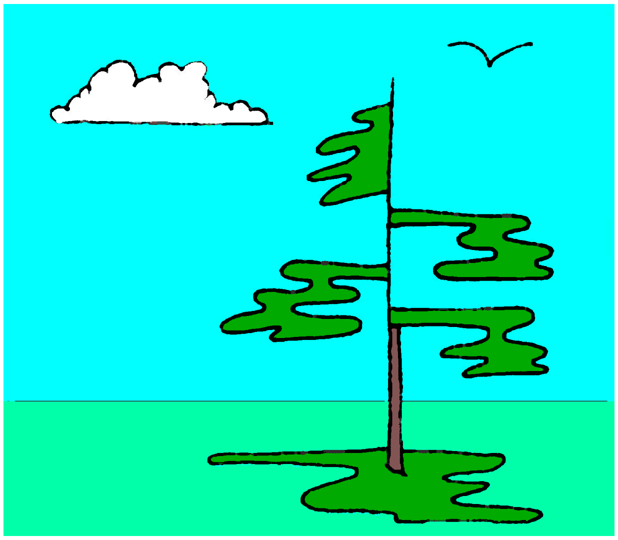
NorthWoods Software



Program Name: Conn-Moment_End_Plate_(8+8_Bolt)

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21-05-18

Reference: NBCC, CSA S16

Created using SMath Studio, a MathCAD workalike from https://en.smath.info/view/SMathStudio. The User is responsible to verify data using an alternative method

Menu:

....	Input Data	....	Important Output	....	Logical Constructs	Blue	Units
....	Sum / For	Red	Important Note	Gray	Temporary Variables		

Defined Units:

$K := kip$ — Force

$K\_ft := K\ ft$ $kN\_m := kN\ m$ $K\_in := K\ in$ $kN\_mm := kN\ mm$ $lb\_in := lbf\ in$ — Moment

$pcf := \frac{lbf}{ft^3}$ $kNpcm := \frac{kN}{m^3}$ $kgpcm := \frac{kg}{m^3}$ — Density

$Klf := \frac{K}{ft}$ $plf := \frac{lbf}{ft}$ $kNpm := \frac{kN}{m}$ $Kpi := \frac{K}{in}$ $kNpmm := \frac{kN}{mm}$ — Force/Unit Length

$psf := \frac{lbf}{ft^2}$ $Ksf := \frac{K}{ft^2}$ $Ksi := \frac{K}{in^2}$ $kNpsm := \frac{kN}{m^2}$ $psi := \frac{lbf}{in^2}$ — Pressure

