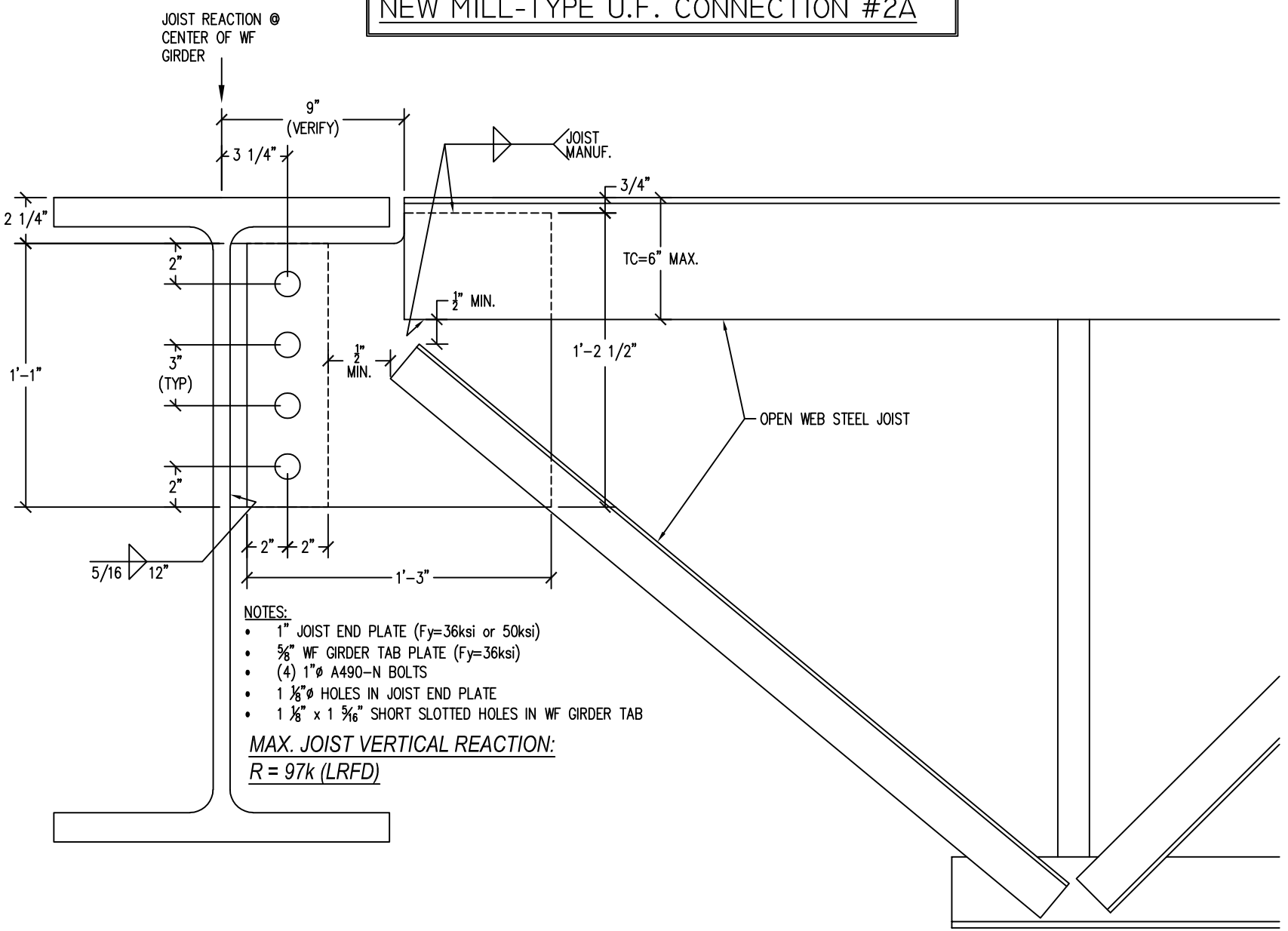
UNDER-FLANGE (UF) CONNECTION

NEW MILL-TYPE U.F. CONNECTION #2A



NOTES:

- 1" JOIST END PLATE (Fy=36ksi or 50ksi)
- 5/8" WF GIRDER TAB PLATE (Fy=36ksi)
- (4) 1"ø A490-N BOLTS
- 1 1/8"ø HOLES IN JOIST END PLATE
- 1 1/8" x 1 5/16" SHORT SLOTTED HOLES IN WF GIRDER TAB

MAX. JOIST VERTICAL REACTION:
R = 97k (LRFD)

