 = 47.5829 kips

1.a. Allowable Bolt Shear Strength - Claw Angles (Per Flange)
(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 4 * 18.8495
= 150.7964 ≥ 114.3127 kips (OK)

1.b. Allowable Bolt Shear Strength - Web Splice Plates
(1 / FS)Rn = nIN * nSP * nB * Fv
= 1 * 2 * 4 * 14.4316
= 115.4535 ≥ 71.3744 kips (OK)

1.c. Design Upper Right Brace Claw Angles
Selected Angle = L4X4X5/16
Gage on Brace Flange = 5.5 in.
Angle Gage on Brace Flange = 2.5 in.
Angle Gage on Gusset (ga) = 2.5 in.
Gage on Gusset = ga + d + ga = 17.3 in.
Claw Angle Length = Lclaw
= 2 * ((Nbf - 1) * s + ea) + eg + ebr + g
= 2 * ((4 - 1) * 3 + 1.5) + 1.5 + 1.5 + 0.5
= 24.5 in.

Bolt Distance to End of Claw Angle:
= 1.5 ≥ 1.25 in. (OK)

Bolt Distance to Edge of Claw Angle (Gusset Side):
= 1.5 ≥ 1.25 in. (OK)

Bolt Distance to Edge of Claw Angle (Brace Side):
= 1.5 ≥ 1.25 in. (OK)

Bolt Distance to Edge of Gusset Plate:
= 1.5 ≥ 1.25 in. (OK)

Bolt Distance to End of Brace:
= 1.5 ≥ 1.25 in. (OK)

1.c.1. Allowable Bearing Strength:
Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.5 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 90 kips/in.
= (1 / 2.0) * 1.2 * 0.9687 * 75 = 43.5937 kips/in.

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 90 kips/in.
= (1 / 2.0) * 1.2 * 1.9375 * 75 = 87.1875 kips/in.

With Tensile Force:
(1 / FS) Rn = 2 * (Fbre + Fbrs * (Nbf - 1)) * t
= 2 * (43.5937 + 87.1875 * (4 - 1)) * 0.313
= 191.0278 ≥ 114.3127 kips (OK)

With Compressive Force:
(1 / FS) Rn = 2 * Fbrs * Nbf * t
= 2 * 87.1875 * 4 * 0.313
= 218.3175 ≥ 76.2085 kips (OK)

1.c.2. Tension Yielding of Claw Angles:
(1 / FS) Rn = 2 * (1 / 1.67) * Fy * Ag
= 2 * (1 / 1.67) * 60 * 2.4
= 172.455 ≥ 114.3127 kips (OK)

1.c.3. Tension Rupture of Claw Angles:
U = Min((1 - x / L), 0.9)
= Min(1 - 1.1157 / 9, 0.9) = 0.876
Ae = Min((0.85 * Ag), U * (Ag - (dh + 0.0625) * t))
= Min(2.0451, 0.876 * (2.406 - 1.125 * 0.313))
= 1.7992 in^2
(1 / FS) Rn = 2 * (1 / 2.0) * Fu * Ae = 2 * (1 / 2.0) * 75 * 1.7992
= 134.9453 ≥ 114.3127 kips (OK)

1.c.4. Block Shear Rupture of Claw Angles:
Agt = Min(et_gusset side, et_brace side) * t = Min(1.5, 1.5) * 0.313 = 0.4695 in^2
Ant = Agt - 0.5 * (dh + 0.0625) * t
= 0.4695 - 0.5 * (1.0625 + 0.0625) * 0.313
= 0.2934 in^2

Agv = ((N - 1) * s + el) * t
= ((4 - 1) * 3 + 1.5) * 0.313
= 3.2865 in^2

Anv = Agv - (N - 0.5) * (dh + 0.0625) * t

= 3.2865 - (4 - 0.5) * (1.0625 + 0.0625) * 0.313
= 2.054 in^2

Block Shear Strength:
(1 / FS)Rn = (1 / FS) * (0.6 * Min(Fu * Anv, Fy * Agv) + Ubs * Fu * Ant)
= (1 / 2.0) * (0.6 * Min(75 * 2.054, 60 * 3.2865) + 1 * 75 * 0.2934)
= 57.2203 ≥ 57.1563 kips (OK)

1.d. Design Upper Right Brace Splice Plates

Splice plates: 2PL 0.25 X 6 X 12.5

Bolt Distance to Transv. Edge of Splice Plate:
= 1.5 ≥ 1.125 in. (OK)

Bolt Distance to Longit. Edge of Splice Plate:
= 1.5 ≥ 1.125 in. (OK)

Bolt Distance to Edge of Gusset Plate:
= 1.5 ≥ 1.25 in. (OK)

Bolt Distance to End of Brace:
= 1.5 ≥ 1.25 in. (OK)

1.d.1. Check Plate Length:

L = 2 * ((Nbwl - 1) * sl + ep) + eg + ebr + g
= 2 * ((2 - 1) * 3 + 1.5) + 1.5 + 1.5 + 0.5
= 12.5

1.d.2. Check Plate Width:

Wp = (Nw - 1) * s + 2 * e = (2 - 1) * 3 + 2 * 1.5
Plate Width = 6 ≤ Brace T-dist. = 9.175 in. (OK)

1.d.3. Allowable Bearing Strength of Plates:

Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 84 kips/in.
= (1 / 2.0) * 1.2 * 1.0312 * 80 = 49.5 kips/in.

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 84 kips/in.
= (1 / 2.0) * 1.2 * 2.0625 * 80 = 99 kips/in.
Use: Fbs = 84 kips/in.

With Tensile Force:
(1 / FS) Rn = 2 * (Fbre * Nw + Fbrs * (n - Nw)) * tp
= 2 * (49.5 * 2 + 84 * (4 - 2)) * 0.25
= 133.5 ≥ 71.3744 kips (OK)

With Compressive Force:
(1 / FS) Rn = 2 * Fbrs * n * tp
= 2 * 84 * 4 * 0.25
= 168 ≥ 47.5829 kips (OK)

1.d.4. Tension Yielding of Plates:

Ag = Wp * t = 6 * 0.25 = 1.5 in^2
(1 / FS) Rn = (1 / 1.67) * 2 * Fy * Ag
= (1 / 1.67) * 2 * 65 * 1.5
= 116.7664 ≥ 71.3744 kips (OK)

1.d.5. Tension Rupture of Plates:

An = Ag - Nw * (dh + 0.0625) * tp
= 1.5 - 2 * (0.9375 + 0.0625) * 0.25
= 1 in^2
Ae = Min(0.85 * Ag, An) = 1 in^2
(1 / FS) Rn = (1 / 2.0) * 2 * Fu * Ae
= (1 / 2.0) * 2 * 80 * 1
= 80 ≥ 71.3744 kips (OK)

1.d.6. Block Shear Rupture of Plates:

Agv = 2 * ((Nl - 1) * s + el) * tp
= 2 * ((2 - 1) * 3 + 1.5) * 0.25
= 2.25 in^2

Anv = Agv - 2 * (Nl - 0.5) * (dh + 0.0625) * tp
= 2.25 - 2 * (2 - 0.5) * (0.9375 + 0.0625) * 0.25
= 1.5 in^2

Agt = (Nw - 1) * st * tp (Inside Block)
= (2 - 1) * 3 * 0.25
= 0.75 in^2

Ant = Agt - (Nw - 1) * (dh + 0.0625) * tp (Inside Block)
= 0.75 - (2 - 1) * (0.9375 + 0.0625) * 0.25
= 0.5 in^2

Agto = (W - st) * tp (Outside Blocks)
= (6 - 3) * 0.25
= 0.75 in^2

Anto = Agto - (Nw - 1) * (dh + 0.0625) * tp (Outside Blocks)
= 0.75 - (2 - 1) * (0.9375 + 0.0625) * 0.25
= 0.5 in^2

Agt = Min(Agt, Agto)= 0.75 in^2
Ant = Min(Ant, Anto)= 0.5 in^2

(1 / FS)Rn = (1 / FS) * (0.6 * Min(Fu * Anv, Fy * Agv) + Ubs * Fu * Ant)
= (1 / 2.0) * (0.6 * Min(80 * 1.5, 65 * 2.25) + 1 * 80 * 0.5)
= 56 ≥ 35.6872 kips (OK)

2. CHECK UPPER RIGHT BRACE

2.a. Allowable Bearing Strength of Flange

Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.5 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 90 kips/in.
= (1 / 2.0) * 1.2 * 0.9687 * 75 = 43.5937 kips/in.
Allowable Bearing Strength of Flange Using Bolt Edge Distance (Fbe)
= 4 * tf * Fbre
= 4 * 0.67 * 43.5937 = 116.8312 kips

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 90 kips/in.
= (1 / 2.0) * 1.2 * 1.9375 * 75 = 87.1875 kips/in.