$pci := \frac{lbf}{in^3}$ — Subgrade Modulus

$psfpf := \frac{psf}{ft}$ $kPapm := \frac{kPa}{m}$ — Pressure per Depth

$pmcf := \frac{lb}{ft^3}$ $lb := lbf$ — Force

$mph := \frac{mi}{hr}$ $kph := \frac{km}{hr}$ — Velocity

$ispf := \frac{in^2}{ft}$ $mmspm := \frac{mm^2}{m}$ — Area per Unit Length

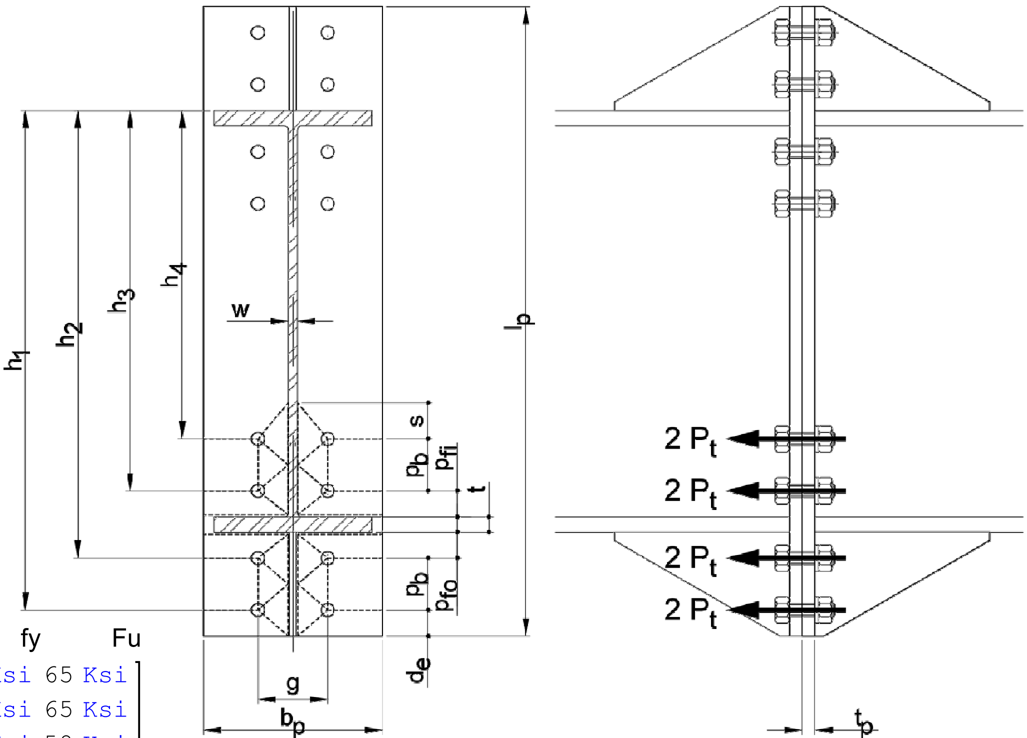
User Defined Functions:

```
Check(arg) := if arg = 1
                 Check := "...OK"
              else
                 Check := "...NG"
```

$Check(2 = 3) = "...NG"$ $Check(2 \le 3) = "...OK"$

$Check(2 \ne 3) = "...OK"$ $Check(3 \ge 2) = "...OK"$

Input Data



Material Property Factors:

$\varphi_s := 0.90$

$\varphi_b := 0.8$

$\varphi_w := 0.67$

$\varphi_{br} := 0.8$

Load Factors:

$\alpha_L := 1.50$

$\alpha_D := 1.25$

Steel Properties:

Rolled Section: $st_{NDX} := 3$

NDX	des	fy	Fu
1	"G40.21-350W"	50 Ksi	65 Ksi
2	"G40.21-300W"	44 Ksi	65 Ksi
3	"A36"	36 Ksi	58 Ksi

$st :=$ the matrix above

$desM_{st1} := st_{st_{NDX}\,2}$ $\quad f_{y1} := st_{st_{NDX}\,3}$ $\quad F_{u1} := st_{st_{NDX}\,4}$

$\nu := 0.3$ $\quad E_s := 29000\ \text{Ksi}$ $\quad G_s := \dfrac{E_s}{2 \cdot (1 + \nu)}$ $\quad \gamma_s := 489\ \text{pcf}$

End Plate: $st_{NDX} := 1$

$desM_{st2} := st_{st_{NDX}\,2}$ $\quad f_{y2} := st_{st_{NDX}\,3}$ $\quad F_{u2} := st_{st_{NDX}\,4}$

Beam Properties:

Input	Imperial	Metric	Description
$desI_b :=$ "W24x104"			Imperial Beam Designation
$desM_b :=$ "W610x155"			Metric Beam Designation
$d := 24.06\ \text{in}$	$d = 24.06\ \text{in}$	$d = 611.1\ \text{mm}$	Depth
$b := 12.75\ \text{in}$	$b = 12.75\ \text{in}$	$b = 323.9\ \text{mm}$	Width
$t := 0.75\ \text{in}$	$t = 0.75\ \text{in}$	$t = 19.1\ \text{mm}$	Flange Thickness
$w := 0.500\ \text{in}$	$w = 0.50\ \text{in}$	$w = 12.7\ \text{mm}$	Web Thickness
$k := 1.50\ \text{in}$	$k = 1.50\ \text{in}$	$k = 38.1\ \text{mm}$	'k' Distance
$k_1 := 1.00\ \text{in}$	$k_1 = 1.00\ \text{in}$	$k_1 = 25.4\ \text{mm}$	'k1' Distance

Connection Geometry:

