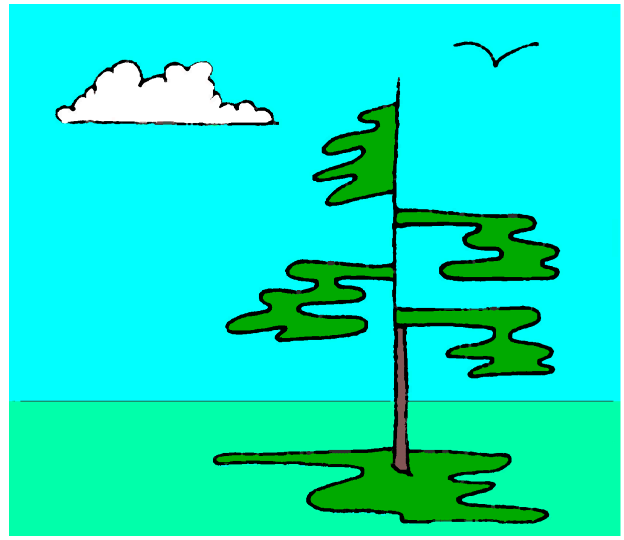
NorthWoods Software



Program Name: Weld-Group

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21-02-15

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**				

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

$pli := \frac{lbf}{in}$

Pressure

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

Subgrade Modulus

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

Pressure per Depth

$psfpf := \frac{psf}{ft}$ $kPapm := \frac{kPa}{m}$

Force

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

Velocity

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

User Defined Functions:

c

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

b

$Check(2 = 3) = "...NG"$

$Check(2 \neq 3) = "...OK"$

a

$Check(2 \leq 3) = "...OK"$

$Check(3 \geq 2) = "...OK"$

Input Data

Material Property Factors:

$\varphi_s := 0.90$

$\varphi_w := 0.67$

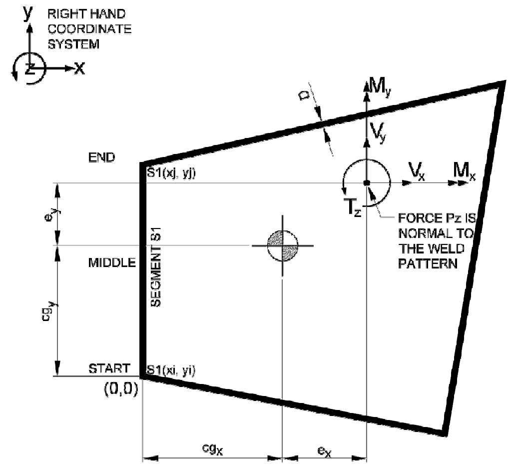
Load Factors:

$\alpha_L := 1.50$

$\alpha_D := 1.25$

$Check\left(\alpha_D \geq 1.25\right) = \text{"...OK"}$

$Check\left(\alpha_L \geq 1.5\right) = \text{"...OK"}$



Applied Factored Loads:

$P_{fz} := 15\ K$	$P_{fz} = 66.72\ kN$	Axial Load
$V_{fx} := 0\ K$	$V_{fx} = 0.00\ kN$	Shear (X-Axis)
$V_{fy} := 0\ K$	$V_{fy} = 0.00\ kN$	Shear (Y-Axis)
$M_{fx} := 20\ K\_ft$	$M_{fx} = 27.12\ kN\_m$	Moment (X-Axis)
$M_{fy} := 0\ K\_ft$	$M_{fy} = 0.00\ kN\_m$	Moment (Y-Axis)
$T_{fz} := 0\ K\_ft$	$T_{fz} = 0.00\ kN\_m$	Torsion (Z-Axis)

Load Eccentricity:

$e_x := .5\ in$	$e_x = 12.7\ mm$	X-Axis Direction
$e_y := .5\ in$	$e_y = 12.7\ mm$	Y-Axis Direction
$e_z := 0\ in$	$e_z = 0.0\ mm$	Z-Axis Direction

Segment Input Data:

s	xi	yi	xj	yj
1	0 in	0 in	0 in	8 in
2	0 in	8 in	.5 in	8 in
3	.5 in	8 in	.5 in	0.5 in
4	.5 in	0.5 in	3 in	0.5 in
5	3 in	0.5 in	3 in	0 in
6	3 in	0 in	0 in	0 in

