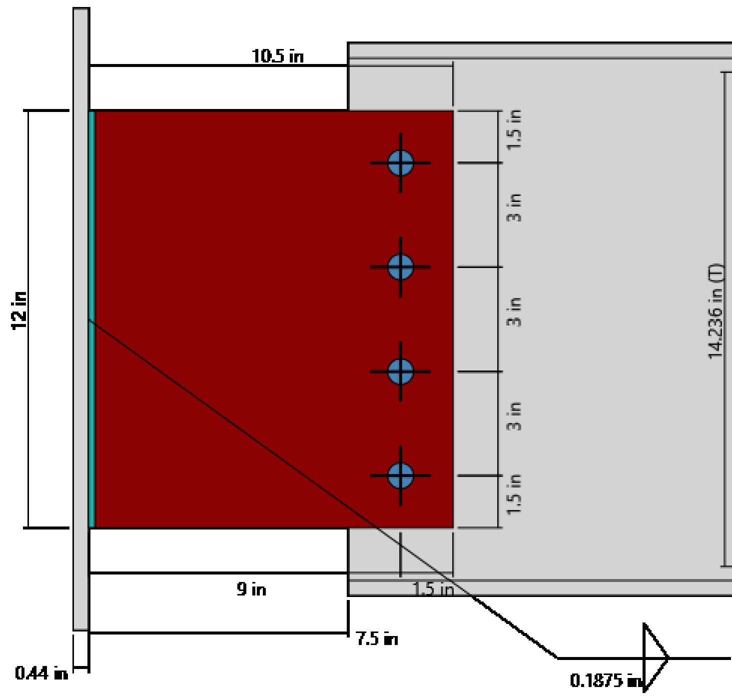
Design Summary: Shear Tab



Beam Design:
d = 15.9 in
T = 14.236 in
bf = 6.99 in
tf = 0.43 in
tw = 0.295 in
Fy = 50 Ksi
Fu = 65 Ksi

Shear Tab Design:
Height = 12 in
Width = 10.5 in
Thickness = 0.25 in
Fy = 36 Ksi
Fu = 58 Ksi

Bolt Design:
Type = Group 120
Diameter = 0.75 in
Thread = N
Row Count = 4
Row Spacing = 3 in
Col. Count = 1

Weld Design:
Type = Double Fillet
Fexx = 70 Ksi
Size = 0.1875 in
Length = 12 in

Support Design:
Thickness = 0.44 in
Fy = 50 Ksi
Fu = 65 Ksi

Steel Specification:
AISC 360-22

Limit State	Load Key	Demand	Capacity	Unity Value
Weld & Bolts				
Fillet Weld	1	13.2 K	44.871 K	0.294
Base Metal - Tab	1	13.2 K	29.009 K	0.455
Base Metal - Support	1	13.2 K	138.28 K	0.095
Bolt Group Capacity - Tab	12	16.655 K	26.991 K	0.617
Bolt Group Capacity - Beam Web	12	16.655 K	27.067 K	0.615
Block Shear - Tab	1	13.2 K	54.08 K	0.244
Block Shear - Beam Web	4	10 K	110.02 K	0.091
Shear Tab				
Shear Yield	1	13.2 K	64.8 K	0.204
Tension Yield	4	10 K	97.2 K	0.103
Compression Buckling	12	12 K	30.263 K	0.397
Flexural Yielding/Buckling	1	118.8 K-in	291.6 K-in	0.407
Yielding/Buckling Interaction	12	-	-	0.541
Shear Rupture	1	13.2 K	55.463 K	0.238
Tension Rupture	4	10 K	92.438 K	0.108
Flexural Rupture	1	118.8 K-in	277.31 K-in	0.428
Rupture Interaction	1	-	-	0.240
Beam				
Shear Yield	1	13.2 K	140.72 K	0.094
Tension Yield	4	10 K	470.17 K	0.021
Compression Buckling	-	-	-	-
Flexural Yielding/Buckling	-	-	-	-
Yielding/Buckling Interaction	4	-	-	0.005
Shear Rupture	-	-	-	-
Tension Rupture	4	10 K	206.07 K	0.049
Flexural Rupture	-	-	-	-
Rupture Interaction	-	-	-	-
Connection Detailing	-	-	-	OK