Input	Imperial	Metric	Description
$b_p := 14\ \text{in}$	$b_p = 14.00\ \text{in}$	$b_p = 355.6\ \text{mm}$	End Plate Width
$t_p := 1.00\ \text{in}$	$t_p = 1.00\ \text{in}$	$t_p = 25.4\ \text{mm}$	End Plate Thickness
$p_b := 3.0\ \text{in}$	$p_b = 3.00\ \text{in}$	$p_b = 76.2\ \text{mm}$	Dimension-See Detail
$p_{fo} := 1.75\ \text{in}$	$p_{fo} = 1.75\ \text{in}$	$p_{fo} = 44.4\ \text{mm}$	Dimension-See Detail
$p_{fi} := 1.75\ \text{in}$	$p_{fi} = 1.75\ \text{in}$	$p_{fi} = 44.4\ \text{mm}$	Dimension-See Detail
$d_e := 1.5\ \text{in}$	$d_e = 1.50\ \text{in}$	$d_e = 38.1\ \text{mm}$	Dimension-See Detail
$g := 5.5\ \text{in}$	$g = 5.50\ \text{in}$	$g = 139.7\ \text{mm}$	Bolt Gauge-See Detail
$t_s := 0.375\ \text{in}$	$t_s = 0.38\ \text{in}$	$t_s = 9.5\ \text{mm}$	End Plate Stiffener Thickness

$l_p := d + 2 \cdot (p_{fo} + p_b + d_e)$	$l_p = 36.56$ in	$l_p = 928.6$ mm	Length of End Plate

Plate Length Override:

$l'_p := 0$ in

```
if l'p = 0 in
  lp := lp
else
  lp := l'p
```

	$l_p = 36.56$ in	$l_p = 928.6$ mm	End Plate Thickness
$h_1 := d + p_{fo} + p_b$	$h_1 = 28.81$ in	$h_1 = 731.8$ mm	Dimension-See Detail
$h_2 := d + p_{fo}$	$h_2 = 25.81$ in	$h_2 = 655.6$ mm	Dimension-See Detail
$h_3 := d - t - p_{fi}$	$h_3 = 21.56$ in	$h_3 = 547.6$ mm	Dimension-See Detail
$h_4 := d - t - p_{fi} - p_b$	$h_4 = 18.56$ in	$h_4 = 471.4$ mm	Dimension-See Detail

Factored Design Forces

$M_f := 590.1$ K_ft	$M_f = 590.1$ K_ft	$M_f = 800.1$ kN_m
$V_f := 292.3$ K	$V_f = 292.3$ K	$V_f = 1300.2$ kN

Welding Electrodes: $Weld_{NDX} := 2$

$Weld :=$

NDX	desI	desM	Xu
1	"E60xx"	"E410xx"	60 ksi
2	"E70xx"	"E480xx"	70 ksi
3	"E80xx"	"E550xx"	80 ksi
4	"E90xx"	"E620xx"	90 ksi

$desI_{we} := Weld_{Weld_{NDX}, 2}$ $desM_{we} := Weld_{Weld_{NDX}, 3}$

$X_u := Weld_{Weld_{NDX}, 4}$

Weld Sizes: $weld_{NDX} := 13$

$weld :=$

NDX	desI	desM	D
1	""	"3mm"	0.11811 in
2	"1/8"	""	0.125 in
3	""	"4mm"	0.15748 in
4	"3/16"	""	0.1875 in
5	""	"5mm"	0.19685 in
6	""	"6mm"	0.23622 in
7	"1/4"	""	0.25 in
8	""	"7mm"	0.275591 in
9	"5/16"	""	0.3125 in
10	""	"8mm"	0.314961 in
11	""	"9mm"	0.354331 in
12	"3/8"	""	0.375 in
13	"1/2"	""	0.50 in

$desI_D := weld_{weld_{NDX}, 2}$ $desM_D := weld_{weld_{NDX}, 3}$

$D := weld_{weld_{NDX}, 4}$

Total Quantity of Bolts:

$N_b := 16$	$N_b = 16$	Total Number of Bolts
$N_{bps} := 8$	$N_{bps} = 8$	Number of Bolts per Side
$N_e := 8$	$N_e = 8$	Number of Effective Bolts

Effective Bolt Override:

$N'_e := 10$ **Add Bolts Here to Increase Shear Capacity** — Effective Fastener Override

```
if N'_e ≠ 0
    N_e := N'_e
else
    N_e := N_e
```

$N_e = 10.00$

Bolt Clearance:

