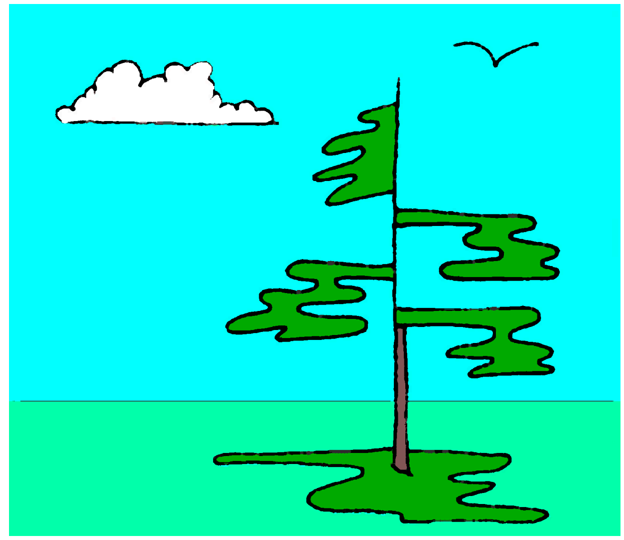
NorthWoods Software



Program Name: Weld-Group

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21-02-14

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

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

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

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

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

Pressure

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

Subgrade Modulus

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

Pressure per Depth

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

Force

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

Velocity

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

User Defined Functions:

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

c

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

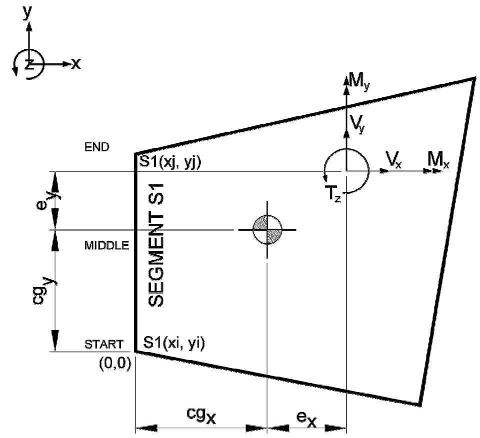
b

```
Check(2 ≠ 3) = "...OK"
```

a

```
Check(2 ≤ 3) = "...OK"
Check(3 ≥ 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:

$pts :=$

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

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. Stretch the matrix downwards or upwards to accommodate number of segments. 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(0, 0) to S1(0, 8).

$pts' := submatrix\left(pts, 1, rows\left(pts\right), 2, 5\right)$

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

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

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

$E_s := 29000\ Ksi$ $\quad G_s := 10.9\ Ksi$ $\quad \gamma_s := 489\ pcf$

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

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

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

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

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

$ws :=$ (matrix above)

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

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

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

$pts_{r\,6} := \frac{pts_{r\,2} + pts_{r\,4}}{2}$ c_x

$pts_{r\,7} := \frac{pts_{r\,3} + pts_{r\,5}}{2}$ c_y

$pts_{r\,8} := pts_{r\,4} - pts_{r\,2}$ m

$pts_{r\,9} := pts_{r\,5} - pts_{r\,3}$ n

$pts_{r\,10} := \sqrt{\left(pts_{r\,8}\right)^2 + \left(pts_{r\,9}\right)^2}$ L

$pts_{r\,11} := \frac{pts_{r\,10} \cdot \left(pts_{r\,9}\right)^2}{12}$ I_{xx}

$pts_{r\,12} := \frac{pts_{r\,10} \cdot \left(pts_{r\,8}\right)^2}{12}$ I_{yy}

$pts_{r\,13} := pts_{r\,10} \cdot pts_{r\,6}$ L cx

$pts_{r\,14} := pts_{r\,10} \cdot pts_{r\,7}$ L cy

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

$pts_{r\,15} := pts_{r\,6} - cg_x$	d_x
$pts_{r\,16} := pts_{r\,7} - cg_y$	d_y
$pts_{r\,17} := pts_{r\,11} + pts_{r\,10} \cdot pts_{r\,16}^2$	I'_{xx}
$pts_{r\,18} := pts_{r\,12} + pts_{r\,10} \cdot \left(pts_{r\,15}\right)^2$	I'_{yy}
$pts_{r\,19} := pts_{r\,10} \cdot pts_{r\,15} \cdot pts_{r\,16}$	I'_{xy}
$pts_{r\,20} := pts_{r\,2} - cg_x$	d_{xi}
$pts_{r\,21} := pts_{r\,3} - cg_y$	d_{yi}
$pts_{r\,22} := pts_{r\,4} - cg_x$	d_{xj}
$pts_{r\,23} := pts_{r\,5} - cg_y$	d_{yj}

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

Load Distance from Centroid:

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

Stress from Applied Factored Loads:

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

Load at Weld Group Centroid:

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