Date: 3/18/2025

NEW MILLENNIUM
A Steel Dynamics Company

JOB NAME:	JOB #:		
LOCATION:	NMBS U.F. #2A 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) =	9	in	Joist Plate w =	15 in
Joist Tab Plate, Fy =	36	ksi	TC Angle Size =	3.5	in	Joist Plate d =	13 in
Joist Plate, d or w=	13	in	Joist Plate Hold-Down from TC =	0.75	in		
Joist Plate Thickness, t=	1	in					
Joist Plate Edge Distances, de=	2	in					
e =	3.25	in				L_{i1} =	4.5
Vertical Shear , Vu=	97	k (LRFD)				L_{i2} =	1.5
Vertical Ecc. Moment , Mu=	315.25	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=	4	(Spreadsheet design limitation, max. 10 bolts)					
Spacing of Bolt Group, S=	3	in					
Vert. C.G. of Bolt Group =	4.5	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}=	145.5	k (LRFD)...**Assumes 1.5:1 End Web Slope**					

Gross Plate Area, Ag =	13	in^2
Effective Plate Area, Ae =	11.88	in^2
Z =	42.25	in^3 (1/4t*w^2)
S =	28.1667	in^3 (1/6t*w^2)

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

Bolt Group I_p =	45.00	in4/in2
r_{py} =	24.25	k (Vu/# Bolts)
r_{mx} =	31.53	k ($Mu*L_{i1}/I_p$)
Hm =	31.53	k (rmx *Nc) Nc = 1 column of bolts
Ru =	39.77	k $(r_{py}^2+r_{mx}^2)^{1/2}$
Ru / ϕRn =	**0.99**	**< 1.0 OK**

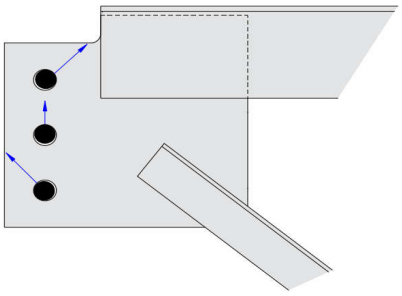
Bolt Bearing & Tearout: (AISC J3.11)

Bearing Rnb =	139.20	k/bolt (2.4*Db*t*Fu) AISC J3-6a
L_{ch} =	1.34	in (d_e - Lh/2)
Horizontal Tearout Rnt =	93.53	k/bolt ($1.2*L_{ch}$*t*Fu) AISC J3-6c
Ru =	39.77	k (worst case bolt shear)
r_{mx} =	31.53	k (worst case horiz. bolt shear)
ϕ =	0.75	(AISC J3.11)
Bearing Ru / ϕRnb =	**0.38**	**< 1.0 OK**
Tearout r_{mx} / ϕRnt =	**0.45**	**< 1.0 OK**

Stress Ratio Results:	
Bolt Shear (V&M):	**0.99**
Bolt Bearing & Tearout:	**0.45**
Shear Plate Rupture:	**0.14**
Shear Plate Block Shear:	**0.46**
Shear Plate Flexural Rupture:	**0.23**
Shear Plate Yielding & Flexural:	**0.17**

Min. Joist TC to Plate Weld:

4 /16th x 7 " Fillet Weld



NOTE: FOR VISUAL FORCE SCHEMATIC ONLY

NEW MILLENNIUM
A Steel Dynamics Company

JOB NAME:	JOB #:		
LOCATION:	NMBS U.F. #2A Joist End Plate	DATE:	3/18/2025

Shear Plate Rupture: (AISC J4.2)

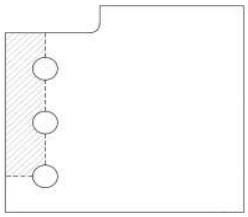
Crushed Hole Width, W' = 1.1875 in (plate hole + 1/16" Crushed width)
Net Plastic Modulus, Z_{net} = 35.24 in^3 (Z - W'*t*d_{hole}) d_{hole} = 5.90625
ϕVn = 309.94 k (ϕ = 0.75, ϕ*.60*Fu*Ae) AISC J4-4
ϕMn = 1532.78 k*in (ϕ = 0.75, ϕ*Fu*Z)
Ru / ϕRn = **0.14** **< 1.0 OK** $(Vu/\phi Vn)^2+(Mu/\phi Mn)^2$

Shear Plate Block Shear: (AISC J4.3)

Vertical Direction

Gross Area in Shear, Agv= 11.00 in^2 (t*(d_e+(Nb-1)*S)
Net Area in Shear, Anv= 6.25 in^2 Agv-(Nb*W')*t
Net Area in Tension, Ant= 1.34 in^2 (t*(d_e-Lh/2)
Gross Area, ϕRn = 236.65 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 221.58 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.

