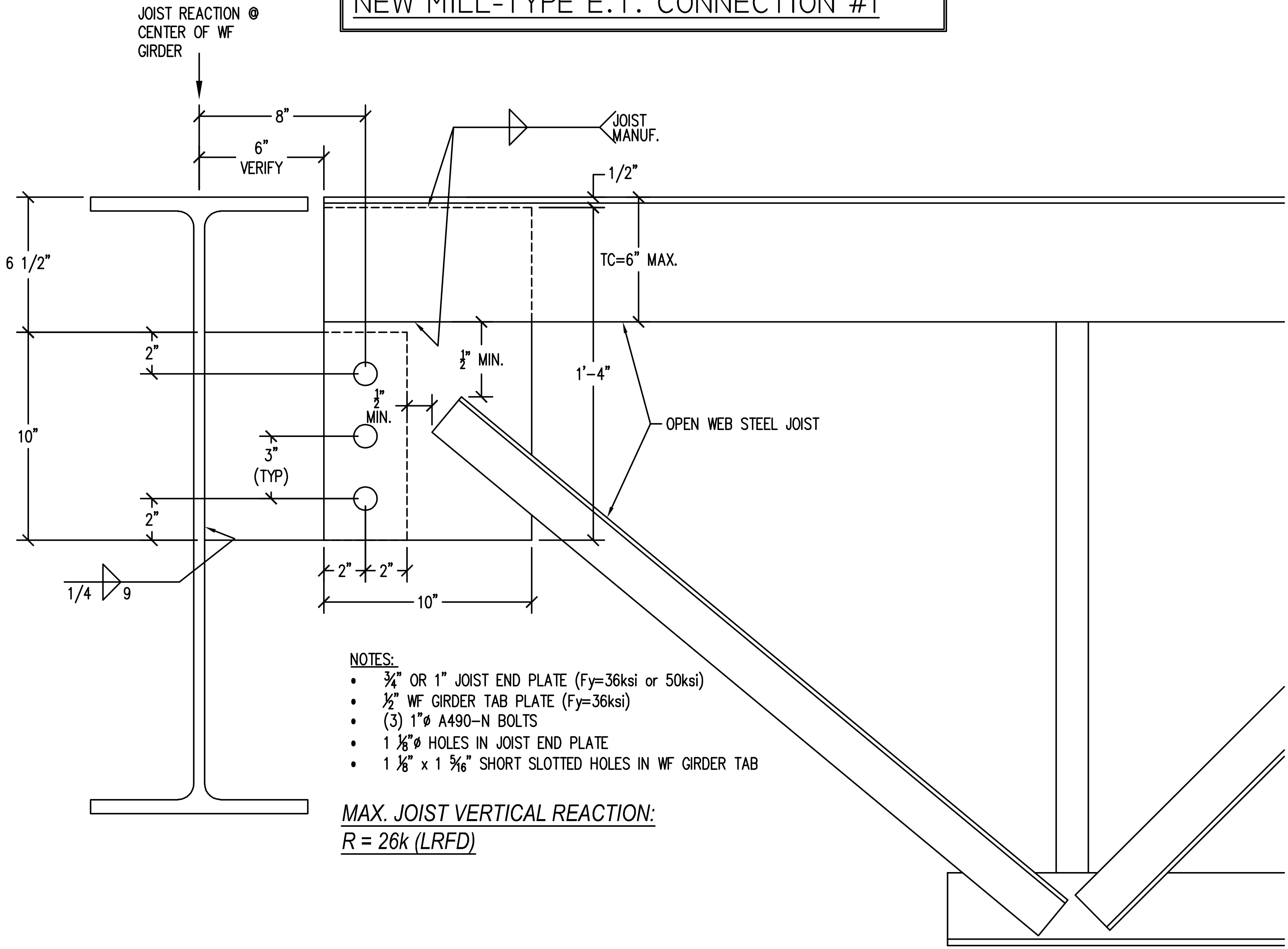
EXTENDED-TAB (ET) CONNECTION

NEW MILL-TYPE E.T. CONNECTION #1



NOTES:

- ¾" OR 1" JOIST END PLATE (Fy=36ksi or 50ksi)
- ½" WF GIRDER TAB PLATE (Fy=36ksi)
- (3) 1"ø A490-N BOLTS
- 1 ⅛"ø HOLES IN JOIST END PLATE
- 1 ⅛" x 1 5/16" SHORT SLOTTED HOLES IN WF GIRDER TAB

MAX. JOIST VERTICAL REACTION:
R = 26k (LRFD)

