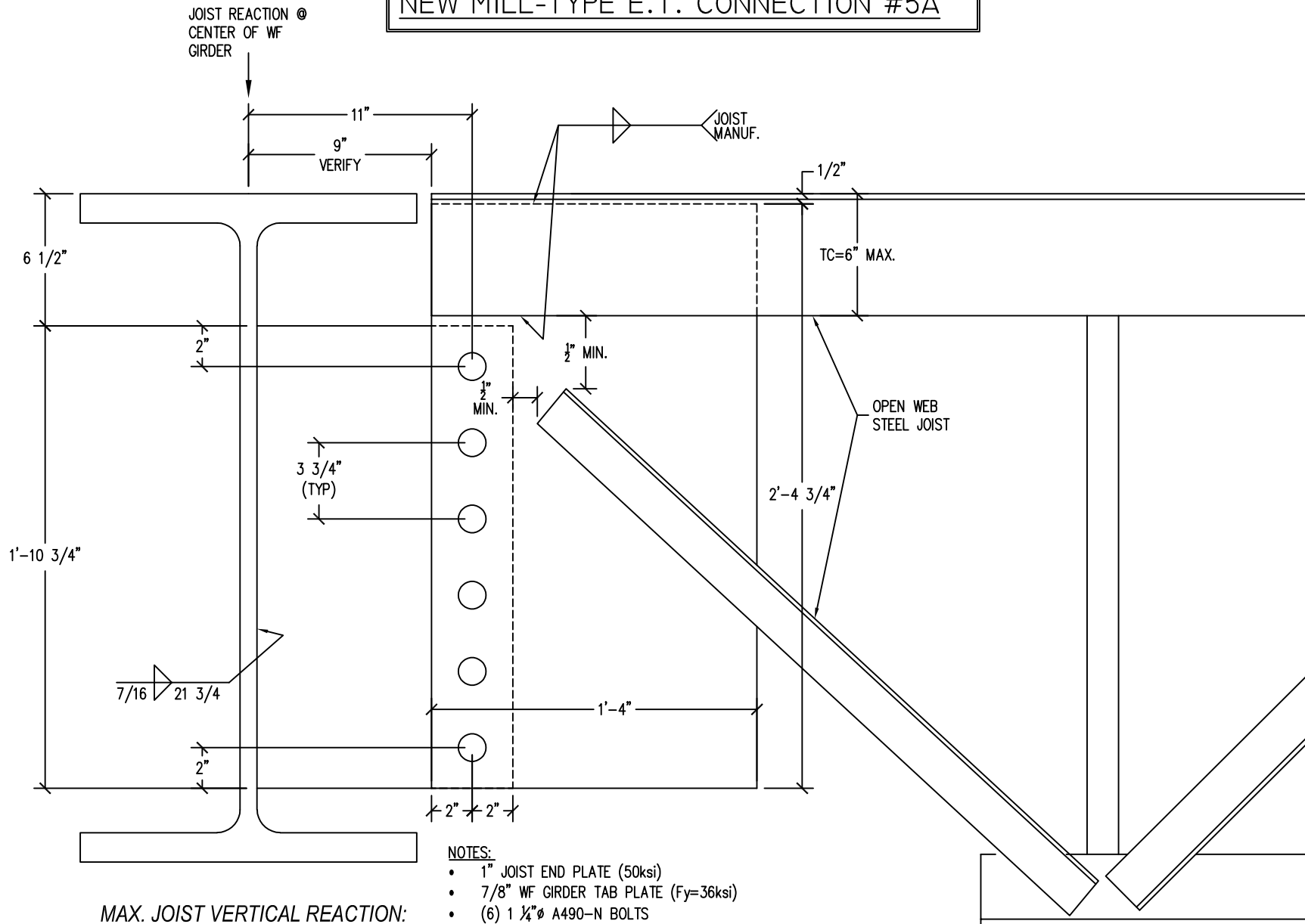


# EXTENDED-TAB (ET) CONNECTION

## NEW MILL-TYPE E.T. CONNECTION #5A



**MAX. JOIST VERTICAL REACTION:**  
 **$R = 136k$  (LRFD)**

**NOTES:**

- 1" JOIST END PLATE (50ksi)
- 7/8" WF GIRDER TAB PLATE ( $F_y=36$ ksi)
- (6) 1 1/4"  $\phi$  A490-N BOLTS
- 1 3/8"  $\phi$  HOLES IN JOIST END PLATE
- 1 3/8" x 1 5/8" SHORT SLOTTED HOLES IN WF GIRDER TAB