With Tensile Force:
Allowable Bearing Strength of Flange Using Bolt Spacing (Fbs):
= 4 * (n - 1) * tf * Fbrs
= 4 * (4 - 1) * 0.67 * 87.1875
= 700.9875 kips
Total Allowable Bearing Strength of Flange (Fbr)
= 116.8312 + 700.9875
= 817.8187 kips ≥ 228.6255 kips (OK)

With Compressive Force:
Allowable Bearing Strength of Flange Using Bolt Spacing (Fbs):
= 4 * n * tf * Fbrs
= 4 * 4 * 0.67 * 87.1875
= 934.65 kips
Total Allowable Bearing Strength of Flange (Fbe)
= 934.65 kips ≥ 152.417 kips (OK)

2.b. Allowable Bearing Strength of Web
Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 78.75 kips/in.
= (1 / 2.0) * 1.2 * 1.0312 * 75 = 46.4062 kips/in.
Allowable Bearing Strength of Web Using Bolt Edge Distance (Wbe)
= Nw * tw * Wbre
= 2 * 0.43 * 46.4062 = 39.9093 kips

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 78.75 kips/in.
= (1 / 2.0) * 1.2 * 2.0625 * 75 = 92.8125 kips/in.
Use: Fbs = 78.75 kips/in.

With Tensile Force:
Allowable Bearing Strength of Web Using Bolt Spacing (Wbs)
= (n - Nw) * tw * Wbrs
= (4 - 2) * 0.43 * 78.75
= 67.725 kips
Total Allowable Bearing Strength of Web (Wbr)
= 39.9093 + 67.725
= 107.6343 kips ≥ 71.3744 kips (OK)

With Compressive Force:
Allowable Bearing Strength of Web Using Bolt Spacing (Wbs)
= n * tw * Wbrs
= (4 * 0.43 * 78.75
= 135.45 kips
Total Allowable Bearing Strength of Web (Wbr)
= 135.45 kips ≥ 47.5829 kips (OK)

2.c. Block Shear Strength of the Flange
Bolt Gage on Angle = 2.5 in.
Bolt Hole Size (Longitudinal) = 1.0625 in.
Bolt Hole Size (Transverse) = 1.0625 in.

Gross Area with Shear Resistance:
Agv = 4 * (s * (n - 1) + e) * tf
= 4 * (3 * (4 - 1) + 1.5) * 0.67
= 28.14 in^2

Net Area with Shear Resistance:
Anv = Agv - 4 * (n - 0.5) * (dh + 0.0625) * tf
= 28.14 - 4 * (4 - 0.5) * (1.0625 + 0.0625) * 0.67
= 17.5875 in^2

Gross Area with Tension Resistance:
Agt = 2 * (bf - (tg + 2 * ga)) * tf
= 2 * (12 - (0.5 + 2 * 2.5)) * 0.67
= 8.71 in^2

Net Area with Tension Resistance:
Ant = Agt - 2 * (dh + 0.0625) * tf
= 8.71 - 2 * (1.0625 + 0.0625) * 0.67
= 7.2025 in^2
(1 / FS)Rn = (1 / FS) * (0.6 * Min(Fu * Anv, Fy * Agv) + Ubs * Fu * Ant)
= (1 / 2.0) * (0.6 * Min(75 * 17.5875, 60 * 28.14) + 1 * 75 * 7.2025)
= 665.8125 ≥ 2 * Pf = 228.6255 kips (OK)

2.d. Block Shear Strength of the Web
Bolt Hole Size (Longitudinal) = 0.9375 in.
Bolt Hole Size (Transverse) = 0.9375 in.

Gross Area with Shear Resistance:
Agv = 2 * (sl * (nl - 1) + e) * tw
= 2 * (3 * (2 - 1) + 1.5) * 0.43
= 3.87 in^2

Net Area with Shear Resistance:
Anv = Agv - 2 * (nl - 0.5) * (dh + 0.0625) * tw
= 3.87 - 2 * (2 - 0.5) * (0.9375 + 0.0625) * 0.43
= 2.58 in^2

PROJECT NAME	Sample Configuration	**PAGES**	8 / 20
PROJECT NO		**CODE**	AISC13
PROJECT DATE		**METHOD**	ASD
CALC DATE	1/17/2019	**UNITS**	US
CALCULATED BY		**SEISMIC**	No
CHECKED BY		**FILE NAME**	Sample Brace Configuration.dsn
DESCRIPTION			

Gross Area with Tension Resistance:
Agt = st * (Nw - 1) * tw
= 3 * (2 - 1) * 0.43
= 1.29 in^2

Net Area with Tension Resistance:
Ant = Agt - (dh + 0.0625) * (Nw - 1) * tw
= 1.29 - (0.9375 + 0.0625) * (2 - 1) * 0.43
= 0.86 in^2
(1 / FS)Rn = (1 / FS) * (0.6 * Min(Fu * Anv, Fy * Agv) + Ubs * Fu * Ant)
= (1 / 2.0) * (0.6 * Min(75 * 2.58, 60 * 3.87) + 1 * 75 * 0.86)
= 90.3 ≥ Pw = 71.3744 kips (OK)

2.e. Allowable Tension Strength

2.e.1. **Tension Yielding:**
(1 / FS) Pn = (1 / 1.67) * Fy * Ag = (1 / 1.67) * 60 * 21.1
= 758.0838 ≥ 300 kips (OK)

2.e.2. **Tension Rupture**
Net Area = An1 = A - 4 * (dh + 0.0625) * tf
= 21.1 - 4 * 1.125 * 0.67
= 18.085 in^2

Net Area = An2 = An1 - Nw * (dh + 0.0625) * tw
= 18.085 - 2 * (1) * 0.43
= 17.225 in^2

An3 = An2 + s * s / 2 / g
= 17.225 + 6^2 / 2 / 7.15
= 19.7424 in^2

TCap1 = An1 * (1 / 2.0) * Fu = 18.085 * (1 / 2.0) * 75 = 678.1875
TCap2 = An2 * (1 / 2.0) * Fu + Tca = 17.225 * (1 / 2.0) * 75 + 114.3127 = 760.2502
TCap3 = An3 * (1 / 2.0) * Fu = 19.7424 * (1 / 2.0) * 75 = 740.343
(1 / FS) Pn = 678.1875 kips ≥ 300 kips (OK)

2.f. Gusset Dimensions:
Upper Right Brace Gusset Dimensions:
Column Side (Lgc) = 24.3479 in.
Right Side Beam Side (Lgb) = 39.5654 in.
Right Side Beam Side Free Edge (Lvfx) = -6.797 in.
Right Side Beam Side Free Edge (Lvfy) = 8.4963 in.
Column Side Free Edge (Lhfx) = 20.087 in.
Column Side Free Edge (Lhfy) = 0 in.

2.g. Gusset Edge Forces
Gusset edge moments carried by: Beam and Column interfaces
Theta (degrees) = 51.3401
eb = 10.8 in.
ec = 7.1 in.
Beta = 11.7893 in.
BetaBar = 12.1739 in.
AlphaBar = 20.2827 in.
Alpha = (Beta + eb) * Tan(Theta) - ec
= (11.7893 + 10.8) * Tan(51.3401) - 7.1
= 21.1367 in.

2.g.1. **With Tensile Brace Force:**
r = Fx / ((Alpha + ec)^2 + (GussetBeta + eb)^2)^0.5
= 300 / ((21.1367 + 7.1)^2 + (11.7893 + 10.8)^2)^0.5
= 8.2963 k/ft.
Hb = Alpha * r = 21.1367 * 8.2963
= 175.3568 kips
Hc = ec * r = 7.1 * 8.2963
= 58.9037 kips
Vb = eb * r = 10.8 * 8.2963
= 89.600 kips
Vc = GussetBeta * r = 11.7893 * 8.2963
= 97.8084
Mb = |Vb * (Alpha - AlphaBar)|
= |89.600 * (21.1367 - 20.2827)|
= 76.5215 k-in.
Mc = |Hc * (Beta - BetaBar)|
= |58.9037 * (11.7893 - 12.1739)|
= 22.6538 k-in.

2.g.2. **With Compressive Brace Force:**
r = Fx / ((Alpha + ec)^2 + (GussetBeta + eb)^2)^0.5
= 200 / ((21.1367 + 7.1)^2 + (11.7893 + 10.8)^2)^0.5
= 5.5308 k/ft.
Hb = Alpha * r = 21.1367 * 5.5308
= 116.9045 kips
Hc = ec * r = 7.1 * 5.5308
= 39.2691 kips
Vb = eb * r = 10.8 * 5.5308
= 59.7333 kips
Vc = GussetBeta * r = 11.7893 * 5.5308
= 65.2056
Mb = |Vb * (Alpha - AlphaBar)|
= |59.7333 * (21.1367 - 20.2827)|
= 51.0143 k-in.
Mc = |Hc * (Beta - BetaBar)|
= |39.2691 * (11.7893 - 12.1739)|
= 15.1025 k-in.

3. COMPUTE UPPER RIGHT BRACE GUSSET THICKNESS

3.a. Claw Angle Bolts:
Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe

Edge Dist. = 1.5 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 69.6 kips/in.
= (1 / 2.0) * 1.2 * 0.9687 * 58 = 33.7125 kips/in.

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 69.6 kips/in.
= (1 / 2.0) * 1.2 * 1.9375 * 58 = 67.425 kips/in.

3.b. Splice Plate Bolts:
Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.5 in., Hole Size = 0.9375 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 60.9 kips/in.
= (1 / 2.0) * 1.2 * 1.0312 * 58 = 35.8875 kips/in.