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Date: 3/18/2025

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JOB NAME:	JOB #:		
LOCATION:	NMBS E.T. #1 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 =	58	ksi	TC Hold Back Distance (H) =	6	in	Joist Plate w =	10	in
Joist Tab Plate, Fy =	36	ksi	TC Angle Size =	3.5	in	Joist Plate d =	16	in
Joist Plate, d or w=	10	in	Joist Plate Hold-Down from TC =	0.5	in			
Joist Plate Thickness, t=	0.75	in						
Joist Plate Edge Distances, de=	2	in						
e =	8	in	L_{i1} =	3				
Vertical Shear , Vu=	26	k (LRFD)	L_{i2} =	0				
Vertical Ecc. Moment , Mu=	208	k*in (LRFD)	L_{i3} =	0				
Bolt Diameter, Db =	1	in	L_{i4} =	0				
Bolt Shear Capacity ϕRn =	40	k (A490-N)	L_{i5} =	0				
# of Bolts, Nb=	3	(Spreadsheet design limitation, max. 10 bolts)						
Spacing of Bolt Group, S=	3	in						
Vert. C.G. of Bolt Group =	3	in						
Fnv/0.9 =	75.56	ksi (Table J3.2, A490-N Bolts)						
Short Slotted Hole, Lh =	1.31	in (conservative design, allows for slotted holes in joist plate)						
Joist Top Chord Axial Force, V_{TC}=	39	k (LRFD)...**Assumes 1.5:1 End Web Slope**						

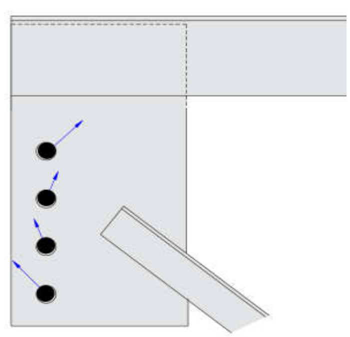
Gross Plate Area, Ag =	7.5	in^2
Effective Plate Area, Ae =	6.66	in^2
Z =	18.75	in^3 (1/4t*w^2)
S =	12.5	in^3 (1/6t*w^2)

Stress Ratio Results:	
Bolt Shear (V&M):	**0.89**
Bolt Bearing & Tearout:	**0.66**
Shear Plate Rupture:	**0.13**
Shear Plate Block Shear:	**0.33**
Shear Plate Flexural Rupture:	**0.34**
Shear Plate Yielding & Flexural:	**0.14**

Min. Joist TC to Plate Weld:
1 /16th x 9.5 " Fillet Weld

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

Bolt Group I_p =	18.00	in4/in2
r_{py} =	8.67	k (Vu/# Bolts)
r_{mx} =	34.67	k $(Mu*L_{i1}/I_p)$
Hm =	34.67	k (rmx *Nc) Nc = 1 column of bolts
Ru =	35.73	k $(r_{py}^2+r_{mx}^2)^{1/2}$
Ru / ϕRn =	**0.89**	**< 1.0 OK**



Bolt Bearing & Tearout: (AISC J3.11)

Bearing Rnb =	104.40	k/bolt (2.4*Db*t*Fu) AISC J3-6a
L_{ch} =	1.34	in (d_e - Lh/2)
Horizontal Tearout Rnt =	70.14	k/bolt (1.2*L_{ch}*t*Fu) AISC J3-6c
Ru =	35.73	k (worst case bolt shear)
r_{mx} =	34.67	k (worst case horiz. bolt shear)
ϕ =	0.75	(AISC J3.11)
Bearing Ru / ϕRnb =	**0.46**	**< 1.0 OK**
Tearout r_{mx} / ϕRnt =	**0.66**	**< 1.0 OK**

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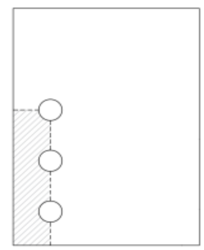
JOB NAME:	JOB #:		
LOCATION:	NMBS E.T. #1 Joist End Plate	DATE:	3/18/2025

Shear Plate Rupture: (AISC J4.2)

Crushed Hole Width, W' = 1.1875 in (plate hole + 1/16" Crushed width)
Net Plastic Modulus, Z_{net} = 14.83 in^3 (Z - W'*t*d_{hole}) d_{hole} = 4.40625
ϕVn = 173.73 k (ϕ = 0.75, ϕ*.60*Fu*Ae) AISC J4-4
ϕMn = 644.92 k*in (ϕ = 0.75, ϕ*Fu*Z)
Ru / ϕRn = **0.13** **< 1.0 OK** $(Vu/\phi Vn)^2+(Mu/\phi Mn)^2$