**NEW MILLENNIUM**  
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Date: 3/18/2025



# NEW MILLENNIUM

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JOB NAME:	JOB #:		
LOCATION:	NMBS E.T. #5A Joist End Plate	DATE:	3/18/2025

### AISC 16TH - p. 10-49 (Extended Configuration)

Holes must satisfy AISC J3.3

Horizontal Axial forces (seismic or wind) if present, to be transferred from beam to joist via tie plate

Joist Plate, $F_u =$	65	ksi	TC Hold Back Distance (H) =	9	in	Joist Plate w =	16	in
Joist Tab Plate, $F_y =$	50	ksi	TC Angle Size =	3.5	in	Joist Plate d =	28.75	in
Joist Plate, d or w =	16	in	Joist Plate Hold-Down from TC =	0.5	in			
Joist Plate Thickness, t =	1	in						
Joist Plate Edge Distances, de =	2	in						
e =	11	in				$L_{11} =$	9.375	
Vertical Shear, $V_u =$	136	k (LRFD)				$L_{12} =$	5.625	
Vertical Ecc. Moment, $M_u =$	1496	k*in (LRFD)				$L_{13} =$	1.875	
Bolt Diameter, $D_b =$	1.25	in				$L_{14} =$	0	
Bolt Shear Capacity $\phi R_n =$	62.7	k (A490-N)				$L_{15} =$	0	
# of Bolts, $N_b =$	6	(Spreadsheet design limitation, max. 10 bolts)						
Spacing of Bolt Group, S =	3.75	in						
Vert. C.G. of Bolt Group =	9.375	in						
$F_{nv}/0.9 =$	75.56	ksi (Table J3.2, A490-N Bolts)						
Short Slotted Hole, Lh =	1.63	in (conservative design, allows for slotted holes in joist plate)						
Joist Top Chord Axial Force, $V_{TC} =$	204	k (LRFD)...Assumes 1.5:1 End Web Slope						

Gross Plate Area, $A_g =$	16	in <sup>2</sup>
Effective Plate Area, $A_e =$	14.63	in <sup>2</sup>
Z =	64	in <sup>3</sup> (1/4t*w <sup>2</sup> )
S =	42.6667	in <sup>3</sup> (1/6t*w <sup>2</sup> )

#### Bolt Shear - Elastic Vector Method: (AISC p. 7-7, 7-8)

Bolt Group $I_p =$	246.09	in <sup>4</sup> /in <sup>2</sup>
$r_{py} =$	22.67	k (Vu/# Bolts)
$r_{mx} =$	56.99	k ( $M_u * L_{11} / I_p$ )
Hm =	56.99	k ( $r_{mx} * N_c$ ) $N_c = 1$ column of bolts
$R_u =$	61.33	k ( $r_{py}^2 + r_{mx}^2$ ) <sup>1/2</sup>
$R_u / \phi R_n =$	0.98	< 1.0 OK

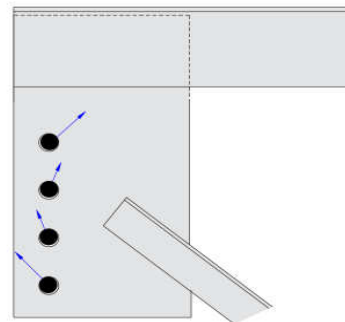
#### Bolt Bearing & Tearout: (AISC J3.11)

Bearing $R_{nb} =$	195.00	k/bolt ( $2.4 * D_b * t * F_u$ ) AISC J3-6a
$L_{ch} =$	1.19	in ( $d_e - L_h / 2$ )
Horizontal Tearout $R_{nt} =$	92.63	k/bolt ( $1.2 * L_{ch} * t * F_u$ ) AISC J3-6c
$R_u =$	61.33	k (worst case bolt shear)
$r_{mx} =$	56.99	k (worst case horiz. bolt shear)
$\phi =$	0.75	(AISC J3.11)
Bearing $R_u / \phi R_{nb} =$	0.42	< 1.0 OK
Tearout $r_{mx} / \phi R_{nt} =$	0.82	< 1.0 OK