$pts :=$ (matrix above)

Enter data into the matrix. Each row is for a Segment with (xi, yi, xj, and yj) entered in columns 2, 3, 4 and 5, being the coordinates for the x and y axis, start point and stop point. Segment numbers have to be incremental from one and are entered in the first column in a downward direction. For example, first row, segment number from S1(xi, yi) to S1(xj, yj). Stretch the matrix downwards or upwards to accommodate number of segments. To stretch the matrix, click on non data part of the matrix and grab the grip at the bottom right corner, moving vertically only, to increase or decrease the matrix size.

$pts' := \text{submatrix}\left(pts, 1, \text{rows}\left(pts\right), 2, 5\right)$ Used for Summary and Plotting Shape

$c := 0$

for $c \in \left[1..\text{rows}\left(pts'\right)\right]$

$ptsn_{c\,1} := pts'_{c\,1} \cdot \frac{1}{in}$

$ptsn_{c\,2} := pts'_{c\,2} \cdot \frac{1}{in}$

$ptsn_{c\,3} := pts'_{c\,3} \cdot \frac{1}{in}$

$ptsn_{c\,4} := pts'_{c\,4} \cdot \frac{1}{in}$

$$pts' = \begin{bmatrix} 0.00 & 0.00 & 0.00 & 8.00 \\ 0.00 & 8.00 & 0.50 & 8.00 \\ 0.50 & 8.00 & 0.50 & 0.50 \\ 0.50 & 0.50 & 3.00 & 0.50 \\ 3.00 & 0.50 & 3.00 & 0.00 \\ 3.00 & 0.00 & 0.00 & 0.00 \end{bmatrix} in$$

$c := 0$

for $c \in \left[1..\text{rows}\left(ptsn\right)\right]$

$weld_{c\,1} := ptsn_{c\,1}$

$weld_{c\,2} := ptsn_{c\,2}$

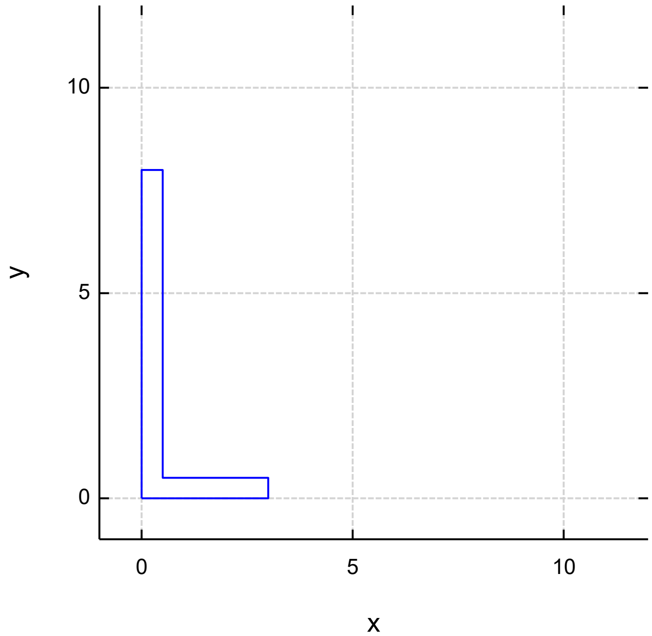
$c := c + 1$

$weld_{c\,1} := ptsn_{1\,1}$

$weld_{c\,2} := ptsn_{1\,2}$

$$ptsn = \begin{bmatrix} 0.00 & 0.00 & 0.00 & 8.00 \\ 0.00 & 8.00 & 0.50 & 8.00 \\ 0.50 & 8.00 & 0.50 & 0.50 \\ 0.50 & 0.50 & 3.00 & 0.50 \\ 3.00 & 0.50 & 3.00 & 0.00 \\ 3.00 & 0.00 & 0.00 & 0.00 \end{bmatrix}$$

Weld Pattern



$$weld = \begin{bmatrix} 0.00 & 0.00 \\ 0.00 & 8.00 \\ 0.50 & 8.00 \\ 0.50 & 0.50 \\ 3.00 & 0.50 \\ 3.00 & 0.00 \\ 0.00 & 0.00 \end{bmatrix}$$