Shear Plate Block Shear: (AISC J4.3)
Vertical Direction

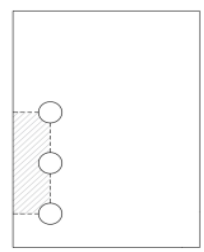


Gross Area in Shear, Agv= 6.00 in^2 (t*(d_e+(Nb-1)*S)
Net Area in Shear, Anv= 3.33 in^2 Agv-(Nb*W')*t
Net Area in Tension, Ant= 1.01 in^2 (t*(d_e-Lh/2)
Gross Area, ϕRn = 141.04 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 130.70 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5

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.

NOTE: SCHEMATIC ONLY, HOLES OR PLATE MAY VARY

Horizontal Direction



Gross Area in Shear, Agv= 3.00 in^2 (2*t*d_e)
Net Area in Shear, Anv= 2.02 in^2 (2*t*(d_e-Lh/2)
Net Area in Tension, Ant= 2.72 in^2 (t*((Nb-1)*S-(Nb-1)*W)
Gross Area, ϕRn = 166.87 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 170.87 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5

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.

ϕRn = **130.70 k** **Controls**
Ru / ϕRn = **0.33** **< 1.0 OK** $(Vu^2+Hm^2)^{1/2}/\phi Rn$

Shear Plate Flexural Rupture: (AISC F11)
Yielding Mc = 607.5 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 142.2 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 607.5 k*in AISC F11-3
Ru / ϕRn = **0.34** **< 1.0 OK** (Mu/Mc)

Shear Plate Yielding & Flexural Strength: (AISC 10-8)
Vc = 162 k (ϕ = 1.0, ϕ*0.6*Fy*Ag) AISC J4-3
Yielding Mc = 607.5 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 142.2 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 607.5 k*in AISC F11-3
Ru / ϕRn = **0.14** **< 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 = 9.5 in (w-0.5")
a_y = 0.2 AISC Table 8-4 a_y = (Weld Centroid - TC Centroid) / L_w
k_y = 0.4 AISC Table 8-4 k_y = Weld Spacing / L_w
Cy = 3.47 (y-axis weld eccentricity, AISC Table 8-4)
D_{min} = **1** /16ths of an inch Fillet Weld Size (min)

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JOB NAME:	JOB #:		
LOCATION:	NMBS Beam Tab E.T. #1	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=	10	in		
Beam Tab Thickness, t=	0.5	in		
Beam Tab Edge Distances, d_e=	2	in	L_{i1} =	3
e =	8	in	L_{i2} =	0
Vertical Shear , Vu=	26	k (LRFD)	L_{i3} =	0
Vertical Ecc. Moment , Mu=	208	k*in (LRFD)	L_{i4} =	0
Bolt Diameter, Db =	1	in	L_{i5} =	0
Bolt Shear Capacity ϕRn =	40	k		
# of Bolts, Nb=	3	(Spreadsheet design limitation, max. 10 bolts)		
Spacing of Bolt Group, S=	3	in		
C.G. of Bolt Group =	3	in		
Fnv/0.9 =	75.56	ksi (Table J3.2, A490-N Bolts)		
Short Slotted Hole, Lh =	1.31	in		

Ab=	0.79	in^2 (Bolt Area)
C'=	5.89	AISC Eq. 7-17
Mmax =	349.46	k*in (Fnv/0.9*Ab*C', Eq. 10-7)
Max. Beam Tab Thickness, tmax =	**0.58**	**in** (6*Mmax)/(Fy*d^2) **AISC Eq. 10-6**
Gross Plate Area, Ag =	5	in^2
Effective Plate Area, Ae =	3.31	in^2
Z =	12.5	in^3 (1/4t*d^2)
S_{net} =	8.33	in^3 (1/6t*d^2)

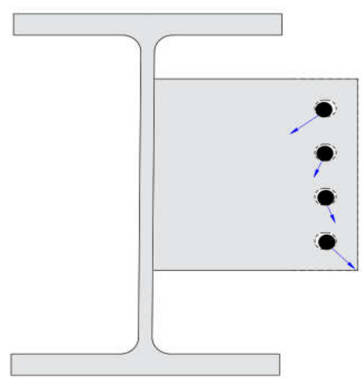
Stress Ratio Results:	
Bolt Shear (V&M):	**0.89**
Bolt Bearing & Tearout:	**0.99**
Shear Tab Rupture:	**0.39**
Shear Tab Block Shear:	**0.50**
Shear Tab Flexural Rupture:	**0.51**
Shear Tab Yielding & Flexural:	**0.32**
4 /16" Tab Weld:	**0.23**
Plate Stability Acceptable	