Stress Ratio Results:	
Bolt Shear (V&M):	0.98
Bolt Bearing & Tearout:	0.82
Shear Plate Rupture:	0.43
Shear Plate Block Shear:	0.36
Shear Plate Flexural Rupture:	0.52
Shear Plate Yielding & Flexural:	0.35

Min. Joist TC to Plate Weld:

3 /16th x 15.5 " Fillet Weld



NOTE: FOR VISUAL FORCE SCHEMATIC ONLY



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JOB NAME:	JOB #:		
LOCATION:	NMBS E.T. #5A Joist End Plate	DATE:	3/18/2025

### Shear Plate Rupture: (AISC J4.2)

Crushed Hole Width,  $W' = 1.4375$  in (plate hole + 1/16" Crushed width)  
 Net Plastic Modulus,  $Z_{net} = 53.53$  in<sup>3</sup> ( $Z - W'*t*d_{hole}$ )  $d_{hole} = 7.28125$   
 $\phi V_n = 427.78$  k ( $\phi = 0.75, \phi*0.6*F_u*A_e$ ) AISC J4-4  
 $\phi M_n = 2609.74$  k\*in ( $\phi = 0.75, \phi*F_u*Z$ )  
 $R_u / \phi R_n = 0.43 < 1.0$  OK ( $(V_u/\phi V_n)^2 + (M_u/\phi M_n)^2$ )

### Shear Plate Block Shear: (AISC J4.3)

Vertical Direction

Gross Area in Shear,  $A_{gv} = 20.75$  in<sup>2</sup> ( $t*(d_e + (Nb-1)*S)$ )  
 Net Area in Shear,  $A_{nv} = 12.13$  in<sup>2</sup>  $A_{gv} - (Nb*W')$   
 Net Area in Tension,  $A_{nt} = 1.19$  in<sup>2</sup> ( $t*(d_e - L_h/2)$ )  
 Gross Area,  $\phi R_n = 524.77$  k ( $0.75*(0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ )  $U_{bs} = 1.0$  for single bolt line  
 Net Area,  $\phi R_n = 412.55$  k ( $0.75*(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt})$ ) AISC J4-5

Note: Use of  $L_h$  for determination of Net Plate Area, allows for the slots to be in either the joist end plate or the beam tab.

Horizontal Direction

Gross Area in Shear,  $A_{gv} = 4.00$  in<sup>2</sup> ( $2*t*d_e$ )  
 Net Area in Shear,  $A_{nv} = 2.38$  in<sup>2</sup> ( $2*t*(d_e - L_h/2)$ )  
 Net Area in Tension,  $A_{nt} = 11.56$  in<sup>2</sup> ( $t*((Nb-1)*S - (Nb-1)*W)$ )  
 Gross Area,  $\phi R_n = 653.67$  k ( $0.75*(0.6*F_y*A_{gv} + U_{bs}*F_u*A_{nt})$ )  $U_{bs} = 1.0$  for single bolt line  
 Net Area,  $\phi R_n = 633.14$  k ( $0.75*(0.6*F_u*A_{nv} + U_{bs}*F_u*A_{nt})$ ) AISC J4-5

Note: Use of  $L_h$  for determination of Net Plate Area, allows for the slots to be in either the joist end plate or the beam tab.

$\phi R_n = 412.55$  k Controls  
 $R_u / \phi R_n = 0.36 < 1.0$  OK ( $(V_u^2 + H_m^2)^{1/2} / \phi R_n$ )

### Shear Plate Flexural Rupture: (AISC F11)

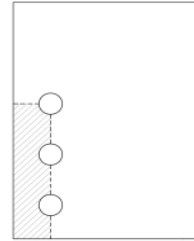
Yielding  $M_c = 2880.0$  k\*in ( $\phi = 0.9, \phi*(F_y*Z < 1.5F_y*S)$ ) AISC F11-1  
 Lateral-Torsional Buckling Check:  $176.0$   $L_b*d/t^2, L_b = e$  Check for Lateral Torsional Buckling per AISC F11-3  
 Lateral-Torsional Buckling,  $M_c = 2880$  k\*in AISC F11-3  
 $R_u / \phi R_n = 0.52 < 1.0$  OK ( $M_u/M_c$ )

