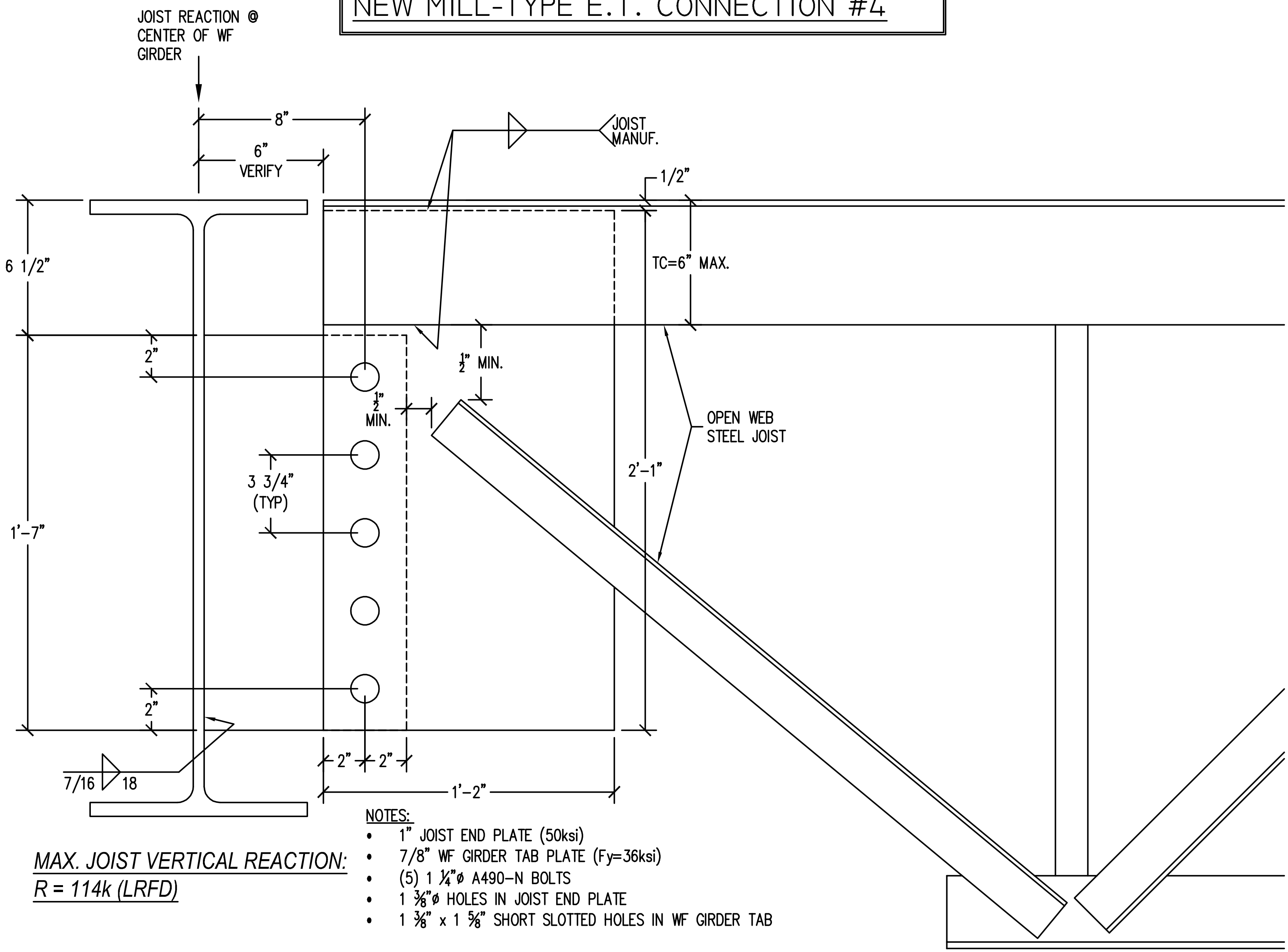
EXTENDED-TAB (ET) CONNECTION

NEW MILL-TYPE E.T. CONNECTION #4



MAX. JOIST VERTICAL REACTION:
R = 114k (LRFD)

NOTES:

- 1" JOIST END PLATE (50ksi)
- 7/8" WF GIRDER TAB PLATE (Fy=36ksi)
- (5) 1 ¼"ø A490-N BOLTS
- 1 ⅜"ø HOLES IN JOIST END PLATE
- 1 ⅜" x 1 ⅝" SHORT SLOTTED HOLES IN WF GIRDER TAB