```
for r ∈ [1..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} + σ_{fz}                     Σσz
    pts_{r 30} := 0 pli                                   σx from T
    pts_{r 31} := pts_{r 30} + σ_{fx}                     Σσx
    pts_{r 32} := 0 pli                                   σy from T
    pts_{r 33} := pts_{r 32} + σ_{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} := pts_{r 21}·M'_{fx}·I'_{yy} / I'_{prod}             σz y from My
    pts_{r 25} := pts_{r 21}·M'_{fy}·I'_{xy} / I'_{prod}             σz x from Mx
    pts_{r 26} := (−1·pts_{r 20})·M'_{fx}·I'_{xy} / I'_{prod}        σz x from My
    pts_{r 27} := (−1·pts_{r 20})·M'_{fy}·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} + σ_{fz}                     σx from T
    pts_{r 30} := (−1·pts_{r 21})·T'_{fz} / I'_{p}        Σσx
    pts_{r 31} := pts_{r 30} + σ_{fx}                     σy from T
    pts_{r 32} := pts_{r 20}·T'_{fz} / I'_{p}             Σσy
    pts_{r 33} := pts_{r 32} + σ_{fy}                     σy combined
    pts_{r 34} := sqrt((pts_{r 29})^2 + (pts_{r 31})^2 + (pts_{r 33})^2)    Σσy     Stress at Start of Segment
    pts_{r 35} := pts_{r 23}·M'_{fx}·I'_{yy} / I'_{prod}             σz y from Mx     Stress at End of Segment
```

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

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

$pts_{r\,36} := 0\ \text{pli}$	σz y from My
$pts_{r\,37} := 0\ \text{pli}$	σz x from Mx
$pts_{r\,38} := 0\ \text{pli}$	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
$pts_{r\,41} := 0\ \text{pli}$	σx from T
$pts_{r\,42} := pts_{r\,41} + \sigma_{fx}$	Σσx
$pts_{r\,43} := 0\ \text{pli}$	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
$pts_{r\,46} := 0\ \text{pli}$	σz y from Mx
$pts_{r\,47} := 0\ \text{pli}$	σz y from My
$pts_{r\,48} := 0\ \text{pli}$	σz x from Mx

$\quad \text{else}$

$pts_{r\,36} := \dfrac{pts_{r\,23} \cdot M'_{fy} \cdot I'_{xy}}{I'_{prod}}$	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	
$pts_{r\,48} := \dfrac{\left(-1 \cdot pts_{r\,15} \cdot M'_{fx} \cdot I'_{xy}\right)}{I'_{prod}}$	σz x from Mx	

```
for r ∈ [1..rows(pts)]
  if pts_{r 10} = 0 in
    pts_{r 49} := 0 pli                                              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} + σ_fz                                  σz Total
    pts_{r 52} := 0 pli                                              σx from T
    pts_{r 53} := pts_{r 52} · σ_fx                                  σx Combined
    pts_{r 54} := 0 pli                                              σy from T
    pts_{r 55} := pts_{r 54} + σ_fy                                  σy Combined
    pts_{r 56} := √((pts_{r 51})² + (pts_{r 53})² + (pts_{r 55})²)  Total σ
  else
    pts_{r 49} := ((−1·pts_{r 15})·M'_fy·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} + σ_fz                                  σz Total
    pts_{r 52} := ((−1·pts_{r 16})·T'_fz) / I'_p                     σx from T
    pts_{r 53} := (pts_{r 52} + σ_fx)                                σx Combined
    pts_{r 54} := (pts_{r 15}·T'_fz) / I'_p                          σy from T
    pts_{r 55} := pts_{r 54} + σ_fy                                  σy Combined
    pts_{r 56} := √((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:

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

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

$\mathrm{Check}(v_r \ge 0.95 \cdot op_{max}) =$ "...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	$\alpha_L = 1.5$	

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

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

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

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

Steel Base Properties

Designation	$desI_1 = "G40.21\text{-}300W"$	
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	$desI_w = "E70xx"$	
Metric Designation	$desM_w = "E480xx"$	
Ultimate Strength	$X_u = 70\ ksi$	$X_u = 483\ MPa$

Weld Size

Imperial Designation	$desI_D = "7/16"$	
Metric Designation	$desM_D = ""$	
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	$A = 22\ \mathrm{in}$	$A = 558.8\ \mathrm{mm}$
Centroid of Weld X-Axis	$cg_x = 0.6477\ \mathrm{in}$	$cg_x = 16.5\ \mathrm{mm}$
Centroid of Weld Y-Axis	$cg_y = 3.1477\ \mathrm{in}$	$cg_y = 80\ \mathrm{mm}$
Moment of Inertia (X-Axis)	$I'_{xx} = 156\ \mathrm{in}^3$	$I'_{xx} = 2.56 \cdot 10^6\ \mathrm{mm}^3$
Moment of Inertia (Y-Axis)	$I'_{yy} = 15.1\ \mathrm{in}^3$	$I'_{yy} = 2.48 \cdot 10^5\ \mathrm{mm}^3$
Product of Inertia	$I'_{xy} = -25.4\ \mathrm{in}^3$	$I'_{xy} = -4.15 \cdot 10^5\ \mathrm{mm}^3$
Polar Moment of Inertia	$I'_p = 171.1\ \mathrm{in}^3$	$I'_p = 2.80 \cdot 10^6\ \mathrm{mm}^3$
Prod of Moment of Inertia	$I'_{prod} = 1719.4\ \mathrm{in}^6$	$I'_{prod} = 4.62 \cdot 10^{11}\ \mathrm{mm}^6$

Weld Force from Applied Factored Loads

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

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

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

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