$weld$

Base Metal Steel Properties: $stl_{NDX} := 2$

$stl :=$

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

$desI_1 := stl_{stl_{NDX}\,2}$ $f_{y1} := stl_{stl_{NDX}\,3}$

$F_{u1} := stl_{stl_{NDX}\,4}$

$E_s := 29000\ \text{Ksi}$ $G_s := 10.9\ \text{Ksi}$ $\gamma_s := 489\ \text{pcf}$

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

$we :=$

NDX	DesI	DesM	UTS
1	"E60xx"	"E410xx"	60 ksi
2	"E70xx"	"E480xx"	70 ksi
3	"E80xx"	"E550xx"	80 ksi
4	"E90xx"	"E620xx"	90 ksi

$desI_w := we_{we_{NDX}\,2}$ $X_u := we_{we_{NDX}\,4}$

$desM_w := we_{we_{NDX}\,3}$

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

$ws :=$

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	"7/16"	""	0.4375 in

$desI_D := ws_{ws_{NDX}\,2}$ $desM_D := ws_{ws_{NDX}\,3}$

$D := ws_{ws_{NDX}\,4}$

Weld Strength:

$v_{rw} := \varphi_w \cdot 0.67 \cdot X_u$ $v_{rw} = 31.4$ ksi $v_{rw} = 216.7$ MPa Limit Weld Stress

Base Strength:

$v_{rb} := \varphi_s \cdot f_{y1}$ $v_{rb} = 39.6$ Ksi $v_{rb} = 273.0$ MPa Limit Base Metal Stress

Maximum Strength per Unit Length:

$v'_{rw} := v_{rw} \cdot D \cdot \frac{1}{\sqrt{2}}$ $v'_{rw} = 9.7$ Kpi $v'_{rw} = 1.7$ kNpmm Weld Resist per Unit Len

$v'_{rb} := v_{rb} \cdot D$ $v'_{rb} = 17.3$ Kpi $v'_{rb} = 3.0$ kNpmm Base Resist per Unit Len

$v_r := \min\left(\left[\, v'_{rw} \;\; v'_{rb} \,\right]\right)$ $v_r = 9.7$ Kpi $v_r = 1.7$ kNpmm Min Resist per Unit Len

Weld Properties:

```
for r ∈ [1..rows(pts)]
    pts[r,6]  := (pts[r,2] + pts[r,4]) / 2              cx
    pts[r,7]  := (pts[r,3] + pts[r,5]) / 2              cy
    pts[r,8]  := pts[r,4] − pts[r,2]                    m
    pts[r,9]  := pts[r,5] − pts[r,3]                    n
    pts[r,10] := √((pts[r,8])² + (pts[r,9])²)           L
    pts[r,11] := pts[r,10] · (pts[r,9])² / 12           Ixx
    pts[r,12] := pts[r,10] · (pts[r,8])² / 12           Iyy
    pts[r,13] := pts[r,10] · pts[r,6]                   L cx
    pts[r,14] := pts[r,10] · pts[r,7]                   L cy
```

