Design Summary: shear tab

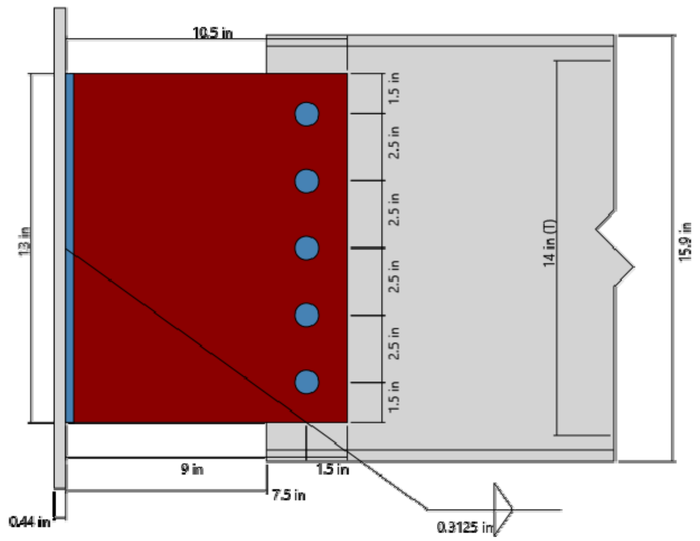
Shear Tab Design:
Thickness = 0.5 in
Fy = 36 Ksi
Fu = 58 Ksi

Beam Design:
Thickness = 0.4 in
Fy = 50 Ksi
Fu = 65 Ksi

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

Bolt Design:
Type = Group A
Diameter = 0.875 in
Thread = N

Steel Specification:
AISC 360-16



Limit State	Load Key	Demand	Capacity	Unity Value
Bolt Group Shear	1	37.947 K	38.958 K	0.974
Bolt Group Bearing - Beam Web	1	37.947 K	48.254 K	0.786
Bolt Group Bearing - Tab	1	37.947 K	53.821 K	0.705
Fillet Weld - Tab to Support	1	37.947 K	89.483 K	0.424
Base Metal - Support	1	37.947 K	165.45 K	0.229
Base Metal - Tab	1	37.947 K	69.42 K	0.547
Block Shear - Beam Web	0	14 K	140.4 K	0.100
Block Shear - Tab	1	-	-	0.107
Shear Yield - Tab	1	36 K	140.4 K	0.256
Tension Yield - Tab	0	14 K	210.6 K	0.066
Compression Buckling - Tab	0	0 K	156.84 K	0.000
Flexural Yielding/Buckling - Tab	1	27 K-ft	57.038 K-ft	0.473
Yielding/Buckling Interaction - Tab	1	-	-	0.318
Shear Rupture - Tab	1	36 K	104.4 K	0.345
Tension Rupture - Tab	0	14 K	174 K	0.080
Flexural Rupture - Tab	1	27 K-ft	48.938 K-ft	0.552
Rupture Interaction - Tab	1	-	-	0.463
Shear Tab Detailing	-	-	-	OK

Shear Tab: Detailed Reports

Bolt Group Shear (AISC 360-16 J3.6)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Rux: 12 K Ruy: -36 K => Ru: 37.947 K Theta: 18.435 deg
Bolt: Size = 0.875 in Fnv = 54 Ksi Count = 5 Threads = N
Single Capacity, rn = 32.471 K
Bolt Group: Spacing = 2.5 in Eccentricity = 9 in
Using the Instantaneous Center of Rotation method, C = 1.600
Capacity: $\phi Rn = \phi \cdot rn \cdot C = 0.75 \cdot 32.471\ K \cdot 1.600 = 38.958\ K$
Unity = Ru / ϕRn = 37.947 K / 38.958 K = **0.974**

Bolt Group Bearing - Beam Web (AISC 360-16 J3.10)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Rux = 12 K Ruy = 36 K
Ru = (Rux^2 + Ruy^2)^(1/2) = 37.947 K
θ = arctan(Rux/Ruy) = 18.435 deg (measured from the vertical axis)
e = 9 in
Using the Instantaneous Center of Rotation method, the effective number of bolts, C = 1.60
Minimum clear edge distance: lcmin = 1.0312 in
Note: It is assumed that standard holes are used and the deformation at the bolt holes at service loads are not a design consideration.