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.9375 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 60.9 kips/in.
= (1 / 2.0) * 1.2 * 2.0625 * 58 = 71.775 kips/in.
Use: Fbs = 60.9 kips/in.
Try Gusset Thickness (t) = 0.5

3.c. Bolt Bearing on Gusset at Claw Angles:
With Tensile Force:
(1 / FS) Rn = 2 * (Fbe + Fbs * (n - 1)) * t
= 2 * (33.7125 + 67.425 * (4 - 1)) * 0.5
= 235.9875 kips
With Compressive Force:
(1 / FS) Rn = 2 * Fbs * n * t
= 2 * 67.425 * 4 * 0.5
= 269.7 kips

3.d. Bolt Bearing on Gusset at Splice Plates:
With Tensile Force:
(1 / FS) Rn = (Nw * Fbe + (n - Nw) * Fbs) * t
= (2 * 35.8875 + (4 - 2) * 60.9) * 0.5
= 96.7875 kips
With Compressive Force:
(1 / FS) Rn = n * Fbs) * t
= (4 * 60.9 * 0.5
= 121.8 kips

3.e. Total Allowable Bearing Strength with Tensile Force:
= 235.9875 + 96.7875
= 332.775 ≥ 300 kips (OK)

3.f. Total Allowable Bearing Strength with Compressive Force:
= 269.7 + 121.8
= 391.5 ≥ 200 kips (OK)

3.g. Gusset Tear-out Through Bolts at Claw Angles:
Claw Angle Gage (g) = 2.5 in.

Agv = 2 * (s * (n - 1) + e) * t
= 2 * (3 * (4 - 1) + 1.5) * 0.5
= 10.5 in^2

Anv = Agv - 2 * (n - 0.5) * (dh + 0.0625) * t
= 10.5 - 2 * (4 - 0.5) * (1.0625 + 0.0625)*0.5
= 6.5625 in^2

Agt = (d_brace + 2 * g) * t
= (12.3 + 2 * 2.5) * 0.5
= 8.65 in^2

Ant = Agt - (dh + 0.0625) * t
= 8.65 - (1.0625 + 0.0625) * 0.5
= 8.0875 in^2
Block Shear Strength:
(1 / FS)Rn = (1 / FS) * (0.6 * Min(Fu * Anv, Fy * Agv) + Ubs * Fu * Ant)
= (1 / 2.0) * (0.6 * Min(58 * 6.5625, 36 * 10.5) + 1 * 58 * 8.0875)
= 347.9375 ≥ 300 kips (OK)

3.h. Gusset Block Shear Through Bolts at Splice Plate:
Agv = 2 * (sl * (nl - 1) + eg) * t
= 2 * (3 * (2 - 1) + 1.5) * 0.5
= 4.5 in^2

Anv = Agv - 2 * (Nl - 0.5) * (dh + 0.0625) * t
= 4.5 - 2 * (2 - 1) * (0.9375 + 0.0625) * 0.5
= 3 in^2

Agt = st * (Nt - 1) * t
= 3 * (2 - 1) * 0.5
= 1.5 in^2

Ant = Agt - (dh + 0.0625) * (Nt - 1) * t
= 1.5 - (0.9375 + 0.0625) * (2 - 1) * 0.5
= 1 in^2
Block Shear Strength:
(1 / FS)Rn = (1 / FS) * (0.6 * Min(Fu * Anv, Fy * Agv) + Ubs * Fu * Ant)
= (1 / 2.0) * (0.6 * Min(58 * 3, 36 * 4.5) + 1 * 58 * 1)
= 77.6 ≥ 71.3744 kips (OK)

3.i. Check Whitmore Section:
Width (Lw) = (n - 1) * s * 1.1547 + d_brace + 2 * g
= (4 - 1) * 3 * 1.1547 + 12.3 + 2 * 2.5
= 27.6923 in.
Lwb = 1.2155 in. of Lw is in the Beam.
Width of Whitmore Section inside gusset boundaries (Lwg) = 26.4767 in.

3.j. Whitmore Section Stress:
fa = Fx / (Lwg * t + Lwb * twb + Lwc * twc)
= 200 / (26.4767 * 0.5 + 1.2155 * 0.58 + 0 * 0.485)
= 14.3437 ksi

PROJECT NAME	Sample Configuration	**PAGES**	10 / 20
PROJECT NO		**CODE**	AISC13
PROJECT DATE		**METHOD**	ASD
CALC DATE	1/17/2019	**UNITS**	US
CALCULATED BY		**SEISMIC**	No
CHECKED BY		**FILE NAME**	Sample Brace Configuration.dsn
DESCRIPTION			

3.j.1. **Whitmore Section Yielding:**
Allowable Strength = (1 / 1.67) * (Lwg * t * Fyg + Lwb * twb * Fyb + Lwc * twc * Fyc)
= (1 / 1.67) * (26.4767 * 0.5 * 36 + 1.2155 * 0.58 * 65 + 0 * 0.485 * 50)
= 312.8187 ≥ 300 (Tension) kips (OK)
= 312.8187 ≥ 200 (Compression) kips (OK)

3.j.2. **Buckling Check:**
Effective Length of Whitmore Section (K = 0.5), Lcr = 9.5652 in.
L1 = 15.7882
L2 = -1.5194, Use 0
L3 = 12.9074
L = (L1 + L2 + L3) / 3 = (15.7882 + 0 + 12.9073) / 3 = 9.5652
Lcr = KL = 0.5 * 9.5652 = 4.7826
$KL / r = Lcr / (t / 12^{0.5}) = 4.7826 / (0.5 / 3.464)$
= 33.1338
$Fe = pi^2 * E / (KL / r)^2 = 3.14^2 * 29000 / 33.1338^2$
= 260.7069 ≥ 0.44 * Fy = 0.44 * 36 = 15.84 ksi
Fy / Fe = 36 / 260.7069 = 0.138
Fcr = 0.658^0.138 * Fy = 0.658^0.138 * 36 = 33.9783 ksi
Buckling Strength = (1 / 1.67) * Fcr = 20.3463 ≥ 14.3437 ksi (OK)

4. UPPER RIGHT BRACE GUSSET TO COLUMN CONNECTION

4.a. **Shear Connection Using Clip Angle(s):**
Clip Angles: 2 L4X3-1/2X1/2 X 17.5 in.
Angle Material: A242-42/290
OSL: Long Leg
Support Side Connection: 12 Bolts (0.75 - A325 - N - STD)
Bolt Holes on Support: 0.8125 in. Vert. X 0.8125 in. Horiz.
Effective Thickness of Support Material: 0.78 in.
Bolt Holes on Angles: 0.8125 in. Vert. X 0.8125 in. Horiz.
Gusset Side Connection: 6 Bolts (0.75 - A325 - N - STD)
Bolt Holes on Beam Web: 0.8125 in. Vert. X 0.8125 in. Horiz.
Bolt Holes on Angles: 0.8125 in. Vert. X 0.8125 in. Horiz.
Gusset Thickness: 0.5 in.
Gusset Height: 24.3479 in.
Beam Setback: 0.5 in.

Transfer Force and Beam Fx
Beam Axial (Wind/Seismic - Left to Right): 234.2606 kips
Beam Axial (Wind/Seismic - Right to Left): -156.1737 kips
Upper Brace Compression: 200 kips
Upper Brace Tension: 300 kips

Loading:
Vertical Shear (V) = 97.8084 kips
Horizontal Force (Hc) = 39.2691 kips
Horizontal Force (Ht) = 58.9037 kips
$Resultant (R) = (V^2 + H^2)^{0.5} = (97.8084^2 + 58.9037^2)^{0.5} = 114.1759$ kips

Theta = Atan(V / H) = Atan(97.8084 / 58.9037) = 58.9421

Check Clearances:
Gusset Height = 24.3479 ≥ 17.5 in. (OK)

4.b. **Support Side Bolts:**
Spacing (s) = 3 ≥ Minimum Spacing = 2 in. (OK)
Distance to Horizontal Edge (ev):
= 1.25 ≥ 1.25 in. (OK)
Distance to Vertical Edge (eh):
= 1.5 ≥ 1 in. (OK)
Gage on OSL:
Angle Gage = 2.5 ≥ 1.75 in. (OK)
Column Gage = 5.5 in.

4.c. **Allowable Bolt Shear Strength - Clip Angles**
(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 6 * 10.6028
= 127.2345 ≥ 97.8084 kips (OK)

4.d. **Tension Strength of Clip Angle(s)**

Nominal Tension Strength per Bolt = rn
= (1.3 * Fnt - (FS * Fnt / Fnv) * (V / (N * Ab))) * Ab ≤ Fnt * Ab
= (1.3 * 90 - (2 * 90 / 48) * (48.9042 / (6 * 0.4417))) * 0.4417 ≤ 90 * 0.4417
47.8146 * 0.4417 ≤ 90 * 0.4417
= 21.1238
Allowable Strength per Bolt, (1 / FS) * rn = (1 / 2.0) * rn = 10.5619 kips

4.d.1. **Allowable Tension Strength per Tributary Area for Each Interior Bolt:**
a = 1.5 in.
b = 2.25 in.
dh = 0.8125 in.
b' = 1.875 in.
a' = 1.875 in.
p = 3 in.