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Date: 3/18/2025

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JOB NAME:	JOB #:		
LOCATION:	NMBS E.T. #4 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, Fu =	65	ksi	TC Hold Back Distance (H) =	6	in	Joist Plate w =	14	in
Joist Tab Plate, Fy =	50	ksi	TC Angle Size =	3.5	in	Joist Plate d =	25	in
Joist Plate, d or w=	14	in	Joist Plate Hold-Down from TC =	0.5	in			
Joist Plate Thickness, t=	1	in						
Joist Plate Edge Distances, de=	2	in						
e =	8	in	L_{i1} =	7.5				
Vertical Shear , Vu=	114	k (LRFD)	L_{i2} =	3.75				
Vertical Ecc. Moment , Mu=	912	k*in (LRFD)	L_{i3} =	0				
Bolt Diameter, Db =	1.25	in	L_{i4} =	0				
Bolt Shear Capacity ϕRn =	62.7	k (A490-N)	L_{i5} =	0				
# of Bolts, Nb=	5	(Spreadsheet design limitation, max. 10 bolts)						
Spacing of Bolt Group, S=	3.75	in						
Vert. C.G. of Bolt Group =	7.5	in						
Fnv/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}=	171	k (LRFD)...**Assumes 1.5:1 End Web Slope**						

Gross Plate Area, Ag =	14	in^2
Effective Plate Area, Ae =	12.63	in^2
Z =	49	in^3 (1/4t*w^2)
S =	32.6667	in^3 (1/6t*w^2)

Stress Ratio Results:	
Bolt Shear (V&M):	**0.86**
Bolt Bearing & Tearout:	**0.70**
Shear Plate Rupture:	**0.31**
Shear Plate Block Shear:	**0.36**
Shear Plate Flexural Rupture:	**0.41**
Shear Plate Yielding & Flexural:	**0.24**

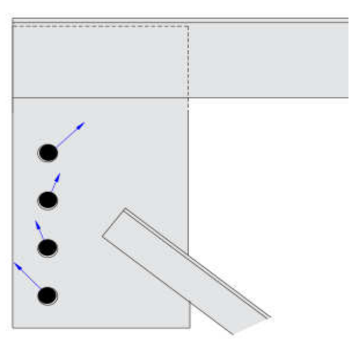
Min. Joist TC to Plate Weld:
3 /16th x 13.5 " Fillet Weld

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

Bolt Group I_p =	140.63	in4/in2
r_{py} =	22.80	k (Vu/# Bolts)
r_{mx} =	48.64	k $(Mu*L_{i1}/I_p)$
Hm =	48.64	k (rmx *Nc) Nc = 1 column of bolts
Ru =	53.72	k $(r_{py}^2+r_{mx}^2)^{1/2}$
Ru / ϕRn =	**0.86**	**< 1.0 OK**

Bolt Bearing & Tearout: (AISC J3.11)

Bearing Rnb =	195.00	k/bolt (2.4*Db*t*Fu) AISC J3-6a
L_{ch} =	1.19	in $(d_e - Lh/2)$
Horizontal Tearout Rnt =	92.63	k/bolt $(1.2*L_{ch}*t*Fu)$ AISC J3-6c
Ru =	53.72	k (worst case bolt shear)
r_{mx} =	48.64	k (worst case horiz. bolt shear)
ϕ =	0.75	(AISC J3.11)
Bearing Ru / ϕRnb =	**0.37**	**< 1.0 OK**
Tearout r_{mx} / ϕRnt =	**0.70**	**< 1.0 OK**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JOB NAME:	JOB #:		
LOCATION:	NMBS E.T. #4 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} = 39.97 in^3 (Z - W'*t*d_{hole}) d_{hole} = 6.28125

ϕVn = 369.28 k (ϕ = 0.75, ϕ*.60*Fu*Ae) AISC J4-4

ϕMn = 1948.57 k*in (ϕ = 0.75, ϕ*Fu*Z)

Ru / ϕRn = **0.31** **< 1.0 OK** $(Vu/\phi Vn)^2+(Mu/\phi Mn)^2$

Shear Plate Block Shear: (AISC J4.3)

Vertical Direction

Gross Area in Shear, Agv= 17.00 in^2 (t*(d_e+(Nb-1)*S)

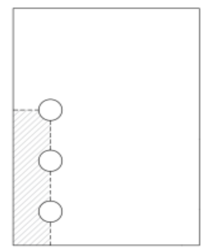
Net Area in Shear, Anv= 9.81 in^2 Agv-(Nb*W')*t

Net Area in Tension, Ant= 1.19 in^2 (t*(d_e-Lh/2)

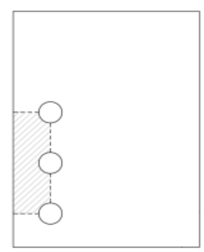
Note: Use of Lh for determination of Net Plate Area, allows for the slots to be in either the joist end plate or the beam tab.