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

Bolt Group I_p =	18.00	in4/in2
r_{py} =	8.67	k (Vu/# Bolts)
r_{mx} =	34.67	k (Mu*L_{i1}/I_p)
Hm =	34.67	k (rmx *Nc) Nc = 1 column of bolts
Ru =	35.73	k $(r_{py}^2+r_{mx}^2)^{1/2}$
Ru / ϕRn =	**0.89**	**< 1.0 OK**

Bolt Bearing & Tearout: (AISC J3.11)

Bearing Rnb =	69.60	k/bolt (2.4*Db*t*Fu) AISC J3-6a
L_{ch} =	1.34	in (d_e - Lh/2)
Horizontal Tearout Rnt =	46.76	k/bolt (1.2*L_{ch}*t*Fu) AISC J3-6c
Ru =	35.73	k (worst case bolt shear)
r_{mx} =	34.67	k (worst case horiz. bolt shear)
ϕ =	0.75	(AISC J3.11)
Bearing Ru / ϕRnb =	**0.68**	**< 1.0 OK**
Tearout r_{mx} / ϕRnt =	**0.99**	**< 1.0 OK**



NOTE: FOR VISUAL FORCE SCHEMATIC ONLY

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JOB NAME:	JOB #:		
LOCATION:	NMBS Beam Tab E.T. #1	DATE:	3/18/2025

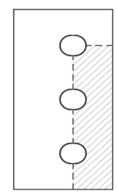
Shear Tab Rupture: (AISC J4.2)

Crushed Hole Width, W' = 1.1875 in (plate hole + 1/16" Crushed width)
Net Plastic Modulus, Z_{net} = 8.76 in^3 (Summation of A*d of net plate section)
ϕVn = 86.46 k (ϕ = 0.75, ϕ*.60*Fu*Ae) AISC J4-4
ϕMn = 381.11 k*in (ϕ = 0.75, ϕ*Fu*Z)
Ru / ϕRn = **0.39** **< 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= 4.00 in^2 $(t*(d_e+(Nb-1)*S)$
Net Area in Shear, Anv= 2.22 in^2 Agv-(Nb*W')*t
Net Area in Tension, Ant= 0.67 in^2 $(t*(d_e-Lh/2)$
Gross Area, ϕRn = 94.03 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 87.14 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5



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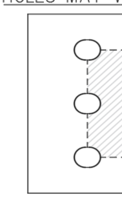

Horizontal Direction

Gross Area in Shear, Agv= 2.00 in^2 $(2*t*d_e)$
Net Area in Shear, Anv= 1.34 in^2 $(2*t*(d_e-*Lh/2)$
Net Area in Tension, Ant= 1.81 in^2 (t*((Nb-1)*S-(Nb-1)*W)
Gross Area, ϕRn = 111.24 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 113.92 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5

ϕRn = **87.14 k** **Controls**
Ru / ϕRn = 0.50 < 1.0 OK $(Vu^2+Hm^2)^{1/2}/\phi Rn$

Shear Tab Flexural Rupture: (AISC F11)

Yielding Mc = 405.0 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 320.0 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 405.0 k*in AISC F11-3
Ru / ϕRn = **0.51** **< 1.0 OK** (Mu/Mc)

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

Vc = 108.0 k (ϕ = 1.0, ϕ*0.6*Fy*Ag) AISC J4-3
Yielding Mc = 405.0 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 320.0 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 405.0 k*in AISC F11-3
Ru / ϕRn = **0.32** **< 1.0 OK** $(Vu/Vc)^2+(Mu/Mc)^2$ AISC 10-8

Shear Tab Weld:

Min. Weld Thickness t_{wmin} = 0.22 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 = 0.25 in
Min. Plate Thickness = 0.43 in (AISC Eq. 9-7, 6.19*D/Fu) **GOOD**
ϕRw = 111.35 k $(\phi*0.6*F_{EXX}*0.707*t_w*d*2)$

Ru / ϕRn = 0.23 < 1.0 OK

Shear Tab Stability: (Thorton and Fortney, 2011)
Lateral Torsional Buckling Check:

ϕRn = **83** 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 = 20.5 k*in
Mt,u = 19.5 k*in $(R*(t_p+t_j)/2$

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

Acceptable