$tc = (4 / (1 / 1.67) * (1 / FS) Rn * b' / (p * Fu))^{0.5}$
$= (4 / (1 / 1.67) * 10.5619 * 1.875 / (3 * 63))^{0.5}$
= 0.8366 in.

delta = 1 - dh / p
= 1 - 0.8125 / 3
= 0.7291

ro = b' / a'
= 1.875 / 1.875
= 1

$Alfa' = ((tc / t)^2 - 1) / (delta * (1 + ro))$

= ((0.8366 / 0.5)^2 - 1) / (0.7291 * (1 + 1))
= 1.2341
(1 / FS)Tn = (1 / FS) Rn * (t / tc)^2 * (1 + delta)
= 10.5619 * (0.5 / 0.8366)^2 * (1 + 0.7291) = 6.5232 kips

4.d.2. **Allowable Tension Strength per Tributary Area for Each Exterior Bolt:**
a = 1.5 in.
b = 2.25 in.
dh = 0.8125 in.
b' = 1.875 in.
a' = 1.875 in.
p = 2.75 in.

tc = (4 / (1 / 1.67) * (1 / FS) Rn * b' / (p * Fu))^0.5
= (4 / (1 / 1.67) * 10.5619 * 1.875 / (2.75 * 63))^0.5
= 0.8738 in.

delta = 1 - dh / p
= 1 - 0.8125 / 2.75
= 0.7045

ro = b' / a'
= 1.875 / 1.875
= 1

Alfa' = ((tc / t)^2 - 1) / (delta * (1 + ro))
= ((0.8738 / 0.5)^2 - 1) / (0.7045 * (1 + 1))
= 1.4578

(1 / FS)Tn = (1 / FS) Rn * (t / tc)^2 * (1 + delta)
= 10.5619 * (0.5 / 0.8738)^2 * (1 + 0.7045)
= 5.8944 kips

4.d.3. **Average Prying Force:**
Alfa = Max[0; (1 / Delta) * (rut / (1 / FS) Rn * (tc / t)^2 - 1)]
= Max(0; (1 / 0.7045) * (6.3136 / 10.5619 * (0.8738 / 0.5)^2 - 1))
= 1.172

qu = (1 / FS) Rn * Delta * alfa * ro * (t / tc)^2
= 10.5619 * 0.7045 * 1.172 * 1 * (0.5 / 0.8738)^2
= 2.8555 kips / bolt
Average (1 / FS)Tn:
= (2 * (1 / FS)Tn_Ext + (N - 2) * (1 / FS)Tn_Int) / N
= (2 * 5.8944 + (6 - 2) * 6.5232) / 6
= 6.3136 kips

4.e. Allowable Bolt Shear Strength - Clip Angles
(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 6 * 6.3136
= 75.7634 ≥ 58.9037 kips (OK)

4.f. Bolt Bearing Check

4.f.1. **Upper Right Brace Bolt Bearing on Angle(s):**
Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.25 in., Hole Size = 0.8125 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 56.7 kips/in.
= (1 / 2.0) * 1.2 * 0.8437 * 63 = 31.8937 kips/in.

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.8125 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 56.7 kips/in.
= (1 / 2.0) * 1.2 * 2.1875 * 63 = 82.6875 kips/in.
Use: Fbs = 56.7 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * (Fbe + Fbs * (nB - 1)) * t * ef
= 2 * 1 * (31.8937 + 56.7 * (6 - 1)) * 0.5 * 1
= 315.3937 ≥ 97.8084 kips (OK)

4.f.2. **Bolt Bearing on Support:**

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 0.8125 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 58.5 kips/in.
= (1 / 2.0) * 1.2 * 2.1875 * 65 = 85.3125 kips/in.
Use: Fbs = 58.5 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * Fbs * nB * t * ef
= 2 * 1 * 58.5 * 6 * 0.78 * 1
= 547.56 ≥ 97.8084 kips (OK)

4.g. Gusset Side Bolts: 6 Bolts - (0.75 - A325 - N - STD)
Spacing (s) = 3 ≥ Minimum Spacing = 2 in. (OK)
Distance to Horizontal Edge (ev):
= 1.5 ≥ 1.25 in. (OK)
Distance to Vertical Edge (eh):
= 1 ≥ 1 in. (OK)
Gage on Angle Leg on Gusset
= 2 ≥ 1.625 in. (OK)

4.h. Allowable Bolt Shear Strength - Clip Angles
(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 6 * 10.6028
= 127.2345 ≥ 97.8084 kips (OK)

4.h.1. **Bolt Bearing on Angles:**
Lc = Min[eh / cos(theta), ev / sin(theta)] - 0.5 * (dh + 0.0625)
= Min[1 / cos(58.9421), 1.5 / sin(58.9421)] - 0.5 * (0.8125 + 0.0625)
= Min[1.9383, 1.751] - 0.5 * 0.875
= 1.751 - 0.5 * 0.875
= 1.3135

Bearing Strength / Bolt / Thickness Using Effective Bolt Edge Distance (Bolt 2) = Fbe2
Effective Edge Dist. = 1.751 in., Hole Size = 0.875 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 56.7 kips/in.
= (1 / 2.0) * 1.2 * 1.3135 * 63 = 49.6508 kips/in.

Lc = eh / cos(theta) - 0.5 * (dh + 0.0625)
= 1 / cos(58.9421) - 0.5 * (0.8125 + 0.0625)
= 1.9383 - 0.5 * 0.875
= 1.5008

Bearing Strength / Bolt / Thickness Using Effective Bolt Edge Distance (Bolt 1) = Fbe1
Effective Edge Dist. = 1.9383 in., Hole Size = 0.875 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 56.7 kips/in.
= (1 / 2.0) * 1.2 * 1.5008 * 63 = 56.732 kips/in.
Use: Fbs = 56.7 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * (Fbe + Fbs * (nB - 1)) * t * ef
= 2 * 1 * (49.6508 + 56.7 * (6 - 1)) * 0.5 * 1
= 333.1508 ≥ 114.1759 kips (OK)

4.h.2. **Bolt Bearing on Gusset Plate:**

Lc = (Lh - 0.25 Underrun) / cos(theta) - 0.5 * (dh + 0.0625)
= 1.25 / cos(58.9421) - 0.5 * (0.8125 + 0.0625)
= 2.4229 - 0.5 * 0.875
= 1.9854

Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 2.4229 in., Hole Size = 0.875 in.
= 2.4229 - 0.5 * 0.875 = 1.9854
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 67.5 kips/in.
= (1 / 2.0) * 1.2 * 1.9854 * 75 = 89.3445 kips/in.
Use: Fbs = 67.5 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * Fbe * nB * t * ef
= 1 * 1 * 67.5 * 6 * 0.5 * 1
= 202.5 ≥ 114.1759 kips (OK)

4.i. Allowable Shear Strength of the Gusset:

4.i.1. **Allowable Shear Yield Strength:**
A = Lgc * tp = 24.3479 * 0.5 = 12.1739 in^2
Rn = 0.6 * Fy * A
= 0.6 * 36 * 12.1739
= 262.9581 kips
(1 / FS) Rn = (1 / 1.5) * 262.9581 = 175.3054 kips
= 175.3054 ≥ 97.8084 kips (OK)

4.i.2. **Allowable Shear Rupture Strength:**
Anv = (Lgc - N * (dh + 0.0625)) * tp
= (24.3479 - 6 * (0.8125 + 0.0625)) * 0.5
= 9.5489 in^2
Rn = 0.6 * Fu * Anv
= 0.6 * 58 * 9.5489
= 332.3048 kips
(1 / FS) Rn = (1 / 2.0) * 332.3048 = 166.1524 kips
= 166.1524 ≥ 97.8084 kips (OK)

4.i.3. **Allowable Block Shear Rupture Strength of Gusset Due to Shear Load (L-Shape)**
Agv = (L - 2 * Lvs + Lvg) * tp
= (17.5 - 2 * 1.25 + 4.6739) * 0.5
= 9.8369 in^2

Anv = (L - 2 * Lvs + Lvg - (Nl - 0.5) * (dv + 0.0625)) * tp
= (17.5 - 2 * 1.25 + 4.6739 - (6 - 0.5) * (0.8125 + 0.0625)) * 0.5
= 7.4307 in^2

Agt = (W - c - Lh) * tp
= (3.5 - 0.5 - 1.5) * 0.5
= 0.75 in^2

Ant = (W - c - Lh - (Nh - 0.5) * (dh + 0.0625)) * tp
= (3.5 - 0.5 - 1.5 - (1 - 0.5) * (0.8125 + 0.0625)) * 0.5
= 0.5312 in^2

(1 / FS)Rn = (1 / 2.0) * Min((0.6 * Fu * Anv + Ubs * Fu * Ant); (0.6 * Fy * Agv + Ubs * Fu * Ant))
= (1 / 2.0) * Min((0.6 * 58 * 7.4307 + 1 * 58 * 0.5312); (0.6 * 36 * 9.8369 + 1 * 58 * 0.5312))
= (1 / 2.0) * Min(289.4024; 243.2915)
= 121.6457 ≥ 97.8084 kips (OK)

4.j. Gusset Allowable Tensile Yielding Strength
(1 / FS) Rn = (1 / FS) * Fy * Ag
= (1 / 1.67) * 36 * 12.1739
= 524.8665 ≥ 58.9037 kips (OK)

4.k. Gusset Allowable Tensile Rupture Strength
U = ((d - 2 * tf) * tw) / Ag
= ((12.3 - 2 * 0.67) * 0.43) / 21.1
= 0.2233

An = Ag - n * (dh + 0.0625) * tp
An = 12.1739 - 6 * (0.8125 + 0.0625) * 0.5
= 9.5489 in^2

(1 / FS) Rn = (1 / FS) * Fu * An * U
= 0.5 * 58 * 9.5489 * 0.2233
= 61.8517 ≥ 58.9037 kips (OK)

4.l. Angle Tensile Rupture Under Gusset Axial Load
(1 / FS) Rn = (1 / 2.0) * (L - nv * (dv + 0.0625) * t * Fu

= (1 / 2.0) * (17.5 - 6 * 0.875) * 0.5 * 58
= 177.625 ≥ 29.4518 kips (OK)

4.m. Angle Tensile Yielding Under Gusset Axial Load
(1 / FS) Rn = (1 / FS) * Fy * L * t
= (1 / 1.67) * 42 * 17.5 * 0.5
= 220.0598 ≥ 29.4518 kips (OK)

4.n. Gusset Block Shear under Axial Load (U-Shape):
Shear Area Length (net) (Lnv) = 2 * (Lh + sh * (nh - 1) - (dh + 0.0625) * (nh - 0.5))
= 2 * (1.5 + 0 * (1 - 1) - 0.875 * (1 - 0.5))
= 2.125 in.