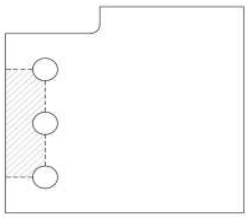


NOTE: SCHEMATIC ONLY, HOLES OR PLATE MAY VARY

Horizontal Direction

Gross Area in Shear, Agv= 4.00 in^2 (2*t*d_e)
Net Area in Shear, Anv= 2.69 in^2 (2*t*(d_e-Lh/2)
Net Area in Tension, Ant= 5.44 in^2 (t*((Nb-1)*S-(Nb-1)*W)
Gross Area, ϕRn = 301.33 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 306.68 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 = **221.58 k** **Controls**
Ru / ϕRn = **0.46** **< 1.0 OK** $(Vu^2+Hm^2)^{1/2}/\phi Rn$

Shear Plate Flexural Rupture: (AISC F11)

Yielding Mc = 1368.9 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 42.3 Lb*d/t^2, Lb = e <0.08*E/Fy Lateral Torsional Buckling does not apply
Lateral-Torsional Buckling, Mc = N/A k*in
Ru / ϕRn = **0.23** **< 1.0 OK** (Mu/Mc)

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

Vc = 280.8 k (ϕ = 1.0, ϕ*0.6*Fy*Ag) AISC J4-3
Yielding Mc = 1368.9 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 42.3 Lb*d/t^2, Lb = e <0.08*E/Fy Lateral Torsional Buckling does not apply
Lateral-Torsional Buckling, Mc = N/A k*in
Ru / ϕRn = **0.17** **< 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 = 7 in (w-(H-1.25)-0.25")
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} = **4** /16ths of an inch Fillet Weld Size (min)

NEW MILLENNIUM
A Steel Dynamics Company

JOB NAME:		JOB #:	
LOCATION:	NMBS Beam Tab U.F. #2, U.F. #2A	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=	13	in		
Beam Tab Thickness, t=	0.625	in		
Beam Tab Edge Distances, d_e=	2	in	L_{i1} =	4.5
e =	3.25	in	L_{i2} =	1.5
Vertical Shear , Vu=	97	k (LRFD)	L_{i3} =	0
Vertical Ecc. Moment , Mu=	315.25	k*in (LRFD)	L_{i4} =	0
Bolt Diameter, Db =	1	in	L_{i5} =	0
Bolt Shear Capacity ϕRn =	40	k		
# of Bolts, Nb=	4	(Spreadsheet design limitation, max. 10 bolts)		
Spacing of Bolt Group, S=	3	in		
C.G. of Bolt Group =	4.5	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'=	11.26	AISC Eq. 7-17
Mmax =	667.96	k*in (Fnv/0.9*Ab*C', Eq. 10-7)
Max. Beam Tab Thickness, tmax =	**0.66**	**in** (6*Mmax)/(Fy*d^2) **AISC Eq. 10-6**

Gross Plate Area, Ag =	8.125	in^2
Effective Plate Area, Ae =	5.31	in^2
Z =	26.4063	in^3 (1/4t*d^2)
S_{net} =	17.60	in^3 (1/6t*d^2)

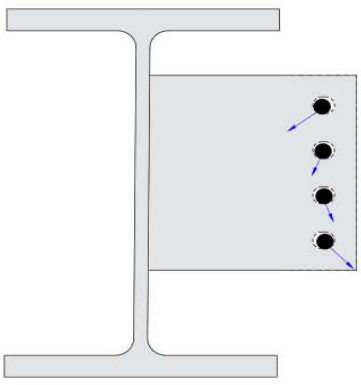
Stress Ratio Results:	
Bolt Shear (V&M):	**0.99**
Bolt Bearing & Tearout:	**0.72**
Shear Tab Rupture:	**0.66**
Shear Tab Block Shear:	**0.74**
Shear Tab Flexural Rupture:	**0.37**
Shear Tab Yielding & Flexural:	**0.44**
5 /16" Tab Weld:	**0.54**

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

Bolt Group I_p =	45.00	in4/in2
r_{py} =	24.25	k (Vu/# Bolts)
r_{mx} =	31.53	k (Mu*L_{i1}/I_p)
Hm =	31.53	k (rmx *Nc) Nc = 1 column of bolts
Ru =	39.77	k (r_{py}^2+r_{mx}^2)$^{1/2}$
Ru / ϕRn =	**0.99**	**< 1.0 OK**