Gross Area, ϕRn = 440.39 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line

Net Area, ϕRn = 344.91 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5



NOTE: SCHEMATIC ONLY, HOLES OR PLATE MAY VARY



Horizontal Direction

Gross Area in Shear, Agv= 4.00 in^2 (2*t*d_e)

Net Area in Shear, Anv= 2.38 in^2 (2*t*(d_e-Lh/2)

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

Net Area in Tension, Ant= 9.25 in^2 (t*((Nb-1)*S-(Nb-1)*W)

Gross Area, ϕRn = 540.94 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line

Net Area, ϕRn = 520.41 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5

ϕRn = **344.91 k** **Controls**

Ru / ϕRn = **0.36 < 1.0 OK** $(Vu^2+Hm^2)^{1/2}/\phi Rn$

Shear Plate Flexural Rupture: (AISC F11)

Yielding Mc = 2205.0 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1

Lateral-Torsional Buckling Check: 112.0 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3

Lateral-Torsional Buckling, Mc = 2205 k*in AISC F11-3

Ru / ϕRn = **0.41** **< 1.0 OK** (Mu/Mc)

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

Vc = 420 k (ϕ = 1.0, ϕ*0.6*Fy*Ag) AISC J4-3

Yielding Mc = 2205 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1

Lateral-Torsional Buckling Check: 112.0 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3

Lateral-Torsional Buckling, Mc = 2205 k*in AISC F11-3

Ru / ϕRn = **0.24** **< 1.0 OK** $(Vu/Vc)^2+(Mu/Mc)^2$ AISC 10-8

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

Length of Plate Weld L_w = 13.5 in (w-0.5")

a_y = 0.1 AISC Table 8-4 a_y = (Weld Centroid - TC Centroid) / L_w

k_y = 0.3 AISC Table 8-4 k_y = Weld Spacing / L_w

Cy = 3.71 (y-axis weld eccentricity, AISC Table 8-4)

D_{min} = **3** /16ths of an inch Fillet Weld Size (min)

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JOB NAME:	JOB #:		
LOCATION:	NMBS Beam Tab E.T. #4	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, Fu =	58	ksi		
Beam Tab Plate, Fy =	36	ksi		
Beam Tab Plate Depth, d=	19	in		
Beam Tab Thickness, t=	0.875	in		
Beam Tab Edge Distances, d_e=	2	in	L_{i1} =	7.5
e =	8	in	L_{i2} =	3.75
Vertical Shear , Vu=	114	k (LRFD)	L_{i3} =	0
Vertical Ecc. Moment , Mu=	912	k*in (LRFD)	L_{i4} =	0
Bolt Diameter, Db =	1.25	in	L_{i5} =	0
Bolt Shear Capacity ϕRn =	62.7	k		
# of Bolts, Nb=	5	(Spreadsheet design limitation, max. 10 bolts)		
Spacing of Bolt Group, S=	3.75	in		
C.G. of Bolt Group =	7.5	in		
Fnv/0.9 =	75.56	ksi (Table J3.2, A490-N Bolts)		
Short Slotted Hole, Lh =	1.63	in		

Ab=	1.23	in^2 (Bolt Area)
C'=	21.43	AISC Eq. 7-17
Mmax =	1987.46	k*in (Fnv/0.9*Ab*C', Eq. 10-7)
Max. Beam Tab Thickness, tmax =	**0.92**	**in** (6*Mmax)/(Fy*d^2) **AISC Eq. 10-6**
Gross Plate Area, Ag =	16.625	in^2
Effective Plate Area, Ae =	10.61	in^2
Z =	78.9688	in^3 (1/4t*d^2)
S_{net} =	52.65	in^3 (1/6t*d^2)

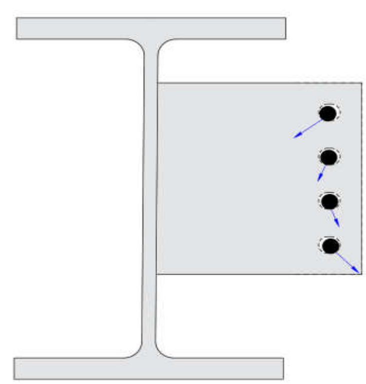
Stress Ratio Results:	
Bolt Shear (V&M):	**0.86**
Bolt Bearing & Tearout:	**0.90**
Shear Tab Rupture:	**0.32**
Shear Tab Block Shear:	**0.46**
Shear Tab Flexural Rupture:	**0.36**
Shear Tab Yielding & Flexural:	**0.23**
7 /16" Tab Weld:	**0.31**
Plate Stability Acceptable	