Shear Area Length (gross) (Lgv) = 2 * (Lh + sh * (nh - 1))
= 2 * (1.5 + 0 * (1 - 1))
= 3 in.

Tension Area Length (net) (Lnt) = (nv - 1) * (sv - (dv + 0.0625))
= (6 - 1) * (3 - 0.875)
= 10.625 in.

Tension Area Length (gross) (Lgt) = (nv - 1) * sv
= (6 - 1) * 3
= 15 in.

(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 58 * 2.125 + 1 * 58 * 10.625); (0.6 * 36 * 3 + 1 * 58 * 10.625)) * 0.5
= 170.2625 ≥ 29.4518 kips (OK)
For two angles, (1 / FS) Rn = 2 * 170.2625
= 340.525 ≥ 58.9037 kips (OK)

4.o. Gusset Block Shear under Axial Load (L-Shape):
Shear Area Length (net) (Lnv) = (Lh + sh * (nh - 1) - (dh + 0.0625) * (nh - 0.5))
= (1.5 + 0 * (1 - 1) - 0.875 * (1 - 0.5))
= 1.0625 in.

Shear Area Length (gross) (Lgv) = (Lh + sh * (nh - 1))
= (1.5 + 0 * (1 - 1))
= 1.5 in.

Tension Area Length (net) (Lnt) = (nv - 1) * (sv - (dv + 0.0625) + ev - (dh + 0.0625) / 2
= (6 - 1) * (3 - 0.875) + 1.5 - (0.8125 + 0.0625) / 2
= 11.6875 in.

Tension Area Length (gross) (Lgt) = (nv - 1) * sv + ev
= (6 - 1) * 3 + 1.5
= 16.5 in.

(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 58 * 1.0625 + 1 * 58 * 11.6875); (0.6 * 36 * 1.5 + 1 * 58 * 11.6875)) * 0.5
= 177.5687 ≥ 29.4518 kips (OK)
For two angles, (1 / FS) Rn = 2 * 355.1375
= 355.1375 ≥ 58.9037 kips (OK)

4.p. Allowable Shear Strength of Angle(s)

4.p.1. Shear Yielding Allowable Strength:
Gross Area (Ag) = L * t = 17.5 * 0.5 = 8.75 in^2
(1 / FS) Rn = 2 * (1 / 1.5) * 0.6 * Ag * Fy = 2 * (1 / 1.5) * 0.6 * 8.75 * 42
= 294 ≥ 97.8084 kips (OK)

4.p.2. Shear Rupture Allowable Strength:
Net Area on Osl (An):
= (L - n * (dh + 0.0625)) * t
= (17.5 - 6 * (0.8125 + 0.0625)) * 0.5 = 6.125 in^2
An = 6.125 in^2
(1 / FS) Rn = 2 * (1 / 2.0) * 0.6 * An * Fu = 2 * (1 / 2.0) * 0.6 * 6.125 * 63 = 231.525 ≥ 97.8084 kips (OK)

4.q. Block Shear Strength of Gusset Side Leg of One Angle Under Shear Load:

Gross Length with Tension resistance (Lgt) = Lh = 1.5 in.

Net Length with Tension resistance (Lnt)
= Lgt - (dh + 0.0625) / 2 = 1.5 - 0.875 / 2 = 0.5625 in.

Gross Length with Shear resistance (Lgv)
= (n - 1) * s + Lv
= (6 - 1) * 3 + 1.5 = 16.5 in.

Net Length with Shear resistance (Lnv)
= Lgv - (n - 0.5) * (dv + 0.0625)
= 16.5 - (6 - 0.5) * (0.8125 + 0.0625)
= 11.6875 in.
(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 63 * 11.6875 + 1 * 63 * 0.5625); (0.6 * 42 * 16.5 + 1 * 63 * 0.5625)) * 0.5
= 112.8093 ≥ 48.9042 kips (OK)

4.r. Check Interaction of Shear and Axial Loads:
Controlling Available Strengths:
Rnv * (1 / FS) = Min(294, 231.525, 225.6187) = 225.6187
Rnt * (1 / FS) = Min(355.25, 340.525, 440.1197, 355.1375) = 340.525

Check Interaction of Shear and Axial Loads:
$(V / (Rnv * (1 / FS)))^2 + (H / (Rnt * (1 / FS)))^2 \le 1$
$(97.8084 / 225.6187)^2 + (58.9037 / 340.525)^2 \le 1$
0.2178 ≤ 1 (OK)

4.r.1. **Block Shear Strength of Support Side Leg of One Angle Under Shear Load:**

Gross Length with Tension resistance (Lgt) = Lh = 1.5 in.

Net Length with Tension resistance (Lnt)
= Lgt - (dh + 0.0625) / 2 = 1.5 - 0.875 / 2 = 1.0625 in.

Gross Length with Shear resistance (Lgv)
= (n - 1) * s + Lv
= (6 - 1) * 3 + 1.25 = 16.25 in.

Net Length with Shear resistance (Lnv)
= Lgv - (n - 0.5) * (dv + 0.0625)
= 16.25 - (6 - 0.5) * (0.8125 + 0.0625)
= 11.4375 in.
(1 / FS) Rn = (1 / 2.0) * (0.6 * Min(Fu * Lnv, Fy * Lgv) + Fu * Lnt) * t
= (1 / 2.0) * (0.6 * Min(63 * 11.4375, 42 * 16.25) + 1 * 63 * 1.0625) * 0.5
= 119.1093 ≥ 48.9042 kips (OK)

5. COLUMN AND BEAM CHECK

5.a. Column Local Stresses for Upper Right Brace

5.a.1. **Column Flange Bending:**

Nominal Tension Strength per Bolt = rn
= (1.3 * Fnt - (FS * Fnt / Fnv) * (V / (N * Ab))) * Ab ≤ Fnt * Ab
= (1.3 * 90 - (2 * 90 / 48) * (48.9042 / (6 * 0.4417))) * 0.4417 ≤ 90 * 0.4417
47.8146 * 0.4417 ≤ 90 * 0.4417
= 21.1238
Allowable Strength per Bolt, (1 / FS) * rn = (1 / 2.0) * rn = 10.5619 kips
Force (H') = (H + 3 * M / ((N + 1) * sl) / 2
31.070 = (58.9037 + 3 * 22.6538 / ((6 + 1) * 3) / 2

Force per Bolt (T) = H' / n
5.1783 = 31.070 / 6

b = 2.5075 in.
a = 1.5 in.
b' = 2.1325 in.
a' = 1.875 in.
ro = 1.1373 in.
p = 3
d' = 0.8125
delta = 1 - d' / p = 1 - 0.8125 / 3
delta = 0.7291
Beta = (B / T - 1) / ro = (10.5619 / 5.1783 - 1) / 1.1373
Beta = 0.9141
Alpha' = Min(1, Beta / (delta * (1 - Beta)) = 1

Required Flange Thickness for Bending (treq'd)
= (4 / (1 / 1.67) * T * b' / (p * Fy * (1 + delta * Alpha'))$^{0.5}$
= (4 / (1 / 1.67) * 5.1783 * 2.1325 / (3 * 50 * (1 + 0.7291 * 1)))$^{0.5}$
= 0.5332 ≤ tf 0.78 (OK)

5.a.2. **Column Flange Shear - Required Flange Thickness for Shear**
= T / Min((1 / 1.5) * 0.6 * p * Fy, (1 / 2.0) * 0.6 * (p - (d' + 0.0625))) * Fu
= 5.1783 / Min((1 / 1.5) * 0.6 * 3 * 50, (1 / 2.0) * 0.6 * (3 - (0.8125 + 0.0625))) * 65
= 0.1249 ≤ tf 0.78 (OK)

5.a.3. **Column Web Local Yielding:**
Force from Gusset (RColumn) = ((H + 3 * M / N)^2 + (1.73 * V)^2)$^{0.5}$
= ((58.9037 + 3 * 22.6538 / 17.5)^2 + (1.73 * 97.8084)^2)$^{0.5}$
= 180.482 kips

Required Web Thickness = RColumn / ((1 / 1.5) * Fy * (N + 5 * k))
= 180.482 / (1 / 1.5) * 50 * (17.5 + 5 * 1.38))
= 0.2219 ≤ tw 0.485 (OK)

5.a.4. **Column Web Crippling:**
Force from Gusset (RColumn) = H + 3 * M / N
= 39.2691 + 3 * 15.1025 / 17.5
= 41.8581 kips

Rcap = (1 / 2.0) * 0.8 * E$^{0.5}$ * tw^2 * (1 + 3 * (N / d) * (tw / tf)^1.5) * (Fy * tf / tw)$^{0.5}$
= (1 / 2.0) * 0.8 * 29000$^{0.5}$ * 0.485^2 * (1 + 3 * 1.2323 * (0.485 / 0.78)^1.5) * (50 * 0.78 / 0.485)$^{0.5}$
= 404.1452 ≥ RColumn 41.8581 kips (OK)

6. UPPER RIGHT BRACE GUSSET TO BEAM CONNECTION
Horizontal Force on Welds (Hb) = 175.3568 kips
Vertical Force on Welds (Vb) = 89.600 kips
Moment on Welds (M) = 76.5215 kip-in./in.
Weld Length on Each Side of Gusset Plate (L) = 39.5654 in.
Average Force on Welds per Unit Length = fraverage
= ((V / L + 3 * M / (L^2))^2 + (H / L)^2)$^{0.5}$
= ((89.600 / 39.5654 + 3 * 76.5215 / (39.5654 ^{2}))^2 + (175.3568 / 39.5654)^2)$^{0.5}$
= 5.0455 kips/in.