### Shear Plate Yielding & Flexural Strength: (AISC 10-8)

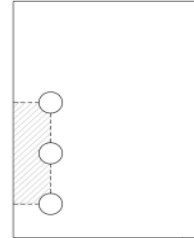
$V_c = 480$  k ( $\phi = 1.0, \phi*0.6*F_y*Ag$ ) AISC J4-3  
 Yielding  $M_c = 2880$  k\*in ( $\phi = 0.9, \phi*(F_y*Z < 1.5F_y*S)$ ) AISC F11-1  
 Lateral-Torsional Buckling Check:  $176.0$   $L_b*d/t^2, L_b = e$  Check for Lateral Torsional Buckling per AISC F11-3  
 Lateral-Torsional Buckling,  $M_c = 2880$  k\*in AISC F11-3  
 $R_u / \phi R_n = 0.35 < 1.0$  OK ( $(V_u/V_c)^2 + (M_u/M_c)^2$ ) AISC 10-8

### Joist Plate Weld (Angle = 0 deg. & $C_1 = 1.00$ E70 Electrode):

Length of Plate Weld  $L_w = 15.5$  in ( $w-0.5''$ )  
 $a_y = 0.1$  AISC Table 8-4  $a_y = (\text{Weld Centroid} - \text{TC Centroid}) / L_w$   
 $k_y = 0.2$  AISC Table 8-4  $k_y = \text{Weld Spacing} / L_w$   
 $C_y = 3.72$  (y-axis weld eccentricity, AISC Table 8-4)  
 $D_{min} = 3$  /16ths of an inch Fillet Weld Size (min)



NOTE: SCHEMATIC ONLY. HOLES OR PLATE MAY VARY





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JOB NAME:	JOB #:		
LOCATION:	NMBS Beam Tab E.T. #5A	DATE:	3/18/2025

### AISC 16TH - p. 10-49 (Extended Configuration)

Holes must satisfy AISC J3.3

Horizontal Axial forces (seismic or wind) if present, to be transferred from beam to joist via tie plate

Beam Tab Plate, $F_u$ =	58	ksi	
Beam Tab Plate, $F_y$ =	36	ksi	
Beam Tab Plate Depth, $d$ =	22.75	in	
Beam Tab Thickness, $t$ =	0.875	in	
Beam Tab Edge Distances, $d_e$ =	2	in	$L_{11} = 9.375$
$e$ =	11	in	$L_{12} = 5.625$
Vertical Shear, $V_u$ =	136	k (LRFD)	$L_{13} = 1.875$
Vertical Ecc. Moment, $M_u$ =	1496	k*in (LRFD)	$L_{14} = 0$
Bolt Diameter, $D_b$ =	1.25	in	$L_{15} = 0$
Bolt Shear Capacity $\phi R_n$ =	62.7	k	
# of Bolts, $N_b$ =	6	(Spreadsheet design limitation, max. 10 bolts)	
Spacing of Bolt Group, $S$ =	3.75	in	
C.G. of Bolt Group =	9.375	in	
$F_{nv}/0.9$ =	75.56	ksi (Table J3.2, A490-N Bolts)	
Short Slotted Hole, $L_h$ =	1.63	in	

$A_b$ =	1.23	in <sup>2</sup> (Bolt Area)
$C'$ =	31.37	AISC Eq. 7-17
$M_{max}$ =	2908.29	k*in ( $F_{nv}/0.9 * A_b * C'$ , Eq. 10-7)

**Max. Beam Tab Thickness,  $t_{max}$  = 0.94 in ( $6 * M_{max} / (F_y * d^2)$ ) AISC Eq. 10-6**

Gross Plate Area, $A_g$ =	19.9063	in <sup>2</sup>
Effective Plate Area, $A_e$ =	12.69	in <sup>2</sup>
$Z$ =	113.217	in <sup>3</sup> ( $1/4t * d^2$ )
$S_{net}$ =	75.48	in <sup>3</sup> ( $1/6t * d^2$ )