$o := \frac{1}{16}\ in$ $o = 0.0625\ in$ $o = 1.5875\ mm$ — Hole Clearance on Fastener

Bolt Grade: $bg_{NDX} := 1$ **Add Data for 'Unknown'**

$bg :=$

NDX	des	fy	Fu
1	"A325"	92 Ksi	120 Ksi
2	"A490"	130 Ksi	150 Ksi
3	"A307"	50 Ksi	60 Ksi
4	"Unknown"	40 Ksi	50 Ksi

$des_b := bg_{bg_{NDX}\ 2}$ $f_{yb} := bg_{bg_{NDX}\ 3}$ $F_{ub} := bg_{bg_{NDX}\ 4}$

Threads: $th_{NDX} := 1$

$th :=$

NDX	des
1	"Included"
2	"Excluded"

$des_{th} := th_{th_{NDX}\ 2}$

Bolt Diameter: $bd_{NDX} := 5$

$bd :=$

NDX	Dia
1	0.5 in
2	0.625 in
3	0.75 in
4	0.875 in
5	1.00 in

$\phi_b := bd_{bd_{NDX}\ 2}$

$\phi_h := bd_{bd_{NDX}\ 2} + o$

```
for i ∈ [1..rows(bd)]
    bd_{i 3} := (bd_{i 2})^2 · π / 4
```

$A_b := bd_{bd_{NDX}\ 3}$

Bolts in Shear:

```
if th_NDX = 1
    v_rb := 0.70 · 0.6 · φ_b · A_b · F_ub
else
    v_rb := 0.6 · φ_b · A_b · F_ub
```

$v_{rb} = 31.7\ K$ $v_{rb} = 140.9\ kN$ — Bolt Shear Capacity

Bolts in Tension:

$t_{rb} := 0.75 \cdot \varphi_b \cdot A_b \cdot F_{ub}$ $t_{rb} = 56.55\ K$ $t_{rb} = 251.54\ kN$ — Bolt Tensile Capacity

Bolts in Bearing:

$b_{rb} := 3 \cdot \varphi_{br} \cdot F_{u2} \cdot \phi_b \cdot t_p$ $b_{rb} = 156.0\ K$ $b_{rb} = 693.9\ kN$ — Bolt Bearing Capacity

Approximate Bolt Diameter:

$$\phi_a := \sqrt{\frac{2 \cdot M_f}{\pi \cdot \varphi_b \cdot f_{yb} \cdot \left(h_1 + h_2 + h_3 + h_4\right)}}$$

$\phi_a = 0.80$ in | $\phi_a = 20.42$ mm | Approximate Bolt Diameter

Yield LIne Distance, s:

$$s := \frac{1}{2} \cdot \sqrt{b_p \cdot g}$$

$s = 4.39$ in | $s = 111.4$ mm | Dimension-See Detail

Bolt Rupture Failure:

$$M_{rb} := \varphi_b \cdot 2 \cdot t_{rb} \cdot \left(h_1 + h_2 + h_3 + h_4\right)$$

$M_{rb} = 714.32$ K_ft | $M_{rb} = 968.49$ kN_m | Bolt Tensile Moment Capacity

End Plate Failure

```
if p_fi > s
   p_fi = s
else
   p_fi = p_fi
```

$p_{fi} = 1.75$ in | $p_{fi} = 44.5$ mm

Yp Value:

if $d_e < s$

$$y_{p1} := \frac{b_p}{2} \cdot \left(h_1 \cdot \left(\frac{1}{2 \cdot d_e}\right) + h_2 \cdot \left(\frac{1}{p_{fo}}\right) + h_3 \cdot \left(\frac{1}{p_{fi}}\right) + h_4 \cdot \left(\frac{1}{s}\right)\right)$$

$$y_{p2} := \frac{2}{g} \cdot \left(h_1 \cdot \left(d_e + \frac{p_b}{4}\right) + h_2 \cdot \left(p_{fo} + 3 \cdot \frac{p_b}{4}\right) + h_3 \cdot \left(p_{fi} + \frac{p_b}{4}\right) + h_4 \cdot \left(s + 3 \cdot \frac{p_b}{4}\right) + p_b^{\,2}\right)$$