Capacity:
(1) Bearing: $rn = 3.0 \cdot d \cdot t \cdot Fu$ (J3-6b)
$= 3.0 \cdot 0.875\ in \cdot 0.4\ in \cdot 65\ Ksi$
$= 68.25\ K$

(2) Tearout: $rn = 1.5 \cdot lc \cdot t \cdot Fu$ (J3-6d)
$= 1.5 \cdot 1.0312\ in \cdot 0.4\ in \cdot 65\ Ksi$
$= 40.219\ K$ **Controls**

Capacity: $\phi Rn = \phi \cdot rn \cdot C$
$= 0.75 \cdot 40.219\ K \cdot 1.60$
$= 48.254\ K$

Unity: = Ru / ϕRn = 37.947 K / 48.254 K = **0.786**

Bolt Group Bearing - Tab (AISC 360-16 J3.10)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Rux = 12 K Ruy = 36 K
Ru = (Rux^2 + Ruy^2)^(1/2) = 37.947 K
θ = arctan(Rux/Ruy) = 18.435 deg (measured from the vertical axis)
e = 9 in
Using the Instantaneous Center of Rotation method, the effective number of bolts, C = 1.60
Minimum clear edge distance: lcmin = 1.0313 in
Note: It is assumed that standard holes are used and the deformation at the bolt holes at service loads are not a design consideration.

Capacity:
(1) Bearing: rn = 3.0·d·t·Fu (J3-6b)
= 3.0 · 0.875 in · 0.5 in · 58 Ksi
= 76.125 K

(2) Tearout: rn = 1.5·lc·t·Fu (J3-6d)
= 1.5 · 1.0313 in · 0.5 in · 58 Ksi
= 44.859 K **Controls**

Capacity: ϕRn = ϕ·rn·C
= 0.75 · 44.859 K · 1.60
= 53.821 K

Unity: = Ru / ϕRn = 37.947 K / 53.821 K = **0.705**

Fillet Weld - Tab to Support (AISC 360-16 J2.4)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Rux = 12 K Ruy = -36 K => Ru = 37.947 Theta = 18.435 Degrees
Weld:
Size = 0.3125 in Fexx = 70 Ksi Length = 13 in Weld Eccentricity = 9 in
Weld Line Count = 2 Concentric Weld Unit Capacity = 111.37 K/ft
Angle Factor = 1.0889 (Equation J2-5)
Eccentricity Reduction Factor = 0.45407 (Using the Instantaneous Center of Rotation method)
ϕRn = 0.75 · 2 · 111.37 K/ft · 13 in · 1.0889 · 0.45407
ϕRn = 89.483 K
Unity = Ru / ϕRn = 37.947 / 89.483 K = **0.424**

Base Metal - Tab (AISC 15th Page 9-5 & AISC 360-16 J4.2)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: R_u = 37.947 K
Weld: Number of Welds = 2
    Weld Unit Capacity: Rn_weld_unit = 111.37 K/ft
    Weld Capacity: Rn_weld = 119.31 K (includes effects of load direction and/or eccentricity)
Tab: Fu = 58 Ksi   Fy = 36 Ksi   t = 0.5 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) · 0.5 in
        ϕRn_bm_unit = 129.6 K/ft
    Phi · Base Metal Capacity:
        ϕRn = Rn_weld · ϕRn_bm_unit · Shear Lines / (Rn_weld_unit · Number of Welds)
        ϕRn = 119.31 K · 129.6 K/ft · 1 / (111.37 K/ft · 2)
        ϕRn = 69.42 K
Base Metal Unity:
    Unity = Ru / ϕRn = 37.947 K / 69.42 K = **0.547**

Shear Yield - Tab (AISC 360-16 J4.2.a)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Ru = 36 K
Capacity: ϕRn = ϕ·0.6·Fy·b·t = 1.00 · 0.6 · 36 Ksi · 13 in · 0.5 in = 140.4 K
Unity = Ru / ϕRn = 36 K / 140.4 K = **0.256**

Tension Yield - Tab(AISC 360-16 J4.1.a)

Load Set: Load Set 1   Load Combination: 1.2D + 1.6L
Demand: Ru = 12 K
Capacity: ϕRn = ϕ·Fy·b·t = 0.90 · 36 Ksi · 13 in · 0.5 in = 210.6 K
Unity = Ru / ϕRn = 12 K / 210.6 K = **0.057**