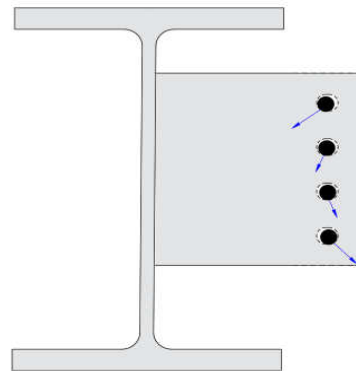
#### Bolt Shear - Elastic Vector Method: (AISC p. 7-7, 7-8)

Bolt Group $I_p$ =	246.09	in <sup>4</sup> /in <sup>2</sup>
$r_{py}$ =	22.67	k (Vu/# Bolts)
$r_{mx}$ =	56.99	k ( $M_u * L_{11} / I_p$ )
$H_m$ =	56.99	k ( $r_{mx} * N_c$ ) $N_c = 1$ column of bolts
$R_u$ =	61.33	k ( $(r_{py}^2 + r_{mx}^2)^{1/2}$ )
$R_u / \phi R_n$ =	0.98	< 1.0 OK

#### Bolt Bearing & Tearout: (AISC J3.11)

Bearing $R_{nb}$ =	152.25	k/bolt ( $2.4 * D_b * t * F_u$ ) AISC J3-6a
$L_{ch}$ =	1.19	in ( $d_e - L_h / 2$ )
Horizontal Tearout $R_{nt}$ =	72.32	k/bolt ( $1.2 * L_{ch} * t * F_u$ ) AISC J3-6c
$R_u$ =	61.33	k (worst case bolt shear)
$r_{mx}$ =	56.99	k (worst case horiz. bolt shear)
$\phi$ =	0.75	(AISC J3.11)
Bearing $R_u / \phi R_{nb}$ =	0.54	< 1.0 OK
Tearout $r_{mx} / \phi R_{nt}$ =	1.05	< 1.5/1.2 O.K. Deformation at hole may occur

Stress Ratio Results:	
Bolt Shear (V&M):	0.98
Bolt Bearing & Tearout:	1.05 O.K.
Shear Tab Rupture:	0.39
Shear Tab Block Shear:	0.46
Shear Tab Flexural Rupture:	0.41
Shear Tab Yielding & Flexural:	0.27
7 / 16" Tab Weld:	0.31
Plate Stability Acceptable	



NOTE: FOR VISUAL FORCE SCHEMATIC ONLY



**NEW MILLENNIUM**

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JOB NAME:	JOB #:	DATE:	3/18/2025
LOCATION:	NMBS Beam Tab E.T. #5A		

**Shear Tab Rupture: (AISC J4.2)**

Crushed Hole Width,  $W' = 1.4375$  in (plate hole + 1/16" Crushed width)  
 Net Plastic Modulus,  $Z_{net} = 73.80$  in<sup>3</sup> (Summation of A\*d of net plate section)  
 $\phi V_n = 331.14$  k ( $\phi = 0.75, \phi * .60 * F_u * A_e$ ) AISC J4-4  
 $\phi M_n = 3210.33$  k\*in ( $\phi = 0.75, \phi * F_u * Z$ )  
 $R_u / \phi R_n = 0.39 < 1.0$  OK ( $(V_u / \phi V_n)^2 + (M_u / \phi M_n)^2$ )

**Shear Tab Block Shear: (AISC J4.3)**

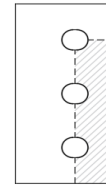
Vertical Direction

Gross Area in Shear,  $A_{gv} = 18.16$  in<sup>2</sup> ( $t * (d_e + (N_b - 1) * S)$ )  
 Net Area in Shear,  $A_{nv} = 10.61$  in<sup>2</sup> ( $A_{gv} - (N_b * W')$ ) \* t  
 Net Area in Tension,  $A_{nt} = 1.04$  in<sup>2</sup> ( $t * (d_e - L_h / 2)$ )  
 Gross Area,  $\phi R_n = 339.33$  k ( $0.75 * (0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ )  $U_{bs} = 1.0$  for single bolt line  
 Net Area,  $\phi R_n = 322.10$  k ( $0.75 * (0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt})$ ) AISC J4-5