$$y_{p3} := g$$

$$y_p := y_{p1} + y_{p2} + y_{p3}$$ **Case 1**

else

$$y_{p1} := \frac{b_p}{2} \cdot \left(h_1 \cdot \left(\frac{1}{s}\right) + h_2 \cdot \left(\frac{1}{p_{fo}}\right) + h_3 \cdot \left(\frac{1}{p_{fi}}\right) + h_4 \cdot \left(\frac{1}{s}\right)\right)$$

$$y_{p2} := \frac{2}{g} \cdot \left(h_1 \cdot \left(d_e + \frac{p_b}{4}\right) + h_2 \cdot \left(p_{fo} + 3 \cdot \frac{p_b}{4}\right) + h_3 \cdot \left(p_{fi} + \frac{p_b}{4}\right) + h_4 \cdot \left(s + 3 \cdot \frac{p_b}{4}\right) + p_b^{\,2}\right)$$

$$y_{p3} := g$$

$$y_p := y_{p1} + y_{p2} + y_{p3}$$ **Case 2**

$y_p = 420.60$ in | $y_p = 10.68$ m

End Plate Thickness:

$$t'_p := \sqrt{\frac{1.11 \cdot \varphi_b \cdot M_f}{\varphi_s \cdot f_{y1} \cdot y_p}}$$

$t'_p = 0.68$ in | $t'_p = 17.25$ mm

Moment Capacity of End Plate: c b a

$$M_{rp} := \varphi_s \cdot f_{y2} \cdot t_p^{\,2} \cdot y_p$$

$M_{rp} = 1577.2$ K_ft | $M_{rp} = 2138.5$ kN_m

Design of End Plate Stiffener:

$h_s := p_{fo} + p_b + d_e$	$h_s = 6.25$ in	$h_s = 158.75$ mm	Width of Stiffener Plate
$l_s := \frac{h_s}{\tan(30\ °)}$	$l_s = 10.83$ in	$l_s = 274.96$ mm	Length of Stiffener Plate

Capacity of Bolts:

Shear

$V_{rb} := v_{rb} \cdot N_e$ | $V_{rb} = 316.67$ K | $V_{rb} = 1408.63$ kN

Bearing

$B_{rb} := b_{rb} \cdot N_e$ | $B_{rb} = 1560.00$ K | $B_{rb} = 6939.23$ kN

Tearout

$A_v := \left(p_b \cdot 2 + p_{fo} + p_{fi} + t + d_e - 3.5 \cdot \phi_h\right) \cdot t_p \cdot 2$

$A_v = 16.06\ in^2$ | $A_v = 10362.88\ mm^2$

$A_t := \left(b_p - g - \phi_h\right) \cdot t_p$ | $A_t = 7.44\ in^2$ | $A_t = 4798.38\ mm^2$

$T_{rb} := A_v \cdot \varphi_s \cdot 0.66 \cdot f_{y1} + A_t \cdot \varphi_s \cdot f_{y1}$

$T_{rb} = 584.46$ K | $T_{rb} = 2599.79$ kN

Minimum Bolt Capacity

$V_r := \min\left(\left[\ V_{rb}\ \ B_{rb}\ \ T_{rb}\ \right]\right)$ | $V_r = 316.67$ K | $V_r = 1408.63$ kN

$Check\ \left(V_r \geq V_f\right) =$ "...OK"

Weld Resistance:

Weld Material Resistance

$v_{rw} := \varphi_w \cdot 0.67 \cdot X_u \cdot \frac{1}{\sqrt{2}}$	$v_{rw} = 22.22$ ksi	$v_{rw} = 153.2$ MPa	Weld Material Resistance

Base Metal Resistance

$v_{rb} := \varphi_w \cdot f_{y1}$	$v_{rb} = 24.12$ Ksi	$v_{rb} = 166.3$ MPa	Base Material Resistance
$v_r := \min\left(\left[\ v_{rw}\ \ v_{rb}\ \right]\right)$	$v_r = 22.22$ Ksi	$v_r = 153.2$ MPa	Min Resistance of Weld

Moment of Inertia

$Ix := \frac{1}{12} \cdot \left(b \cdot d^3 - (b - w) \cdot (d - 2 \cdot t)^3\right)$