for $r \in [1..\text{rows}(pts)]$

$pts_{r\,15} := pts_{r\,6} - cg_x$

$pts_{r\,16} := pts_{r\,7} - cg_y$

$pts_{r\,17} := pts_{r\,11} + pts_{r\,10} \cdot pts_{r\,16}^{2}$

$pts_{r\,18} := pts_{r\,12} + pts_{r\,10} \cdot \left(pts_{r\,15}\right)^{2}$

$pts_{r\,19} := pts_{r\,10} \cdot pts_{r\,15} \cdot pts_{r\,16}$

$pts_{r\,20} := pts_{r\,2} - cg_x$

$pts_{r\,21} := pts_{r\,3} - cg_y$

$pts_{r\,22} := pts_{r\,4} - cg_x$

$pts_{r\,23} := pts_{r\,5} - cg_y$

d_x d_y I'_{xx} I'_{yy} I'_{xy} d_{xi} d_{yi} d_{xj} d_{yj}

$A := \sum \text{col}(pts, 10)$	$A = 22.00\ \text{in}$	$A = 558.8\ \text{mm}$	Total Length of Weld
$cg_x := \sum \left(\frac{\text{col}(pts, 13)}{A}\right)$	$cg_x = 0.65\ \text{in}$	$cg_x = 16.5\ \text{mm}$	Centroid of Weld X-Axis
$cg_y := \sum \left(\frac{\text{col}(pts, 14)}{A}\right)$	$cg_y = 3.15\ \text{in}$	$cg_y = 80.0\ \text{mm}$	Centroid of Weld Y-Axis
$I'_{xx} := \sum \text{col}(pts, 17)$	$I'_{xx} = 156.0\ \text{in}^3$	$I'_{xx} = 2.56 \cdot 10^{6}\ \text{mm}^3$	Moment of Inertia (X-Axis)
$I'_{yy} := \sum \text{col}(pts, 18)$	$I'_{yy} = 15.1\ \text{in}^3$	$I'_{yy} = 2.48 \cdot 10^{5}\ \text{mm}^3$	Moment of Inertia (Y-Axis)
$I'_{xy} := \sum \text{col}(pts, 19)$	$I'_{xy} = -25.4\ \text{in}^3$	$I'_{xy} = -4.15 \cdot 10^{5}\ \text{mm}^3$	Product of Inertia
$I'_p := I'_{xx} + I'_{yy}$	$I'_p = 171.1\ \text{in}^3$	$I'_p = 2.80 \cdot 10^{6}\ \text{mm}^3$	Polar Moment of Inertia
$I'_{prod} := I'_{xx} \cdot I'_{yy} - I'_{xy}{}^{2}$	$I'_{prod} = 1719.4\ \text{in}^6$	$I'_{prod} = 4.62 \cdot 10^{11}\ \text{mm}^6$	Product of Inertia

Load Distance from Centroid:

$e'_x := e_x - cg_x$	$e'_x = -0.15\ \text{in}$	$e'_x = -3.7523\ \text{mm}$	X-Axis Direction
$e'_y := e_y - cg_y$	$e'_y = -2.65\ \text{in}$	$e'_y = -67.2523\ \text{mm}$	Y-Axis Direction
$e'_z := e_z$	$e'_z = 0.00\ \text{in}$	$e'_z = 0\ \text{mm}$	Z-Axis Direction

Stress from Applied Factored Loads:

$\sigma_{fx} := \frac{V_{fx}}{A}$	$\sigma_{fx} = 0.00\ \text{Kpi}$	$\sigma_{fx} = 0\ \text{kNpmm}$	X-Axis Direction
$\sigma_{fy} := \frac{V_{fy}}{A}$	$\sigma_{fy} = 0\ \text{Kpi}$	$\sigma_{fy} = 0\ \text{kNpmm}$	Y-Axis Direction
$\sigma_{fz} := \frac{P_{fz}}{A}$	$\sigma_{fz} = 0.6818\ \text{Kpi}$	$\sigma_{fz} = 0.1194\ \text{kNpmm}$	Z-Axis Direction

Load at Weld Group Centroid:

$d_x := e_x - cg_x$	$d_x = -0.15\ \text{in}$	$d_x = -3.75\ \text{mm}$
$d_y := e_y - cg_y$	$d_y = -2.6477\ \text{in}$	$d_y = -67.2523\ \text{mm}$
$d_z := e_z$	$d_z = 0\ \text{in}$	$d_z = 0\ \text{mm}$
$M'_{fx} := M_{fx} - V_{fy} \cdot d_z + P_{fz} \cdot d_y$	$M'_{fx} = 16.69\ \text{K\_ft}$	$M'_{fx} = 16.6903\ \text{K\_ft}$
$M'_{fy} := M_{fy} + V_{fx} \cdot d_z - P_{fz} \cdot d_x$	$M'_{fy} = 0.1847\ \text{K\_ft}$	$M'_{fy} = 0.1847\ \text{K\_ft}$
$T'_{fz} := T_{fz} - V_{fx} \cdot d_y + V_{fy} \cdot d_x$	$T'_{fz} = 0\ \text{K\_ft}$	$T'_{fz} = 0\ \text{K\_ft}$