Flexural Yielding/Buckling - Tab (AISC 15th Part 9 & AISC 360-16 F11)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Mu = Ruy·EccentricityX = 36 K · 9 in = 27 K-ft
Beam: Depth, d = 15.9 in Cope Depth, dct = 2.95 in
Tab: Fy = 36 Ksi t = 0.5 in Depth = 13 in Lb = 9 in
Flexural Capacity:

$$C_b = \left[3 + ln\left(\frac{L_b}{d}\right)\right]\left(1 - \frac{d_{ct}}{d}\right) \geq 1.84 \qquad \text{(Equation 9-15)}$$

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

$$M_n = M_p = F_y Z \leq 1.6 F_y S_x \qquad \text{(Equation F11-1)}$$

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

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

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

$$M_n = F_{cr} S_x \leq M_p \qquad \text{(Equation F11-3)}$$

$$F_{cr} = \frac{1.9 E C_b}{\frac{L_b d}{t^2}} \qquad \text{(Equation F11-4)}$$

Lb·d/t^2 = 468 0.08·E/Fy = 64.444 1.9·E/Fy = 1530.6 Cb = 1.9799
ϕMn = 0.90 · 760.5 = 57.038 K-ft (Equation F11-2)
Unity = Mu / ϕMn = 27 K-ft / 57.038 K-ft= **0.473**

Yielding/Buckling Interaction - Tab (AISC 15th Part 9 & AISC 360-16 H1)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Rux = 12 K Ruy = 36 K Mu = 27 K-ft
Capacity: ϕRnx = 210.6 K ϕRny =140.4 K ϕMn = 57.038 K-ft
Rux / ϕRnx = 0.05698

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

$$\left(\frac{R_{ux}}{\phi R_{nx}} + \frac{8}{9}\frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equations H1-1a \& 10-5)}$$

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

$$\left(\frac{R_{ux}}{2\phi R_{nx}} + \frac{M_u}{\phi M_n}\right)^2 + \left(\frac{R_{uy}}{\phi R_{ny}}\right)^2 \leq 1.0 \qquad \text{(Equations H1-1b \& 10-5)}$$

Unity = **0.31761** (Equations H1-1b & 10-5)

Shear Rupture - Tab (AISC 360-16 J4.2.b)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Ru = 36 K
Tab: Length = 13 in Thickness = 0.5 in
Bolt: Bolt Size = 0.875 in Number = 5 Hole Size = 0.9375 in
Capacity:

L_rupture = Plate Length - Number Bolts · (Hole Size + 1/16 in)
L_rupture = 13 in - 5 · (0.9375 in + 0.0625 in) = 8 in
Anv = L_rupture·Thickness = 8 in · 0.5 in = 4 in^2
ϕRn = ϕ·0.6·Fu·Anv = 0.75 · 0.6 · 58 Ksi ·4 in^2 = 104.4 K

Unity = Ru / ϕRn = 36 K / 104.4 K = **0.345**

Flexural Rupture - Tab (AISC Part 9)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Mu = Ruy·EccentricityX = 36 K·9 in = 27 K-ft
Capacity:

Znet = Zsolid - Zholes = 21.125 in^3 - 7.625 in^3 = 13.5 in^3
ϕMn = ϕ·Fu·Znet = 0.75 · 58 Ksi · 13.5 in^3 = 48.938 K-ft (Equation 9-4)

Unity = Mu / ϕMn = 27 K-ft / 48.938 K-ft = **0.552**

Rupture Interaction - Tab (AISC 15th Part 9 & AISC 360-16 H1)

Load Set: Load Set 1 Load Combination: 1.2D + 1.6L
Demand: Rux = 12 K Ruy = 36 K Mu = 27 K-ft
Capacity: ϕRnx = 174 K ϕRny =104.4 K ϕMn = 48.938 K-ft

Rux / ϕRnx = 0.06897

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

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

(Equations H1-1a & 10-5)

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

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

(Equations H1-1b & 10-5)

Unity = **0.46254** (Equations H1-1b & 10-5)

Shear Tab 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 fits in beam T dimension.
Shear Tab moment capacity is less than the bolt group moment capacity.
Shear Tab weld size is adequate.
Shear Tab weld is double sided.
Weld develops the strength of the Shear Tab.
Bolt spacing is adequate.
Bolt edge distances are adequate.

Design Loads

Load Key	Fvu (K)	Fau (K)
0	-8.4	14
1	-36	12
2	-16.2	12