	$Ix = 3077.23\ in^4$	$Ix = 1.28 \cdot 10^9\ mm^4$	Moment of Inertia of Section
$d' := d + 2 \cdot D$	$d' = 25.06$ in	$d' = 636.52$ mm	
$b' := b + 2 \cdot D$	$b' = 13.75$ in	$b' = 349.25$ mm	
$t' := t + 2 \cdot D$	$t' = 1.75$ in	$t' = 44.45$ mm	
$w' := w + 2 \cdot D$	$w' = 1.50$ in	$w' = 38.10$ mm	

$Ix' := \frac{1}{12} \cdot \left(b' \cdot d'^3 - (b' - w') \cdot (d' - 2 \cdot t')^3\right)$

	$Ix' = 7802.26\ in^4$	$Ix' = 3.25 \cdot 10^9\ mm^4$	Ix of Section + Weld
$Ix_w := Ix' - Ix$	$Ix_w = 4725.03\ in^4$	$Ix_w = 1.97 \cdot 10^9\ mm^4$	Moment of Inertia of Weld

Moment Resistance of Weld

$Sx' := \frac{2 \cdot Ix_w}{d'}$ $\quad Sx' = 377.10\ in^3$ $\quad Sx' = 6.18\ m^2\ mm$

$M_{rw} := v_r \cdot Sx'$ $\quad M_{rw} = 698.2\ K\_ft$ $\quad M_{rw} = 946.7\ kN\_m$

Shear Resistance of Weld

$V_{rw} := 2 \cdot (d - 2 \cdot k) \cdot D \cdot v_r$ $\quad V_{rw} = 467.94\ K$ $\quad V_{rw} = 2081.50\ kN$

Summary:

Material Property Factor (Bolts Shear or Tension)	$\varphi_b = 0.8$	
Material Property Factor (Rolled Steel)	$\varphi_s = 0.9$	
Dead Load Factor	$\alpha_D = 1.25$	
Live Load Factor	$\alpha_L = 1.5$	
Steel		
Designation (Beam)	$desM_{st1}$ = "A36"	
Yield Strength (Beam)	$f_{y1} = 36$ Ksi	$f_{y1} = 248$ MPa
Ultimate Strength (Beam)	$F_{u1} = 58$ Ksi	$F_{u1} = 400$ MPa
Designation (End Plate)	$desM_{st2}$ = "G40.21-350W"	
Yield Strength (End Plate)	$f_{y2} = 50$ Ksi	$f_{y2} = 345$ MPa
Ultimate Strength (End Plate)	$F_{u2} = 65$ Ksi	$F_{u2} = 448$ MPa
Young's Modulus	$E_s = 29000$ Ksi	$E_s = 2.00 \cdot 10^5$ MPa
Shear Modulus	$G_s = 11153.8462$ Ksi	$G_s = 76903$ MPa
Density	$\gamma_s = 489$ pcf	$\gamma_s = 76.8$ kNpcm
Beam Designation (Imperial)	$desI_b$:= "W16x26"	
Beam Designation (Metric)	$desM_b$:= "W410x39"	
Welds		
Designation (Welding Electrode)	$desI_{we}$ = "E70xx"	$desM_{we}$ = "E480xx"
Ultimate Strength (Welding Electrode)	$X_u = 70$ Ksi	$X_u = 483$ MPa
Designation (Fillet Weld Size)	$desI_D$ = "1/2"	$desM_D$ = ""
Dimension (Fillet Weld Size)	$D = 0.5$ in	$D = 12.7$ mm
Bolts		
Designation	des_b = "A325"	
Yield Strength	$f_{yb} = 92$ Ksi	$f_{yb} = 634$ MPa
Ultimate Strength	$F_{ub} = 120$ Ksi	$F_{ub} = 827$ MPa
Threads Included/Excluded from Shear Plane	des_{th} = "Included"	
Diameter	$\phi_b = 1$ in	$\phi_b = 25.4$ mm
Hole Diameter (plus 1/16")	$\phi_h = 1.0625$ in	$\phi_h = 27.0$ mm
Area	$A_b = 0.785\ in^2$	$A_b = 507\ mm^2$
Total Number of Bolts	$N_b = 16$	
Number of Bolts per Side	$N_{bps} = 8$	
Number of Effective Bolts	$N_e = 10$	
Shear Resistance	$V_{rb} = 316.7$ K	$V_{rb} = 1408.6$ kN
Tension Resistance	$T_{rb} = 584.5$ K	$T_{rb} = 2599.8$ kN