for $r \in [1..\mathrm{rows}(pts)]$

  if $pts_{r\,10} = 0$ in

$pts_{r\,24} := 0$ pli	σz y from Mx	Stress at Start of Segment
$pts_{r\,25} := 0$ pli	σz y from My	
$pts_{r\,26} := 0$ pli	σz x from Mx	
$pts_{r\,27} := 0$ pli	σz x from My	
$pts_{r\,28} := pts_{r\,24} + pts_{r\,25} + pts_{r\,26} + pts_{r\,27}$	Σσz from M	
$pts_{r\,29} := pts_{r\,28} + \sigma_{fz}$	Σσz	
$pts_{r\,30} := 0$ pli	σx from T	
$pts_{r\,31} := pts_{r\,30} + \sigma_{fx}$	Σσx	
$pts_{r\,32} := 0$ pli	σy from T	
$pts_{r\,33} := pts_{r\,32} + \sigma_{fy}$	Σσy	
$pts_{r\,34} := \sqrt{pts_{r\,29}^{2} + pts_{r\,31}^{2} + pts_{r\,33}^{2}}$	σy combined	
$pts_{r\,35} := 0$ pli	σz y from Mx	

  else

$pts_{r\,24} := \dfrac{pts_{r\,21} \cdot M'_{fx} \cdot I'_{yy}}{I'_{prod}}$	σz y from My	
$pts_{r\,25} := \dfrac{pts_{r\,21} \cdot M'_{fy} \cdot I'_{xy}}{I'_{prod}}$	σz x from Mx	
$pts_{r\,26} := \dfrac{\left(-1 \cdot pts_{r\,20}\right) \cdot M'_{fx} \cdot I'_{xy}}{I'_{prod}}$	σz x from My	
$pts_{r\,27} := \dfrac{\left(-1 \cdot pts_{r\,20}\right) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$	Σσz from M	
$pts_{r\,28} := pts_{r\,24} + pts_{r\,25} + pts_{r\,26} + pts_{r\,27}$	Σσz	
$pts_{r\,29} := pts_{r\,28} + \sigma_{fz}$	σx from T	
$pts_{r\,30} := \dfrac{\left(-1 \cdot pts_{r\,21}\right) \cdot T'_{fz}}{I'_{p}}$	Σσx	
$pts_{r\,31} := pts_{r\,30} + \sigma_{fx}$	σy from T	
$pts_{r\,32} := \dfrac{pts_{r\,20} \cdot T'_{fz}}{I'_{p}}$	Σσy	
$pts_{r\,33} := pts_{r\,32} + \sigma_{fy}$	σy combined	
$pts_{r\,34} := \sqrt{\left(pts_{r\,29}\right)^{2} + \left(pts_{r\,31}\right)^{2} + \left(pts_{r\,33}\right)^{2}}$	Σσy	Stress at Start of Segment
$pts_{r\,35} := \dfrac{pts_{r\,23} \cdot M'_{fx} \cdot I'_{yy}}{I'_{prod}}$	σz y from Mx	Stress at End of Segment

for $r \in [1..rows(pts)]$

if $pts_{r\,10} = 0$ in

$pts_{r\,36} := 0$ pli — σz y from My

$pts_{r\,37} := 0$ pli — σz x from Mx

$pts_{r\,38} := 0$ pli — σz x from My

$pts_{r\,39} := pts_{r\,35} + pts_{r\,36} + pts_{r\,37} + pts_{r\,38}$ — Σσz from M

$pts_{r\,40} := \left(pts_{r\,39} + \sigma_{fz}\right)$ — Σσz

$pts_{r\,41} := 0$ pli — σx from T

$pts_{r\,42} := pts_{r\,41} + \sigma_{fx}$ — Σσx

$pts_{r\,43} := 0$ pli — σy from T

$pts_{r\,44} := pts_{r\,43} + \sigma_{fy}$ — Σσy

$pts_{r\,45} := \sqrt{\left(pts_{r\,40}\right)^2 + \left(pts_{r\,42}\right)^2 + \left(pts_{r\,44}\right)^2}$ — σy combined

$pts_{r\,46} := 0$ pli — σz y from Mx

$pts_{r\,47} := 0$ pli — σz y from My

$pts_{r\,48} := 0$ pli — σz x from Mx

else

$pts_{r\,36} := \dfrac{pts_{r\,23} \cdot M'_{fy} \cdot I'_{xy}}{I'_{prod}}$ — σz y from My