Shear Tab: Detailed Reports

Fillet Weld - Tab to Support (AISC 360-22 J2.4)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Rux = 0 K Ruy = -13.2 K => Ru = 13.2 Theta = 0 Degrees
Weld:
Size = 0.1875 in   Fexx Effective = 70 Ksi   Weld Count = 2
l = 12 in   kl = 0 in   xl = 0 in   yl = 6 in   ex = al = 9 in
a = 0.75   k = 0   x = 0   y = 0.5
C = 0.83095   C1 = 1   D = 3   (Using the Instantaneous Center of Rotation method)
ϕRn = ϕ · C · C1 · D · l · Weld Count
ϕRn = 0.75 · 0.83095 · 1 · 3 · 12 in · 2
ϕRn = 44.871 K
Unity = Ru / ϕRn = 13.2 / 44.871 K = **0.294**

Base Metal - Tab (AISC 16th Page 9-6 & AISC 360-22 J4.2)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Ru = 13.2 K
Weld: Number of Welds = 2
Weld Unit Capacity: Rn_weld_unit = 5.5685 K/in
Weld Capacity: Rn_weld = 59.828 K (includes effects of load direction and/or eccentricity)
Tab: Fu = 58 Ksi   Fy = 36 Ksi t = 0.25 in   Shear Lines = 1
Phi · Base Metal Unit Capacity:
ϕRn_bm_unit = 0.6 · Min(Phi · Fy, Phi · Fu) · t
ϕRn_bm_unit = 0.6 · Min(1.0 · 36 Ksi , 0.75 · 58 Ksi) · 0.25 in
ϕRn_bm_unit = 5.4 K/in
Phi · Base Metal Capacity:
ϕRn = Rn_weld · ϕRn_bm_unit · Shear Lines / (Rn_weld_unit · Number of Welds)
ϕRn = 59.828 K · 5.4 K/in · 1 / (5.5685 K/in · 2)
ϕRn = 29.009 K
Base Metal Unity:
Unity = Ru / ϕRn = 13.2 K / 29.009 K = **0.455**

Base Metal - Support (AISC 16th Page 9-6 & AISC 360-22 J4.2)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Ru = 13.2 K
Weld: Number of Welds = 2
Weld Unit Capacity: Rn_weld_unit = 5.5685 K/in
Weld Capacity: Rn_weld = 59.828 K (includes effects of load direction and/or eccentricity)
Support: Fu = 65 Ksi   Fy = 50 Ksi t = 0.44 in   Shear Lines = 2
Phi · Base Metal Unit Capacity:
ϕRn_bm_unit = 0.6 · Min(Phi · Fy, Phi · Fu) · t
ϕRn_bm_unit = 0.6 · Min(1.0 · 50 Ksi , 0.75 · 65 Ksi) · 0.44 in
ϕRn_bm_unit = 12.87 K/in
Phi · Base Metal Capacity:
ϕRn = Rn_weld · ϕRn_bm_unit · Shear Lines / (Rn_weld_unit · Number of Welds)
ϕRn = 59.828 K · 12.87 K/in · 2 / (5.5685 K/in · 2)
ϕRn = 138.28 K
Base Metal Unity:
Unity = Ru / ϕRn = 13.2 K / 138.28 K = **0.095**

Bolt Group Capacity - Tab (AISC 360-22 J3.7 & J3.11)

Load Set: Load Set 2   Load Combination: 1.2D + 0.5L + W+X
Demand:
Rux = 12 K   Ruy = 11.55 K
Ru = (Rux^2 + Ruy^2)^(1/2) = 16.655 K
θ = arctan(Rux/Ruy) = 46.095 deg (measured from the vertical axis)
e = 9 in
C = 1.51 (Effective number of bolts using the Instantaneous Center of Rotation method)
N = 4.00 (Total number of bolts)
Assumptions: Standard holes used and deformation at the bolt hole at service load is not a design consideration.

Single Bolt Capacity:
rn = Min(Shear, Bearing, Tearout)
= Min(Fn·Ab·planes, 3.0·d·t·Fu·n, 1.5·lc·t·Fu·n)   J3-1 & J3-6b & J3-6d
= Min(54 Ksi · 0.44179 in^2 · 1, 3.0 · 0.75 in · 0.25 in · 58 Ksi · 1, 1.5 · lc · 0.25 in · 58 Ksi · 1)
= Min(23.856 K, 32.625 K, lc · 21.75 K/in)
Eccentric Bolt Group Capacity:
Note: lc is conservatively taken as the smallest possible value for each bolt.

lc1 = 1.0938 in	rn1 = 23.789 K
lc2 = 1.0938 in	rn2 = 23.789 K
lc3 = 1.0938 in	rn3 = 23.789 K
lc4 = 1.0938 in	rn4 = 23.789 K

ϕRn = ϕ·Σrn·C / N
ϕRn = 0.75 · 95.156 K · 1.51 / 4.00
ϕRn = 26.991 K
Unity: = Ru / ϕRn = 16.655 K / 26.991 K = **0.617**