Connection Geometry

End Plate Width	$b_p = 14.00$ in	$b_p = 355.6$ mm
Bolt Gauge	$g = 5.50$ in	$g = 139.7$ mm
Thickness of End Plate	$t_p = 1.00$ in	$t_p = 25.4$ mm

$Check\left(t_p \geq t'_p\right) = "...OK"$

Thickness of End Plate Stiffener	$t_s = 0.38$ in	$t_s = 9.5$ mm
Width of End Plate Stiffener	$h_s = 6.25$ in	$h_s = 158.75$ mm

$Check\left(\frac{h_s}{t_s} \leq 0.56 \cdot \sqrt{\frac{E_s}{f_{y2}}}\right) = "...NG"$ **If 'NG' Increase Thickness of Stiffener**

Bolt Moment Arm	$h_1 = 28.81$ in	$h_1 = 731.8$ mm
Bolt Moment Arm	$h_2 = 25.81$ in	$h_2 = 655.6$ mm
Bolt Moment Arm	$h_3 = 21.56$ in	$h_3 = 547.6$ mm
Bolt Moment Arm	$h_4 = 18.56$ in	$h_4 = 471.4$ mm
Bolt Spacing (see Diagram)	$d_e = 1.50$ in	$d_e = 38.1$ mm
Bolt Spacing (see Diagram)	$p_{fo} = 1.75$ in	$p_{fo} = 44.5$ mm
Bolt Spacing (see Diagram)	$p_{fi} = 1.75$ in	$p_{fi} = 44.5$ mm
Bolt Spacing (see Diagram)	$p_b = 3.00$ in	$p_b = 76.2$ mm

Factored Loads

Factored Moment	$M_f = 590.1$ K_ft	$M_f = 800.1$ kN_m
Factored Shear	$V_f = 292.3$ K	$V_f = 1300.2$ kN
Moment Resistance of End Plate	$M_{rp} = 1577.2$ K_ft	$M_{rp} = 2138.5$ kN_m

$Check\left(M_{rp} \geq M_f\right) = "...OK"$ $Check\left(\frac{M_{rp}}{\varphi_s} \geq M_f\right) = "...OK"$ **Allow for Overload**

Moment Resistance of Bolts	$M_{rb} = 714.3$ K_ft	$M_{rb} = 968.5$ kN_m
Minimum Shear Resistance of Bolts	$V_r = 316.67$ K	$V_r = 1408.63$ kN

$Check\left(V_r \geq V_f\right) = "...OK"$ $Check\left(\frac{V_r}{\varphi_s} \geq V_f\right) = "...OK"$ **Allow for Overload. If 'NG' Override Ne for Bolts.**

Weld Material Resistance	$v_{rw} = 22.22$ ksi	$v_{rw} = 153.2$ MPa
Base Material Resistance	$v_{rb} = 24.12$ Ksi	$v_{rb} = 166.3$ MPa
Min Resistance of Weld	$v_r = 22.22$ Ksi	$v_r = 153.2$ MPa
Moment of Inertia of Section	$Ix = 3077.23\ in^4$	$Ix = 1.28 \cdot 10^9\ mm^4$
Ix of Section + Weld	$Ix' = 7802.26\ in^4$	$Ix' = 3.25 \cdot 10^9\ mm^4$
Moment of Inertia of Weld	$Ix_w = 4725.03\ in^4$	$Ix_w = 1.97 \cdot 10^9\ mm^4$
Moment Resistance of Weld	$M_{rw} = 698.2$ K_ft	$M_{rw} = 946.7$ kN_m

$Check\left(M_{rw} \geq M_f\right) = "...OK"$ $Check\left(\frac{M_{rw}}{\varphi_s} \geq M_f\right) = "...OK"$ **Allow for Overload. If 'NG' Increase Weld**

Shear Resistance of Weld	$V_{rw} = 467.94$ K	$V_{rw} = 2081.50$ kN

$Check\left(V_{rw} \geq V_f\right) = "...OK"$ $Check\left(\frac{V_{rw}}{\varphi_s} \geq V_f\right) = "...OK"$ **Allow for Overload**