$pts_{r\,37} := \dfrac{\left(-1 \cdot pts_{r\,22}\right) \cdot M'_{fx} \cdot I'_{xy}}{I'_{prod}}$ — σz x from Mx

$pts_{r\,38} := \dfrac{\left(-1 \cdot pts_{r\,22}\right) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$ — σz x from My

$pts_{r\,39} := pts_{r\,35} + pts_{r\,36} + pts_{r\,37} + pts_{r\,38}$ — Σσz from M

$pts_{r\,40} := \left(pts_{r\,39} + \sigma_{fz}\right)$ — Σσz

$pts_{r\,41} := \left(-\dfrac{1 \cdot pts_{r\,23} \cdot T'_{fz}}{I'_{p}}\right)$ — σx from T

$pts_{r\,42} := pts_{r\,41} + \sigma_{fx}$ — Σσx

$pts_{r\,43} := \dfrac{pts_{r\,22} \cdot T'_{fz}}{I'_{p}}$ — σy from T

$pts_{r\,44} := pts_{r\,43} + \sigma_{fy}$ — Σσy

$pts_{r\,45} := \sqrt{\left(pts_{r\,40}\right)^2 + \left(pts_{r\,42}\right)^2 + \left(pts_{r\,44}\right)^2}$ — σy combined — Stress at End of Segment

$pts_{r\,46} := \dfrac{pts_{r\,16} \cdot M'_{fx} \cdot I'_{yy}}{I'_{prod}}$ — σz y from Mx — Stress at Midpoint of Segment

$pts_{r\,47} := \dfrac{pts_{r\,16} \cdot M'_{fy} \cdot I'_{xy}}{I'_{prod}}$ — σz y from My

$pts_{r\,48} := \dfrac{\left(-1 \cdot pts_{r\,15} \cdot M'_{fx} \cdot I'_{xy}\right)}{I'_{prod}}$

$$\text{for } r \in [1..\text{rows}(pts)]$$

$\quad$ if $pts_{r\,10} = 0\ in$

$pts_{r\,49} := 0\ pli$	σz x from Mx σz x from My
$pts_{r\,50} := pts_{r\,46} + pts_{r\,47} + pts_{r\,48} + pts_{r\,49}$	σz frin M
$pts_{r\,51} := pts_{r\,50} + \sigma_{fz}$	σz Total
$pts_{r\,52} := 0\ pli$	σx from T
$pts_{r\,53} := pts_{r\,52} \cdot \sigma_{fx}$	σx Combined
$pts_{r\,54} := 0\ pli$	σy from T
$pts_{r\,55} := pts_{r\,54} + \sigma_{fy}$	σy Combined
$pts_{r\,56} := \sqrt{(pts_{r\,51})^2 + (pts_{r\,53})^2 + (pts_{r\,55})^2}$	Total σ

$\quad$ else

$pts_{r\,49} := \dfrac{(-1 \cdot pts_{r\,15}) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$	σz x from My
$pts_{r\,50} := pts_{r\,46} + pts_{r\,47} + pts_{r\,48} + pts_{r\,49}$	σz frin M
$pts_{r\,51} := pts_{r\,50} + \sigma_{fz}$	σz Total
$pts_{r\,52} := \dfrac{(-1 \cdot pts_{r\,16}) \cdot T'_{fz}}{I'_{p}}$	σx from T
$pts_{r\,53} := (pts_{r\,52} + \sigma_{fx})$	σx Combined
$pts_{r\,54} := \dfrac{pts_{r\,15} \cdot T'_{fz}}{I'_{p}}$	σy from T
$pts_{r\,55} := pts_{r\,54} + \sigma_{fy}$	σy Combined
$pts_{r\,56} := \sqrt{(pts_{r\,51})^2 + (pts_{r\,53})^2 + (pts_{r\,55})^2}$	Total σ — Stress at Midpoint of Segment

Max and Min Stress in Segment:

$op_1 := \max(\text{col}(pts, 34))$	$op_1 = 8.68$ Kpi	$op_1 = 1.52$ kNpmm	Max Stress at Start of Segment
$op'_1 := \min(\text{col}(pts, 34))$	$op'_1 = 2$ Kpi	$op'_1 = 0$ kNpmm	Min Stress at Start of Segment
$op_2 := \max(\text{col}(pts, 45))$	$op_2 = 8.68$ Kpi	$op_2 = 1.52$ kNpmm	Max Stress at End of Segment
$op'_2 := \max(\text{col}(pts, 45))$	$op'_2 = 8.6768$ Kpi	$op'_2 = 1.5195$ kNpmm	Min Stress at End of Segment
$op_3 := \max(\text{col}(pts, 56))$	$op_3 = 7.99$ Kpi	$op_3 = 1.4$ kNpmm	Max Stress at Middle of Segment
$op'_3 := \min(\text{col}(pts, 56))$	$op'_3 = 0.3747$ Kpi	$op'_3 = 0.0656$ kNpmm	Min Stress at Middle of Segment

Max and Min Stress in Welds:

$op_{max} := \max([\,op_1\ op_2\ op_3\,])$	$op_{max} = 8.68$ Kpi	$op_{max} = 1.52$ kNpmm	Maximum Stress in Segment
$op'_{min} := \min([\,op_1\ op_2\ op_3\,])$	$op'_{min} = 7.9887$ Kpi	$op'_{min} = 1.399$ kNpmm	Minimum Stress in Segment
	$v_r = 9.72$ Kpi	$v_r = 1.7024$ kNpmm	Weld Resistance:

$Check(v_r \geq op_{max}) =$ "...OK"

$Check(v_r \geq 0.95 \cdot op_{max}) =$ "...OK"

Summary:

Material Property Factors

Rolled Sections	$\varphi_s = 0.9$	
Weld	$\varphi_w = 0.67$	
Dead Load Factor	$\alpha_D = 1.25$	
Live Load Factor	$\alpha_L = 1.5$	

$Check\left(\alpha_D \geq 1.25\right) = \text{"...OK"}$

$Check\left(\alpha_L \geq 1.5\right) = \text{"...OK"}$

Applied Factored Loads:

Axial Load	$P_{fz} = 15$ K	$P_{fz} = 66.7233$ kN
Shear (X-Axis)	$V_{fx} = 0$ K	$V_{fx} = 0$ kN
Shear (Y-Axis)	$V_{fy} = 0$ K	$V_{fy} = 0$ kN
Moment (X-Axis)	$M_{fx} = 20$ K_ft	$M_{fx} = 27.1164$ kN_m
Moment (Y-Axis)	$M_{fy} = 0$ K_ft	$M_{fy} = 0$ kN_m
Torsion (Z-Axis)	$T_{fz} = 0$ K_ft	$T_{fz} = 0$ kN_m

Load Eccentricity from Origin:

X-Axis Direction	$e_x = 0.5$ in	$e_x = 12.7$ mm
Y-Axis Direction	$e_y = 0.5$ in	$e_y = 12.7$ mm
Z-Axis Direction	$e_z = 0$ in	$e_z = 0$ mm

Segment Input Data:

Row Represents Segment Number
Columns represent S(xi, yi, xj, yj) coordinates

$$pts' = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 8.0 \\ 0.0 & 8.0 & 0.5 & 8.0 \\ 0.5 & 8.0 & 0.5 & 0.5 \\ 0.5 & 0.5 & 3.0 & 0.5 \\ 3.0 & 0.5 & 3.0 & 0.0 \\ 3.0 & 0.0 & 0.0 & 0.0 \end{bmatrix} \text{ in} \qquad pts' = \begin{bmatrix} 0 & 0 & 0 & 203.2 \\ 0 & 203.2 & 12.7 & 203.2 \\ 12.7 & 203.2 & 12.7 & 12.7 \\ 12.7 & 12.7 & 76.2 & 12.7 \\ 76.2 & 12.7 & 76.2 & 0 \\ 76.2 & 0 & 0 & 0 \end{bmatrix} \text{ mm}$$

Steel Base Properties

Designation	$desI_1 = \text{"G40.21-300W"}$	
Yield Strength	$f_{y1} = 44$ Ksi	$f_{y1} = 303$ MPa
Ultimate Strength	$F_{u1} = 65$ Ksi	$F_{u1} = 448$ MPa
Young's Modulus	$E_s = 29000$ Ksi	$E_s = 1.9995 \cdot 10^5$ MPa
Shear Modulus	$G_s = 10.9$ Ksi	$G_s = 75$ MPa
Density	$\gamma_s = 489$ pcf	$\gamma_s = 76.8158$ kNpcm