Bolt Group Capacity - Beam Web (AISC 360-22 J3.7 & J3.11)

Load Set: Load Set 2   Load Combination: 1.2D + 0.5L + W+X
Demand:
Rux = 12 K   Ruy = 11.55 K
Ru = (Rux^2 + Ruy^2)^(1/2) = 16.655 K
θ = arctan(Rux/Ruy) = 46.095 deg (measured from the vertical axis)
e = 9 in
C = 1.51 (Effective number of bolts using the Instantaneous Center of Rotation method)
N = 4.00 (Total number of bolts)
Assumptions: Standard holes used and deformation at the bolt hole at service load is not a design consideration.

Single Bolt Capacity:
rn = Min(Shear, Bearing, Tearout)
= Min(Fn·Ab·planes, 3.0·d·t·Fu·n, 1.5·lc·t·Fu·n)   J3-1 & J3-6b & J3-6d
= Min(54 Ksi · 0.44179 in^2 · 1, 3.0 · 0.75 in · 0.295 in · 65 Ksi · 1, 1.5 · lc · 0.295 in · 65 Ksi · 1)
= Min(23.856 K, 43.144 K, lc · 28.763 K/in)
Eccentric Bolt Group Capacity:
Note: lc is conservatively taken as the smallest possible value for each bolt.

lc1 = 1.0938 in	rn1 = 23.856 K
lc2 = 1.0938 in	rn2 = 23.856 K
lc3 = 1.0938 in	rn3 = 23.856 K
lc4 = 1.0938 in	rn4 = 23.856 K

ϕRn = ϕ·Σrn·C / N
ϕRn = 0.75 · 95.426 K · 1.51 / 4.00
ϕRn = 27.067 K
Unity: = Ru / ϕRn = 16.655 K / 27.067 K = **0.615**

Block Shear - Tab (AISC 360-22 J4.3)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Bolt: Bolt Size = 0.75 in Number = 4 Hole Size =0.875 in
Tab: Fu = 58 Ksi Fy = 36 Ksi Thickness = 0.25 in n = 1
Demand: Ruy = 13.2 K
Block Shear in Y-direction:
Gross Areas: Agv = 2.625 in^2   Net Areas: Ant = 0.26563 in^2   Anv = 1.8594 in^2   Ubs = 1
Ubs·Fu·Ant = 15.406 K   0.6·Fu·Anv = 64.706 K   0.6·Fy·Agv = 56.7 K
ϕRn = Phi·min(0.6·Fu·Anv + Ubs·Fu·Ant, 0.6·Fy·Agv + Ubs·Fu·Ant)·n (Equation J4-5)
ϕRn = 0.75·min(64.706 K + 15.406 K, 56.7 K + 15.406 K)·1
ϕRny = 0.75 · 72.106 K = 54.08 K
Unity: **=** Ruy / ϕRny = 13.2 K / 54.08 K = **0.244**

Block Shear - Beam Web (AISC 360-22 J4.3)

Load Set: Load Set 1 Load Combination: 1.2D + 0.5L + W+X
Bolt: Bolt Size = 0.75 in Number = 4 Hole Size =0.875 in
Beam Web: Fu = 65 Ksi Fy = 50 Ksi Thickness = 0.295 in n = 1
Demand: Rux = 10 K
Block Shear in X-direction:
Gross Areas: Agv = 0.885 in^2 Net Areas: Ant = 1.8806 in^2 Anv = 0.62688 in^2 Ubs = 1
Ubs·Fu·Ant = 122.24 K 0.6·Fu·Anv = 24.448 K 0.6·Fy·Agv = 26.55 K
ϕRn = Phi·min(0.6·Fu·Anv + Ubs·Fu·Ant, 0.6·Fy·Agv + Ubs·Fu·Ant)·n (Equation J4-5)
ϕRn = 0.75·min(24.448 K + 122.24 K, 26.55 K + 122.24 K)·1
ϕRnx = 0.75 · 146.69 K = 110.02 K
Unity: = Rux / ϕRnx = 10 K / 110.02 K = **0.091**

Shear Yield - Tab (AISC 360-22 J4.2.a)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Ru = 13.2 K
Capacity: ϕRn = ϕ·0.6·Fy·b·t·n = 1.00 · 0.6 · 36 Ksi · 12 in · 0.25 in · 1 = 64.8 K
Unity = Ru / ϕRn = 13.2 K / 64.8 K = **0.204**

Tension Yield - Tab (AISC 360-22 J4.1.a)