Max. Force on Welds per Unit Length = fr
= ((V / L + 6 * M / (L^2))^2 + (H / L)^2)$^{0.5}$
= ((89.600 / 39.5654 + 6 * 76.5215 / (39.5654 ^ 2))^2 + (175.3568 / 39.5654)^2)$^{0.5}$
= 5.1172 kips/in.

	PROJECT NAME	Sample Configuration	**PAGES**	15 / 20
	PROJECT NO		**CODE**	AISC13
	PROJECT DATE		**METHOD**	ASD
	CALC DATE	1/17/2019	**UNITS**	US
	CALCULATED BY		**SEISMIC**	No
	CHECKED BY		**FILE NAME**	Sample Brace Configuration.dsn
	DESCRIPTION			

Maximum useful weld size = 0.7072 * Fu * t / Fexx
= 0.7072 * 58 * 0.5 / 70
= 0.2929 in.
Use Richard Factor (Rf) = 1.25

Required Weld Size (w) = Max(Rf * f_avrg, f_peak) / ((1 / 2.0) * 0.6 * 1.41 * Fexx)
= 6.3069 / ((1 / 2.0) * 0.6 * 1.41 * 70)
= 0.2123 ≤ 0.2929 in. (OK)

Try 0.25 in. Weld
Minimum Weld size = 0.1875 ≤ 0.25 in. (OK)

Weld Size = 0.25 in. ≥ 0.2123 in. (OK)

All Welds Are E70XX

RIGHT SIDE BEAM

7. RIGHT SIDE BEAM TO COLUMN CONNECTION

7.a. Shear Connection Using Clip Angle(s):

Clip Angles: 2 L4X3-1/2X1/2 X 12.5 in.
Angle Material: A529-55/345
OSL: Long Leg
Support Side Connection: 8 Bolts (1 - A325 - N - STD)
Bolt Holes on Support: 1.0625 in. Vert. X 1.0625 in. Horiz.
Effective Thickness of Support Material: 0.78 in.
Bolt Holes on Angles: 1.0625 in. Vert. X 1.0625 in. Horiz.
Beam Side Connection: 4 Bolts (0.75 - A490 - N - STD)
Bolt Holes on Beam Web: 0.8125 in. Vert. X 0.8125 in. Horiz.
Bolt Holes on Angles: 0.8125 in. Vert. X 0.8125 in. Horiz.
Beam Web Thickness: 0.58 in.
Beam Web Height: 18.35 in.
Beam Setback: 0.5 in.

Transfer Force and Beam Fx
Beam Axial (Wind/Seismic - Left to Right): 234.2606 kips
Beam Axial (Wind/Seismic - Right to Left): -156.1737 kips
Upper Brace Compression: 200 kips
Upper Brace Tension: 300 kips
Vertical Force on Clip Angle = V (Maximum Combined Force) = 74.7333 kips
Horizontal Force on Clip Angle = H
H (Tension) = 39.2691 kips
H (Compression) = 58.9037 kips
Resultant (R) = $(V^2 + H^2)^{0.5}$ = $(74.7333^2 + 58.9037^2)^{0.5}$ = 95.1563 kips

Loading:
Vertical Shear (V) = 74.7333 kips
Horizontal Force (Hc) = 58.9037 kips
Horizontal Force (Ht) = 39.2691 kips

Resultant (R) = $(V^2 + H^2)^{0.5}$ = $(74.7333^2 + 58.9037^2)^{0.5}$ = 95.1563 kips
Theta = Atan(V / H) = Atan(74.7333 / 58.9037) = 51.7553

Check Clearances:
Connection Top Location: (OK)
Connection Bottom Location: (OK)
Connection Depth = 12.5 ≥ T / 2 (OK)
Minimum Length of Clip Angle = T / 2 = 18.35 / 2 = 9.25 ≤ 12.5 in. (OK)

7.b. Support Side Bolts:

Spacing (s) = 3 ≥ Minimum Spacing = 2.6666 in. (OK)
Distance to Horizontal Edge (ev):
= 1.75 ≥ 1.25 in. (OK)
Distance to Vertical Edge (eh):
= 1.54 ≥ 1.25 in. (OK)
Gage on OSL:
Angle Gage = 2.46 ≥ 2 in. (OK)
Column Gage = 5.5 in.

7.c. Allowable Bolt Shear Strength - Clip Angles

(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 4 * 18.8495
= 150.7964 ≥ 74.7333 kips (OK)

7.d. Tension Strength of Clip Angle(s)

Nominal Tension Strength per Bolt = rn
= (1.3 * Fnt - (FS * Fnt / Fnv) * (V / (N * Ab))) * Ab ≤ Fnt * Ab
= (1.3 * 90 - (2 * 90 / 48) * (7.5 / (4 * 0.7853))) * 0.7853 ≤ 90 * 0.7853
108.0475 * 0.7853 ≤ 90 * 0.7853
= 70.6858
Allowable Strength per Bolt, (1 / FS) * rn = (1 / 2.0) * rn = 35.3429 kips

7.d.1. Allowable Tension Strength per Tributary Area for Each Interior Bolt:

a = 1.54 in.
b = 2.21 in.
dh = 1.0625 in.
b' = 1.71 in.
a' = 2.04 in.
p = 3 in.

tc = $(4 / (1 / 1.67) * (1 / FS)\ Rn * b' / (p * Fu))^{0.5}$
= $(4 / (1 / 1.67) * 35.3429 * 1.71 / (3 * 70))^{0.5}$
= 1.3865 in.

delta = 1 - dh / p
= 1 - 1.0625 / 3
= 0.6458

ro = b' / a'
= 1.71 / 2.04
= 0.8382

Alfa' = ((tc / t)^2 - 1) / (delta * (1 + ro))
= ((1.3865 / 0.5)^2 - 1) / (0.6458 * (1 + 0.8382))
= 5.6349
(1 / FS)Tn = (1 / FS) Rn * (t / tc)^2 * (1 + delta)
= 35.3429 * (0.5 / 1.3865)^2 * (1 + 0.6458) = 7.5643 kips

7.d.2. **Allowable Tension Strength per Tributary Area for Each Exterior Bolt:**
a = 1.54 in.
b = 2.21 in.
dh = 1.0625 in.
b' = 1.71 in.
a' = 2.04 in.
p = 3 in.

tc = (4 / (1 / 1.67) * (1 / FS) Rn * b' / (p * Fu))^0.5
= (4 / (1 / 1.67) * 35.3429 * 1.71 / (3 * 70))^0.5
= 1.3865 in.

delta = 1 - dh / p
= 1 - 1.0625 / 3
= 0.6458

ro = b' / a'
= 1.71 / 2.04
= 0.8382

Alfa' = ((tc / t)^2 - 1) / (delta * (1 + ro))
= ((1.3865 / 0.5)^2 - 1) / (0.6458 * (1 + 0.8382))
= 5.6349

(1 / FS)Tn = (1 / FS) Rn * (t / tc)^2 * (1 + delta)
= 35.3429 * (0.5 / 1.3865)^2 * (1 + 0.6458)
= 7.5643 kips

7.d.3. **Average Prying Force:**
Alfa = Max[0; (1 / Delta) * (rut / (1 / FS) Rn * (tc / t)^2 - 1)]
= Max(0; (1 / 0.6458) * (7.5643 / 35.3429 * (1.3865 / 0.5)^2 - 1))
= 1

qu = (1 / FS) Rn * Delta * alfa * ro * (t / tc)^2
= 35.3429 * 0.6458 * 1 * 0.8382 * (0.5 / 1.3865)^2
= 2.4881 kips / bolt
Average (1 / FS)Tn:
= (2 * (1 / FS)Tn_Ext + (N - 2) * (1 / FS)Tn_Int) / N
= (2 * 7.5643 + (4 - 2) * 7.5643) / 4
= 7.5643 kips

7.e. Allowable Bolt Shear Strength - Clip Angles
(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 4 * 7.5643
= 60.5149 ≥ 39.2691 kips (OK)

7.f. Bolt Bearing Check

7.f.1. **Right Side Beam Bolt Bearing on Angle(s):**
Bearing Strength / Bolt / Thickness Using Bolt Edge Distance = Fbe
Edge Dist. = 1.75 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 84 kips/in.
= (1 / 2.0) * 1.2 * 1.2187 * 70 = 51.1875 kips/in.