Welding Electrodes

Imperial Designation	$desI_w = \text{"E70xx"}$	
Metric Designation	$desM_w = \text{"E480xx"}$	
Ultimate Strength	$X_u = 70$ ksi	$X_u = 483$ MPa

Weld Size

Imperial Designation	$desI_D = \text{"7/16"}$	
Metric Designation	$desM_D = \text{""}$	
Size	$D = 0.4375$ in	$D = 11.1$ mm
Limit Weld Stress	$v_{rw} = 31.4$ ksi	$v_{rw} = 216.7$ MPa
Limit Base Metal Stress	$v_{rb} = 39.6$ Ksi	$v_{rb} = 273$ MPa
Weld Resist per Unit Len	$v'_{rw} = 9.7$ Kpi	$v'_{rw} = 1.7$ kNpmm
Base Resist per Unit Len	$v'_{rb} = 17.3$ Kpi	$v'_{rb} = 3$ kNpmm
Min Resistance per Unit Len	$v_r = 9.7$ Kpi	$v_r = 1.7$ kNpmm

Weld Properties

Total Length of Weld	$A = 22$ in	$A = 558.8$ mm
Centroid of Weld X-Axis	$cg_x = 0.6477$ in	$cg_x = 16.5$ mm
Centroid of Weld Y-Axis	$cg_y = 3.1477$ in	$cg_y = 80$ mm
Moment of Inertia (X-Axis)	$I'_{xx} = 156\ in^3$	$I'_{xx} = 2.56 \cdot 10^6\ mm^3$
Moment of Inertia (Y-Axis)	$I'_{yy} = 15.1\ in^3$	$I'_{yy} = 2.48 \cdot 10^5\ mm^3$
Product of Inertia	$I'_{xy} = -25.4\ in^3$	$I'_{xy} = -4.15 \cdot 10^5\ mm^3$
Polar Moment of Inertia	$I'_p = 171.1\ in^3$	$I'_p = 2.80 \cdot 10^6\ mm^3$
Prod of Moment of Inertia	$I'_{prod} = 1719.4\ in^6$	$I'_{prod} = 4.62 \cdot 10^{11}\ mm^6$

Weld Force from Applied Factored Loads

X-Axis Direction	$\sigma_{fx} = 0.00$ Kpi	$\sigma_{fx} = 0.00$ kNpmm
Y-Axis Direction	$\sigma_{fy} = 0.00$ Kpi	$\sigma_{fy} = 0.00$ kNpmm
Z-Axis Direction	$\sigma_{fz} = 0.68$ Kpi	$\sigma_{fz} = 0.12$ kNpmm
Max Weld Force at Start of Segment in Pattern	$op_1 = 8.68$ Kpi	$op_1 = 1.52$ kNpmm
Min Weld Force at Start of Segment in Pattern	$op'_1 = 2$ Kpi	$op'_1 = 0$ kNpmm
Max Weld Force at End of Segment in Pattern	$op_2 = 8.68$ Kpi	$op_2 = 1.52$ kNpmm
Min Weld Force at End of Segment in Pattern	$op'_2 = 8.68$ Kpi	$op'_2 = 1.52$ kNpmm
Max Weld Force at Mid Point of Segment in Pattern	$op_3 = 7.99$ Kpi	$op_3 = 1.40$ kNpmm
Min Weld Force at Mid Point of Segment in Pattern	$op'_3 = 0.37$ Kpi	$op'_3 = 0.07$ kNpmm
Maximum Weld Force in Pattern	$op_{max} = 8.68$ Kpi	$op_{max} = 1.52$ kNpmm
Minimum Weld Force in Pattern	$op'_{min} = 7.99$ Kpi	$op'_{min} = 1.4$ kNpmm
Weld Resistance:	$v_r = 9.72$ Kpi	$v_r = 1.70$ kNpmm

$Check\left(v_r \geq op_{max}\right) = \text{"...OK"}$

$Check\left(v_r \geq 0.95 \cdot op_{max}\right) = \text{"...OK"}$

$Check\left(v_r \geq \left|op'_{min}\right|\right) = \text{"...OK"}$