Load Set: Load Set 1 Load Combination: 1.2D + 0.5L + W+X
Demand: Ru = 10 K
Capacity: ϕRn = ϕ·Fy·l·t·n = 0.90 · 36 Ksi · 12 in · 0.25 in · 1
ϕRn = 97.2 K
Unity = Ru / ϕRn = 10 K / 97.2 K = **0.103**

Compression Buckling - Tab (AISC 360-22 E3)

Load Set: Load Set 2 Load Combination: 1.2D + 0.5L + W+X
Demand: Ru = 12 K
Plate: Fy = 36 Ksi Thickness = 0.25 in Ag = 3 in^2 K = 1.20 L = 9 in r = 0.07217 in n = 1
Capacity:
KL/r = 149.649 Fe = 12.781 Ksi (Equation E3-4) Fcr = 11.209 Ksi (Equation E3-3)
ϕRn = ϕ·Ag·Fcr·n = 0.90 · 3 in^2 · 11.209 Ksi · 1 = 30.263 K
Unity = 12 K / 30.263 K = **0.397**

Flexural Yielding/Buckling - Tab (AISC 16th Part 10 & AISC 360-22 F11)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Mu = 13.2 K · 9 in = 118.8 K-in
Beam: Beam Depth, d = 15.9 in   Cope Depth, dct = 0 in
Tab: Fy = 36 Ksi   t = 0.25 in   Plate Depth, dp = 12 in   Lb = 9 in   n = 1
Flexural Capacity:

For $\frac{L_b d_p}{t^2} \leq \frac{0.08E}{F_y}$

$$M_n = M_p = F_y Z \leq 1.5 F_y S_x \qquad \text{(Equation F11-1)}$$

For $\frac{0.08E}{F_y} < \frac{L_b d_p}{t^2} \leq \frac{1.9E}{F_y}$

$$M_n = C_b \left[1.52 - 0.274\left(\frac{L_b d_p}{t^2}\right)\frac{F_y}{E}\right] M_y \leq M_p \qquad \text{(Equation F11-3)}$$

For $\frac{L_b d_p}{t^2} > \frac{1.9E}{F_y}$

$$M_n = F_{cr} S_x \leq M_p \qquad \text{(Equation F11-4)}$$

$$F_{cr} = \frac{1.9 E C_b}{\frac{L_b d_p}{t^2}} \qquad \text{(Equation F11-5)}$$

Lb·dp/t^2 = 1728   0.08·E/Fy = 64.444   1.9·E/Fy = 1530.6   Cb = 1.84
ϕMn = ϕ · Mn · n = 0.90 · 324 K-in · 1
ϕMn = 0.90 · 324 = 291.6 K-in (Equation F11-4)
Unity = Mu / ϕMn = 118.8 K-in / 291.6 K-in= **0.407**

Yielding/Buckling Interaction - Tab (AISC 16th Part 12)

Load Set: Load Set 2   Load Combination: 1.2D + 0.5L + W+X
Demand: Rux = 12 K   Ruy = 11.55 K   Mu = 103.95 K-in
Capacity: ϕRnx = 30.263 K   ϕRny =64.8 K   ϕMn = 291.6 K-in
Rux / ϕRnx = 0.39652

When $\frac{R_{ux}}{\phi R_{nx}} < 0.2$

$$\left(\frac{R_{ux}}{2\phi R_{nx}} + \frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equation 12-2)}$$

When $\frac{R_{ux}}{\phi R_{nx}} \geq 0.2$

$$\left(\frac{R_{ux}}{\phi R_{nx}} + \frac{8}{9}\frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equation 12-3)}$$

Unity = **0.5407** (Equation 12-3)

Shear Rupture - Tab (AISC 360-22 J4.2.b)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Ru = 13.2 K
Tab: Length = 12 in Thickness = 0.25 in n = 1
Bolt: Bolt Size = 0.75 in Number = 4 Hole Size = 0.875 in (effecive)
Capacity:

Lrupture = Length - Number Bolts · (Hole Size + 1/16 in)
Lrupture = 12 in - 4 · 0.875 in = 8.5 in
Anv = Lrupture·Thickness = 8.5 in · 0.25 in = 2.125 in^2
ϕRn = ϕ·0.6·Fu·Anv·n = 0.75 · 0.6 · 58 Ksi · 2.125 in^2 · 1 = 55.463 K

Unity = Ru / ϕRn = 13.2 K / 55.463 K = **0.238**

Tension Rupture - Tab (AISC 360-22 J4.1)

Load Set: Load Set 1 Load Combination: 1.2D + 0.5L + W+X
Demand: Ru = 10 K
Tab: Fu = 58 Ksi U = 1 (Table D3.1 Case 1)