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 84 kips/in.
= (1 / 2.0) * 1.2 * 1.9375 * 70 = 81.375 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * (Fbe + Fbs * (nB - 1)) * t * ef
= 2 * 1 * (51.1875 + 81.375 * (4 - 1)) * 0.5 * 1
= 295.3125 ≥ 74.7333 kips (OK)

7.f.2. **Bolt Bearing on Support:**

Bearing Strength / Bolt / Thickness Using Bolt Spacing = Fbs
Bolt Spacing = 3 in., Hole Size = 1.0625 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 78 kips/in.
= (1 / 2.0) * 1.2 * 1.9375 * 65 = 75.5625 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * Fbs * nB * t * ef
= 2 * 1 * 75.5625 * 4 * 0.78 * 1
= 471.51 ≥ 74.7333 kips (OK)

7.g. Beam Side Bolts: 4 Bolts - (0.75 - A490 - N - STD)
Spacing (s) = 3 ≥ Minimum Spacing = 2 in. (OK)
Distance to Horizontal Edge (ev):
= 1.75 ≥ 1.25 in. (OK)
Distance to Vertical Edge (eh):
= 1.5 ≥ 1 in. (OK)
Gage on Angle Leg in Beam Web:
= 2 ≥ 1.625 in. (OK)

7.h. Allowable Bolt Shear Strength - Clip Angles
(1 / FS)Rn = nIN * nSP * nB * Fv
= 2 * 1 * 4 * 13.2535
= 106.0287 ≥ 74.7333 kips (OK)

7.h.1. **Bolt Bearing on Angles:**
Lc = Min[eh / cos(theta), ev / sin(theta)] - 0.5 * (dh + 0.0625)
= Min[1.5 / cos(51.7553), 1.75 / sin(51.7553)] - 0.5 * (0.8125 + 0.0625)
= Min[2.4231, 2.2282] - 0.5 * 0.875

= 2.2282 - 0.5 * 0.875
= 1.7907

Bearing Strength / Bolt / Thickness Using Effective Bolt Edge Distance (Bolt 2) = Fbe2
Effective Edge Dist. = 2.2282 in., Hole Size = 0.875 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 63 kips/in.
= (1 / 2.0) * 1.2 * 1.7907 * 70 = 75.2109 kips/in.
Use: Fbe = 63 kips/in.

Lc = eh / cos(theta) - 0.5 * (dh + 0.0625)
= 1.5 / cos(51.7553) - 0.5 * (0.8125 + 0.0625)
= 2.4231 - 0.5 * 0.875
= 1.9856

Bearing Strength / Bolt / Thickness Using Effective Bolt Edge Distance (Bolt 1) = Fbe1
Effective Edge Dist. = 2.4231 in., Hole Size = 0.875 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 63 kips/in.
= (1 / 2.0) * 1.2 * 1.9856 * 70 = 83.3986 kips/in.
Use: Fbs = 63 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * (Fbe + Fbs * (nB - 1)) * t * ef
= 2 * 1 * (63 + 63 * (4 - 1)) * 0.5 * 1
= 252 ≥ 95.1563 kips (OK)

7.h.2. **Bolt Bearing on Beam Web:**

Lc = (Lh - 0.25 Underrun) / cos(theta) - 0.5 * (dh + 0.0625)
= 1.25 / cos(51.7553) - 0.5 * (0.8125 + 0.0625)
= 2.0193 - 0.5 * 0.875
= 1.5818

Bearing Strength / Bolt / Thickness Using Effective Bolt Edge Distance (Bolt 1) = Fbe1
Effective Edge Dist. = 2.0193 in., Hole Size = 0.875 in.
= (1 / 2.0) * 1.2 * Lc * Fu ≤ (1 / 2.0) * 2.4 * d * Fu = 72 kips/in.
= (1 / 2.0) * 1.2 * 1.5818 * 80 = 75.9272 kips/in.
Use: Fbs = 72 kips/in.

Allowable Bearing Strength at Bolt Holes = nIN * nL * Fbe * nB * t * ef
= 1 * 1 * 72 * 4 * 0.58 * 1
= 167.04 ≥ 95.1563 kips (OK)

7.i. Allowable Shear Strength of the Beam:

7.i.1. **Allowable Shear Yield Strength:**
A = dw * tw = 21.6 * 0.58 = 12.528 in^2
Rn = 0.6 * Fy * A * Cv
= 0.6 * 50 * 12.528 * 1
= 375.84 kips
(1 / FS) Rn = (1 / 1.5) * 375.84 = 250.56 kips
= 250.56 ≥ 74.7333 kips (OK)

7.i.2. **Allowable Shear Rupture Strength:**
Anv = (dw - N * (dh + 0.0625)) * tw
= (21.6 - 4 * (0.8125 + 0.0625)) * 0.58
= 10.498 in^2
Rn = 0.6 * Fu * Anv
= 0.6 * 65 * 10.498
= 409.422 kips
(1 / FS) Rn = (1 / 2.0) * 409.422 = 204.711 kips
= 204.711 ≥ 74.7333 kips (OK)

7.j. Beam Allowable Tensile Yielding Strength
(1 / FS) Rn = (1 / FS) * Fy * Ag
=(1 / 1.67) * 50 * 27.3
= 817.3652 ≥ 156.1737 kips (OK)

7.k. Beam Allowable Tensile Rupture Strength
xbar = (2 * bf^2 * tf + tw^2 * (d - 2 * tf)) / (8 * bf * tf + 4 * tw * (d - 2 * tf))
= (2 * 8.42^2 * 0.93 + 0.58^2 * (21.6 - 2 * 0.93)) / (8 * 8.42 * 0.93 + 4 * 0.58 * (21.6 - 2 * 0.93))
= 1.2772 in.

U = Ag_BeamWeb / Ag
U = 11.4492 / 27.3
= 0.4193

An = Ag - n * (dh + 0.0625) * tw
An = 27.3 - 4 * (0.8125 + 0.0625) * 0.58
= 25.27 in^2

(1 / FS) Rn = (1 / FS) * Fu * An * U
= 0.5 * 65 * 25.27 * 0.4193
= 344.4301 ≥ 156.1737 kips (OK)

7.l. Beam Web Block Shear under Axial Load (U-Shape):
Shear Area Length (net) (Lnv) = 2 * (Lh + sh * (nh - 1) - (dh + 0.0625) * (nh - 0.5))
= 2 * (1.5 + 0 * (1 - 1) - 0.875 * (1 - 0.5))
= 2.125 in.

Shear Area Length (gross) (Lgv) = 2 * (Lh + sh * (nh - 1))
= 2 * (1.5 + 0 * (1 - 1))
= 3 in.

Tension Area Length (net) (Lnt) = (nv - 1) * (sv - (dv + 0.0625))
= (4 - 1) * (3 - 0.875)
= 6.375 in.

Tension Area Length (gross) (Lgt) = (nv - 1) * sv
= (4 - 1) * 3
= 9 in.

(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 65 * 2.125 + 1 * 65 * 6.375); (0.6 * 50 * 3 + 1 * 65 * 6.375)) * 0.58
= 144.2025 ≥ 39.2691 kips (OK)

7.m. Angle Tensile Rupture Under Beam Axial Load
(1 / FS) Rn = (1 / 2.0) * (L - nv * (dv + 0.0625) * t * Fu
= (1 / 2.0) * (12.5 - 4 * 0.875) * 0.5 * 70
= 157.5 ≥ 19.6345 kips (OK)

7.n. Angle Tensile Yielding Under Beam Axial Load
(1 / FS) Rn = (1 / FS) * Fy * L * t
= (1 / 1.67) * 55 * 12.5 * 0.5
= 205.8383 ≥ 19.6345 kips (OK)

7.o. Beam Block Shear under Axial Load (U-Shape):
Shear Area Length (net) (Lnv) = 2 * (Lh + sh * (nh - 1) - (dh + 0.0625) * (nh - 0.5))
= 2 * (1.5 + 0 * (1 - 1) - 0.875 * (1 - 0.5))
= 2.125 in.

Shear Area Length (gross) (Lgv) = 2 * (Lh + sh * (nh - 1))
= 2 * (1.5 + 0 * (1 - 1))
= 3 in.

Tension Area Length (net) (Lnt) = (nv - 1) * (sv - (dv + 0.0625))
= (4 - 1) * (3 - 0.875)
= 6.375 in.

Tension Area Length (gross) (Lgt) = (nv - 1) * sv
= (4 - 1) * 3
= 9 in.

(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 70 * 2.125 + 1 * 70 * 6.375); (0.6 * 55 * 3 + 1 * 70 * 6.375)) * 0.5
= 133.875 ≥ 19.6345 kips (OK)
For two angles, (1 / FS) Rn = 2 * 133.875
= 267.75 ≥ 39.2691 kips (OK)

7.p. Beam Block Shear under Axial Load (L-Shape):
Shear Area Length (net) (Lnv) = (Lh + sh * (nh - 1) - (dh + 0.0625) * (nh - 0.5))
= (1.5 + 0 * (1 - 1) - 0.875 * (1 - 0.5))
= 1.0625 in.