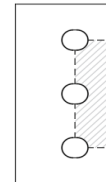
Horizontal Direction

Gross Area in Shear,  $A_{gv} = 3.50$  in<sup>2</sup> ( $2 * t * d_e$ )  
 Net Area in Shear,  $A_{nv} = 2.08$  in<sup>2</sup> ( $2 * t * (d_e - L_h / 2)$ )  
 Net Area in Tension,  $A_{nt} = 10.12$  in<sup>2</sup> ( $t * ((N_b - 1) * S - (N_b - 1) * W)$ )  
 Gross Area,  $\phi R_n = 496.80$  k ( $0.75 * (0.6 * F_y * A_{gv} + U_{bs} * F_u * A_{nt})$ )  $U_{bs} = 1.0$  for single bolt line  
 Net Area,  $\phi R_n = 494.34$  k ( $0.75 * (0.6 * F_u * A_{nv} + U_{bs} * F_u * A_{nt})$ ) AISC J4-5

$\phi R_n = 322.10$  k Controls  
 $R_u / \phi R_n = 0.46 < 1.0$  OK ( $(V_u^2 + H_m^2)^{1/2} / \phi R_n$ )



NOTE: SCHEMATIC ONLY, HOLES MAY VARY



**Shear Tab Flexural Rupture: (AISC F11)**

Yielding  $M_c = 3668.2$  k\*in ( $\phi = 0.9, \phi * (F_y * Z < 1.5 F_y * S)$ ) AISC F11-1  
 Lateral-Torsional Buckling Check: 326.9 Lb\*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3  
 Lateral-Torsional Buckling,  $M_c = 3668.2$  k\*in AISC F11-3  
 $R_u / \phi R_n = 0.41 < 1.0$  OK ( $M_u / M_c$ )

**Shear Tab Yielding & Flexural Strength: (AISC 10-8)**

$V_c = 430.0$  k ( $\phi = 1.0, \phi * 0.6 * F_y * A_g$ ) AISC J4-3  
 Yielding  $M_c = 3668.2$  k\*in ( $\phi = 0.9, \phi * (F_y * Z < 1.5 F_y * S)$ ) AISC F11-1  
 Lateral-Torsional Buckling Check: 326.9 Lb\*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3  
 Lateral-Torsional Buckling,  $M_c = 3668.2$  k\*in AISC F11-3  
 $R_u / \phi R_n = 0.27 < 1.0$  OK ( $(V_u / V_c)^2 + (M_u / M_c)^2$ ) AISC 10-8

**Shear Tab Weld:**

Min. Weld Thickness  $t_{wmin} = 0.39$  in.  $t_{wmin} = (t * F_y * 3^{1/2}) / (2 * F_{EXX})$ ,  $F_{EXX} = 70$ ksi Electrode, AISC Engineering Journal, Vol. 46, 2009  
 Weld Provided  $t_w = 0.4375$  in  
 Min. Plate Thickness = 0.75 in (AISC Eq. 9-7, 6.19\*D/Fu) **GOOD**  
 $\phi R_w = 443.32$  k ( $\phi * 0.6 * F_{EXX} * 0.707 * t_w * d * 2$ )  
 $R_u / \phi R_n = 0.31 < 1.0$  OK

**Shear Tab Stability: (Thorton and Fortney, 2011)**

**Lateral Torsional Buckling Check:**

$\phi R_n = 534$  k **Acceptable**

$$R_{req'd} \leq \phi R_n \text{ (LRFD)}$$

$$R_n = 1500 \pi \frac{l^3}{a^2}$$

l = beam tab plate length (depth)  
 t = tp = beam tab plate thickness  
 a = Eccentricity 'e'

**Lap Splice Eccentricity Check:**

$\phi M_{t,u} = 128.6$  k\*in  
 $M_{t,u} = 127.5$  k\*in ( $R * (t_p + t_t) / 2$ )

$$\phi M_{t,u} \leq \left[ \phi_v \left( U_{bs} F_y S_x \right) - \frac{R_M}{t_p} \right] \frac{t_p^2}{2} \quad \phi_v = 1.0$$

(LRFD)

**Acceptable**