Ag = 3 in^2 An = 2.125 in^2
Ae = U·An = 2.125 in^2 (Equation D3-1) n = 1

Capacity:

ϕRn = ϕ·Fu·Ae·n = 0.75 · 58 Ksi · 2.125 in^2 · 1 = 92.438 K (Equation J4-2)

Unity = Ru / ϕRn = 10 K / 92.438 K = **0.108**

Flexural Rupture - Tab (AISC 16th Part 9)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Mu = Ruy·EccentricityX = 13.2 K·9 in = 118.8 K-in
Capacity:

Znet = Zsolid - Zholes = 9 in^3 - 2.625 in^3 = 6.375 in^3
ϕMn = ϕ·Fu·Znet·n = 0.75 · 58 Ksi · 6.375 in^3 · 1 = 277.31 K-in (Equation 9-8)

Unity = Mu / ϕMn = 118.8 K-in / 277.31 K-in = **0.428**

Rupture Interaction - Tab (AISC 16th Part 12)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Rux = 0 K   Ruy = 13.2 K   Mu = 118.8 K-in
Capacity: ϕRnx = -NA-   ϕRny =55.463 K   ϕMn = 277.31 K-in
Rux / ϕRnx = 0

$$\text{When } \frac{R_{ux}}{\phi R_{nx}} < 0.2$$

$$\left(\frac{R_{ux}}{2\phi R_{nx}} + \frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equation 12-2)}$$

$$\text{When } \frac{R_{ux}}{\phi R_{nx}} \geq 0.2$$

$$\left(\frac{R_{ux}}{\phi R_{nx}} + \frac{8}{9}\frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equation 12-3)}$$

Unity = **0.24017** (Equation 12-2)

Shear Yield - Beam Web (AISC 360-22 J4.2.a)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Ru = 13.2 K
Capacity: ϕRn = ϕ·0.6·Fy·b·t·n = 1.00 · 0.6 · 50 Ksi · 15.9 in · 0.295 in · 1 = 140.72 K
Unity = Ru / ϕRn = 13.2 K / 140.72 K = **0.094**

Tension Yield - Beam (AISC 360-22 J4.1.a)

Load Set: Load Set 1   Load Combination: 1.2D + 0.5L + W+X
Demand: Ru = 10 K
Capacity: ϕRn = ϕ·Fy·Ag = 0.90 · 50 Ksi · 10.448 in^2 (No Cope)
ϕRn = 470.17 K
Unity = Ru / ϕRn = 10 K / 470.17 K = **0.021**

Yielding/Buckling Interaction - Beam (AISC 16th Part 12)

Load Set: Load Set 1   Load Combination: 1.2D + 0.5L + W+X
Demand: Rux = 10 K   Ruy = 9.9 K   Mu = 0 K-in
Capacity: ϕRnx = 470.17 K   ϕRny =140.72 K   ϕMn = -NA-
Rux / ϕRnx = 0.02127

When $\frac{R_{ux}}{\phi R_{nx}} < 0.2$

$$\left(\frac{R_{ux}}{2\phi R_{nx}} + \frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equation 12-2)}$$

When $\frac{R_{ux}}{\phi R_{nx}} \geq 0.2$

$$\left(\frac{R_{ux}}{\phi R_{nx}} + \frac{8}{9}\frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equation 12-3)}$$

Unity = **0.00506** (Equation 12-2)

Tension Rupture - Beam (AISC 360-22 J4.1)

Load Set: Load Set 1   Load Combination: 1.2D + 0.5L + W+X
Demand: Ru = 10 K
Beam: Fu = 65 Ksi U = 0.44893 (Table D3.1 U = AgConnected / Ag)
Ag = 10.448 in^2 An = 9.4157 in^2
Ae = U·An = 4.227 in^2 (Equation D3-1)   n = 1
Capacity:
ϕRn = ϕ·Fu·Ae·n = 0.75 · 65 Ksi · 4.227 in^2 · 1 = 206.07 K (Equation J4-2)
Unity = Ru / ϕRn = 10 K / 206.07 K = **0.049**

Connection Detailing

Messages:
Adequate torsional bracing of the beam is assumed at the connection.
The beam is assumed to have no underrun.
Weld lengths are not reduced to account for weld termination.
Shear Tab has an extended configuration.
Shear Tab fits in beam T dimension.
Shear Tab moment capacity is less than the bolt group moment capacity (Equation 10-6).
Shear Tab weld size is adequate.
Shear Tab weld is double sided.
Shear Tab strength is developed by the welds.
Shear Tab bolt spacing is adequate.
Shear Tab bolt edge distances are adequate.