Shear Area Length (gross) (Lgv) = (Lh + sh * (nh - 1))
= (1.5 + 0 * (1 - 1))
= 1.5 in.

Tension Area Length (net) (Lnt) = (nv - 1) * (sv - (dv + 0.0625) + ev - (dh + 0.0625) / 2
= (4 - 1) * (3 - 0.875) + 1.75 - (0.8125 + 0.0625) / 2
= 7.6875 in.

Tension Area Length (gross) (Lgt) = (nv - 1) * sv + ev
= (4 - 1) * 3 + 1.75
= 10.75 in.

(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 70 * 1.0625 + 1 * 70 * 7.6875); (0.6 * 55 * 1.5 + 1 * 70 * 7.6875)) * 0.5
= 145.6875 ≥ 19.6345 kips (OK)
For two angles, (1 / FS) Rn = 2 * 291.375
= 291.375 ≥ 39.2691 kips (OK)

7.q. Allowable Shear Strength of Angle(s)

7.q.1. Shear Yielding Allowable Strength:
Gross Area (Ag) = L * t = 12.5 * 0.5 = 6.25 in^2
(1 / FS) Rn = 2 * (1 / 1.5) * 0.6 * Ag * Fy = 2 * (1 / 1.5) * 0.6 * 6.25 * 55
= 275 ≥ 74.7333 kips (OK)

7.q.2. Shear Rupture Allowable Strength:
Net Area on Osl (An1):
= (L - n * (dh + 0.0625)) * t = (12.5 - 4 * (1.0625 + 0.0625)) * 0.5 = 4 in^2
Net Area on Beam Side Leg (An2):
= (L - n * dh + 0.0625) * t = (12.5 - 4 * (0.8125 + 0.0625)) * 0.5 = 4.5 in^2
An = Min(An1, An2)= 4 in^2
(1 / FS) Rn = 2 * (1 / 2.0) * 0.6 * An * Fu = 2 * (1 / 2.0) * 0.6 * 4 * 70 = 168 ≥ 74.7333 kips (OK)

7.r. Block Shear Strength of Beam Side Leg of One Angle Under Shear Load:

Gross Length with Tension resistance (Lgt) = Lh = 1.5 in.

Net Length with Tension resistance (Lnt)
= Lgt - (dh + 0.0625) / 2 = 1.5 - 0.875 / 2 = 1.0625 in.

Gross Length with Shear resistance (Lgv)
= (n - 1) * s + Lv
= (4 - 1) * 3 + 1.75 = 10.75 in.

Net Length with Shear resistance (Lnv)
= Lgv - (n - 0.5) * (dv + 0.0625)
= 10.75 - (4 - 0.5) * (0.8125 + 0.0625)
= 7.6875 in.
(1 / FS) Rn = (1 / 2.0) * Min((0.6 * Fu * Lnv + Ubs * Fu * Lnt); (0.6 * Fy * Lgv + Ubs * Fu * Lnt)) * t
= (1 / 2.0) * Min((0.6 * 70 * 7.6875 + 1 * 70 * 1.0625); (0.6 * 55 * 10.75 + 1 * 70 * 1.0625)) * 0.5
= 99.3125 ≥ 37.3666 kips (OK)

7.s. Check Interaction of Shear and Axial Loads:
Controlling Available Strengths:
Rnv * (1 / FS) = Min(275, 168, 198.625) = 168
Rnt * (1 / FS) = Min(315, 267.75, 411.6766, 291.375) = 267.75

Check Interaction of Shear and Axial Loads:
(V / (Rnv * (1 / FS)))^2 + (H / (Rnt * (1 / FS)))^2 ≤ 1
(74.7333 / 168)^2 + (39.2691 / 267.75)^2 ≤ 1
0.2193 ≤ 1 (OK)

7.s.1. Block Shear Strength of Support Side Leg of One Angle Under Shear Load:

Gross Length with Tension resistance (Lgt) = Lh = 1.54 in.

Net Length with Tension resistance (Lnt)
= Lgt - (dh + 0.0625) / 2 = 1.54 - 1.125 / 2 = 0.9775 in.

Gross Length with Shear resistance (Lgv)
= (n - 1) * s + Lv
= (4 - 1) * 3 + 1.75 = 10.75 in.

Net Length with Shear resistance (Lnv)
= Lgv - (n - 0.5) * (dv + 0.0625)
= 10.75 - (4 - 0.5) * (1.0625 + 0.0625)
= 6.8125 in.
(1 / FS) Rn = (1 / 2.0) * (0.6 * Min(Fu * Lnv, Fy * Lgv) + Fu * Lnt) * t
= (1 / 2.0) * (0.6 * Min(70 * 6.8125, 55 * 10.75) + 1 * 70 * 0.9775) * 0.5
= 88.6375 ≥ 7.5 kips (OK)

8. COLUMN AND BEAM CHECK

8.a. Beam and Column Local Stresses for Right Side Beam

8.a.1. Beam Web Local Yielding:
Force from Top, Rtop = ((1.73 * HbTop)^2 + (VbTop + 3 * MbTop / LTop)^2)^0.5
318.0147= ((1.73 * 175.3568)^2 + (89.600 + 3 * 76.5215 / 39.5654)^2)^0.5
Required Web Thickness = Rtop / ((1 / 1.5) * Fy * (L + 2.5 * k))
0.1701 in. = 318.0147 / (0.6666 * 65 * (39.5654 + 2.5 * 1.43))
Web Yielding Top 0.1701 ≤ 0.58 in. (OK)

8.a.2. Beam Web Crippling:
Force from Top, Rtop = VbTop + 3 * MbTop / Ltop
= 89.600 + 3 *76.5215 / 39.5654
= 65.5355 kips
for Top Loading, FiRn:
= (1 / 2.0) * 0.4 * 29000^0.5 * tw^2 * (1 + (4 * (Ntop / d) - 0.2) * (tw / tf)^1.5) * (Fy * tf / tw)^0.5
= (1 / 2.0) * 0.4 * 29000 * 0.58^2 * (1 + (4 * (39.5654 / 21.6) - 0.2) * (0.58 / 0.93)^1.5) * (65 * 0.93 / 0.58)^0.5
Rcap Top = 527.5404 ≥ 65.5355 kips (OK)

8.a.3. Column Flange Bending:

Nominal Tension Strength per Bolt = rn
= (1.3 * Fnt - (FS * Fnt / Fnv) * (V / (N * Ab))) * Ab ≤ Fnt * Ab
= (1.3 * 90 - (2 * 90 / 48) * (74.7333 / (12.5 * 0.7853))) * 0.7853 ≤ 90 * 0.7853
88.4539 * 0.7853 ≤ 90 * 0.7853
= 69.4715
Allowable Strength per Bolt, (1 / FS) * rn = (1 / 2.0) * rn = 34.7357 kips
Force (H') = (H + 3 * M / N) / 2
29.4518 = (58.9037 + 3 * 0 / 12.5) / 2

Force per Bolt (T) = H' / n
7.3629 = 29.4518 / 4

b = 2.21 in.
a = 1.54 in.
b' = 1.71 in.
a' = 2.04 in.
ro = 0.8382 in.
p = 3
d' = 1.0625
delta = 1 - d' / p = 1 - 1.0625 / 3
delta = 0.6458
Beta = (B / T - 1) / ro = (34.7357 / 7.3629 - 1) / 0.8382
Beta = 4.435
Alpha' = 1

Required Flange Thickness for Bending (treq'd)
= (4 / (1 / 1.67) * T * b' / (p * Fy * (1 + delta * Alpha'))^0.5
= (4 / (1 / 1.67) * 7.3629 * 1.71 / (3 * 50 * (1 + 0.6458 * 1)))^0.5
= 0.5836 ≤ tf 0.78 (OK)

8.a.4. Column Flange Shear - Required Flange Thickness for Shear
= T / Min((1 / 1.5) * 0.6 * p * Fy, (1 / 2.0) * 0.6 * (p - (d' + 0.0625))) * Fu
= 7.3629 / Min((1 / 1.5) * 0.6 * 3 * 50, (1 / 2.0) * 0.6 * (3 - (1.0625 + 0.0625))) * 65
= 0.2013 ≤ tf 0.78 (OK)

8.a.5. Column Web Local Yielding:
Force from Beam (RColumn) = ((H + 3 * M / N)^2 + (1.73 * V)^2)^0.5
= ((58.9037 + 3 * 0 / 12.5)^2 + (1.73 * 74.7333)^2)^0.5
= 142.0747 kips

Required Web Thickness = RColumn / ((1 / 1.5) * Fy * (N + 5 * k))
= 142.0747 / (1 / 1.5) * 50 * (12.5 + 5 * 1.38))

= 0.2197 ≤ tw 0.485 (OK)

8.a.6. **Column Web Crippling:**
Force from Beam (RColumn) = H + 3 * M / N
= 58.9037 + 3 * 0 / 12.5
= 58.9037

Rcap = (1 / 2.0) * 0.8 * $E^{0.5}$ * tw^2 * (1 + 3 * (N / d) * (tw / tf)^1.5) * $(Fy * tf / tw)^{0.5}$
= (1 / 2.0) * 0.8 * $29000^{0.5}$ * 0.485^2 * (1 + 3 * 0.8802 * (0.485 / 0.78)^1.5) * $(50 * 0.78 / 0.485)^{0.5}$
= 329.7273 ≥ RColumn 58.9037 kips (OK)