Bolt Bearing & Tearout: (AISC J3.11)

Bearing Rnb =	87.00	k/bolt (2.4*Db*t*Fu) AISC J3-6a
L_{ch} =	1.34	in (d_e - Lh/2)
Horizontal Tearout Rnt =	58.45	k/bolt (1.2*L_{ch}*t*Fu) AISC J3-6c
Ru =	39.77	k (worst case bolt shear)
r_{mx} =	31.53	k (worst case horiz. bolt shear)
ϕ =	0.75	(AISC J3.11)
Bearing Ru / ϕRnb =	**0.61**	**< 1.0 OK**
Tearout r_{mx} / ϕRnt =	**0.72**	**< 1.0 OK**



NOTE: FOR VISUAL FORCE SCHEMATIC ONLY

NEW MILLENNIUM
A Steel Dynamics Company

JOB NAME:		JOB #:	
LOCATION:	NMBS Beam Tab U.F. #2, U.F. #2A	DATE:	3/18/2025

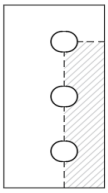
Shear Tab Rupture: (AISC J4.2)

Crushed Hole Width, W' = 1.1875 in (plate hole + 1/16" Crushed width)
Net Plastic Modulus, Z_{net} = 17.50 in^3 (Summation of A*d of net plate section)
ϕVn = 138.66 k (ϕ = 0.75, ϕ*.60*Fu*Ae) AISC J4-4
ϕMn = 761.25 k*in (ϕ = 0.75, ϕ*Fu*Z)
Ru / ϕRn = **0.66** **< 1.0 OK** $(Vu/\phi Vn)^2+(Mu/\phi Mn)^2$

Shear Tab Block Shear: (AISC J4.3)

Vertical Direction

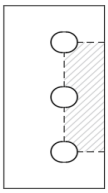
Gross Area in Shear, Agv= 6.88 in^2 ($t*(d_e+(Nb-1)*S)$
Net Area in Shear, Anv= 3.91 in^2 Agv-(Nb*W')*t
Net Area in Tension, Ant= 0.84 in^2 ($t*(d_e-Lh/2)$
Gross Area, ϕRn = 147.91 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 138.49 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5



NOTE: SCHEMATIC ONLY, HOLES MAY VARY

Horizontal Direction

Gross Area in Shear, Agv= 2.50 in^2 ($2*t*d_e$)
Net Area in Shear, Anv= 1.68 in^2 ($2*t*(d_e$-*Lh/2)
Net Area in Tension, Ant= 3.40 in^2 (t*((Nb-1)*S-(Nb-1)*W)
Gross Area, ϕRn = 188.33 k (0.75*(0.6*Fy*Agv+Ubs*Fu*Ant)) Ubs = 1.0 for single bolt line
Net Area, ϕRn = 191.67 k (0.75*(0.6*Fu*Anv+Ubs*Fu*Ant)) AISC J4-5



ϕRn = **138.49 k** **Controls**
Ru / ϕRn = **0.74** **< 1.0 OK** $(Vu^2+Hm^2)^{1/2}/\phi Rn$

Shear Tab Flexural Rupture: (AISC F11)

Yielding Mc = 855.6 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 108.2 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 855.6 k*in AISC F11-3
Ru / ϕRn = **0.37** **< 1.0 OK** (Mu/Mc)

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

Vc = 175.5 k (ϕ = 1.0, ϕ*0.6*Fy*Ag) AISC J4-3
Yielding Mc = 855.6 k*in (ϕ = 0.9, ϕ*(Fy*Z<1.5Fy*S)) AISC F11-1
Lateral-Torsional Buckling Check: 108.2 Lb*d/t^2, Lb = e Check for Lateral Torsional Buckling per AISC F11-3
Lateral-Torsional Buckling, Mc = 855.6 k*in AISC F11-3
Ru / ϕRn = **0.44** **< 1.0 OK** $(Vu/Vc)^2+(Mu/Mc)^2$ AISC 10-8

Shear Tab Weld:

Min. Weld Thickness t_{wmin} = 0.28 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 = 0.3125 in
Min. Plate Thickness = 0.53 in (AISC Eq. 9-7, 6.19*D/Fu) **GOOD**
ϕRw = 180.95 k (ϕ*0.6*F_{EXX}*0.707*t_w*d*2)

Ru / ϕRn = **0.54** **< 1.0 OK**