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

Bolt Group I_p =	140.63	in4/in2
r_{py} =	22.80	k (Vu/# Bolts)
r_{mx} =	48.64	k (Mu*L_{i1}/I_p)
Hm =	48.64	k (rmx *Nc) Nc = 1 column of bolts
Ru =	53.72	k $(r_{py}^2+r_{mx}^2)^{1/2}$
Ru / ϕRn =	**0.86**	**< 1.0 OK**

Bolt Bearing & Tearout: (AISC J3.11)

Bearing Rnb =	152.25	k/bolt (2.4*Db*t*Fu) AISC J3-6a
L_{ch} =	1.19	in (d_e - Lh/2)
Horizontal Tearout Rnt =	72.32	k/bolt (1.2*L_{ch}*t*Fu) AISC J3-6c
Ru =	53.72	k (worst case bolt shear)
r_{mx} =	48.64	k (worst case horiz. bolt shear)
ϕ =	0.75	(AISC J3.11)
Bearing Ru / ϕRnb =	**0.47**	**< 1.0 OK**
Tearout r_{mx} / ϕRnt =	**0.90**	**< 1.0 OK**



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JOB NAME:	JOB #:		
LOCATION:	NMBS Beam Tab E.T. #4	DATE:	3/18/2025

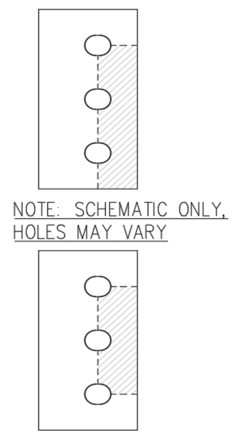
Shear Tab Rupture: (AISC J4.2)

Crushed Hole Width, W' = 1.4375 in (plate hole + 1/16" Crushed width)
Net Plastic Modulus, Z_{net} = 53.25 in^3 (Summation of A*d of net plate section)
ϕVn = 276.90 k (ϕ = 0.75, ϕ*.60*Fu*Ae) AISC J4-4
ϕMn = 2316.42 k*in (ϕ = 0.75, ϕ*Fu*Z)
Ru / ϕRn = **0.32** **< 1.0 OK** $(Vu/\phi Vn)^2+(Mu/\phi Mn)^2$

Shear Tab Block Shear: (AISC J4.3)

Vertical Direction

Gross Area in Shear, Agv= 14.88 in^2 $(t*(d_e+(Nb-1)*S)$
Net Area in Shear, Anv= 8.59 in^2 Agv-(Nb*W')*t
Net Area in Tension, Ant= 1.04 in^2 $(t*(d_e-Lh/2)$
Gross Area, ϕRn = 286.17 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 269.29 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5



Horizontal Direction

Gross Area in Shear, Agv= 3.50 in^2 $(2*t*d_e)$
Net Area in Shear, Anv= 2.08 in^2 $(2*t*(d_e-*Lh/2)$
Net Area in Tension, Ant= 8.09 in^2 (t*((Nb-1)*S-(Nb-1)*W)
Gross Area, ϕRn = 408.78 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 406.32 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5

ϕRn = **269.29 k** **Controls**
Ru / ϕRn = **0.46 < 1.0 OK** $(Vu^2+Hm^2)^{1/2}/\phi Rn$

Shear Tab Flexural Rupture: (AISC F11)

Yielding Mc = 2558.6 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 198.5 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 2558.6 k*in AISC F11-3
Ru / ϕRn = **0.36** **< 1.0 OK** (Mu/Mc)

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

Vc = 359.1 k (ϕ = 1.0, ϕ*0.6*Fy*Ag) AISC J4-3
Yielding Mc = 2558.6 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 198.5 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 2558.6 k*in AISC F11-3
Ru / ϕRn = **0.23** **< 1.0 OK** $(Vu/Vc)^2+(Mu/Mc)^2$ AISC 10-8

Shear Tab Weld:

Min. Weld Thickness t_{wmin} = 0.39 in. $t_{wmin} = (t*Fy*3^{1/2})/(2*F_{EXX})$, F_{EXX} = 70ksi 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**
ϕRw = 370.25 k $(\phi*0.6*F_{EXX}*0.707*t_w*d*2)$

Ru / ϕRn = **0.31 < 1.0 OK**

Shear Tab Stability: (Thorton and Fortney, 2011)

Lateral Torsional Buckling Check:

ϕRn = **843** k **Acceptable**

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

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

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

Lap Splice Eccentricity Check:

ϕMt,u = 107.2 k*in
Mt,u = 106.9 k*in $(R*(t_p+t_j)/2$

$$M_{t,u} \le \left[\phi_v (0.6F_{yp}) - \frac{R_u}{t_p}\right]\frac{t_p^2}{2} \quad \phi_v = 1.0$$

(LRFD)

Acceptable