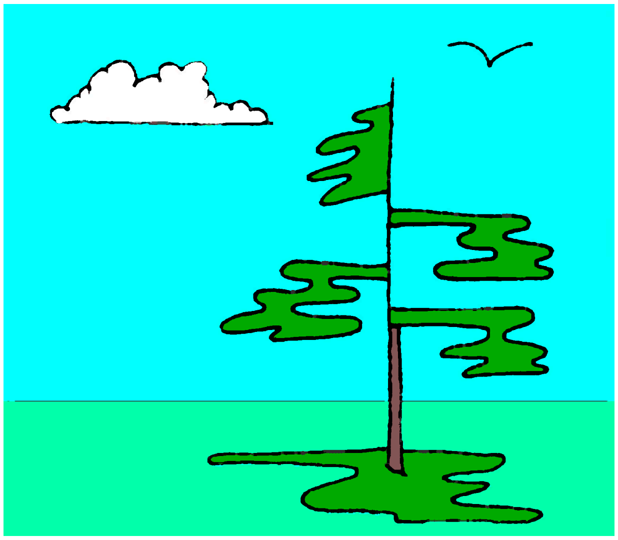
NorthWoods Software



Program Name: Weld-Group_W

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21-02-25

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

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:

$\varphi_s := 0.90$

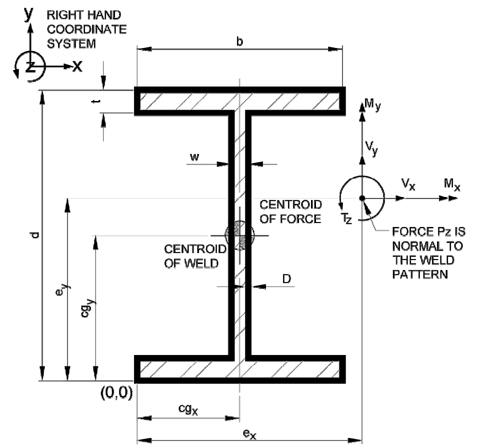
$\varphi_w := 0.67$

Load Factors:

$\alpha_L := 1.50$

$\alpha_D := 1.25$

Weld interface is taken at the face of the attached member rather than the centreline of the weld.



Applied Factored Loads:

$P_{fz} := 0\ K$ — $P_{fz} = 0.00\ kN$ — 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)

$M_{fx} := 0\ K\_ft$ — $M_{fx} = 0\ kN\_m$ — Moment (X-Axis)

$M_{fy} := 0\ K\_ft$ — $M_{fy} = 0.00\ kN\_m$ — Moment (Y-Axis)

$T_{fz} := 14\ K\_ft$ — $T_{fz} = 18.98\ kN\_m$ — Torsion (Z-Axis)

Load Eccentricity:

$e_x := 3\ in$ — $e_x = 76.2\ mm$ — X-Axis Direction

$e_y := 5\ in$ — $e_y = 127\ mm$ — Y-Axis Direction

$e_z := 0\ in$ — $e_z = 0.0\ mm$ — Z-Axis Direction

W Shape Input Data:

$d := 11.9\ in$ — $d = 302.3\ mm$

$b := 8.01\ in$ — $b = 203.5\ mm$

$t := .515\ in$ — $t = 13.1\ mm$

$w := .295\ in$ — $w = 7.5\ mm$

$d' := d - 2 \cdot t$ — $d' = 10.87\ in$ — $d' = 276.10\ mm$

$b' := 0.5 \cdot (b - w)$ — $b' = 3.8575\ in$ — $b' = 97.9805\ mm$

$pts :=$

s	xi	yi	xj	yj
1	0 in	0 in	0 in	t
2	0 in	t	b'	t
3	b'	t	b'	t + d'
4	b'	t + d'	0 in	t + d'
5	0 in	t + d'	0 in	d
6	0 in	d	b	d
7	b	d	b	t + d'
8	b	t + d'	b' + w	t + d'
9	b' + w	t + d'	b' + w	t
10	b' + w	t	b	t
11	b	t	b	0 in
12	b	0 in	0 in	0 in

$pts' := \mathrm{submatrix}(pts, 1, \mathrm{rows}(pts), 2, 5)$

Used for Summary and Plotting Shape

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

$$ptsn_{c\,1} := pts'_{c\,1} \cdot \frac{1}{in}$$
$$ptsn_{c\,2} := pts'_{c\,2} \cdot \frac{1}{in}$$
$$ptsn_{c\,3} := pts'_{c\,3} \cdot \frac{1}{in}$$
$$ptsn_{c\,4} := pts'_{c\,4} \cdot \frac{1}{in}$$

$c := 0$

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

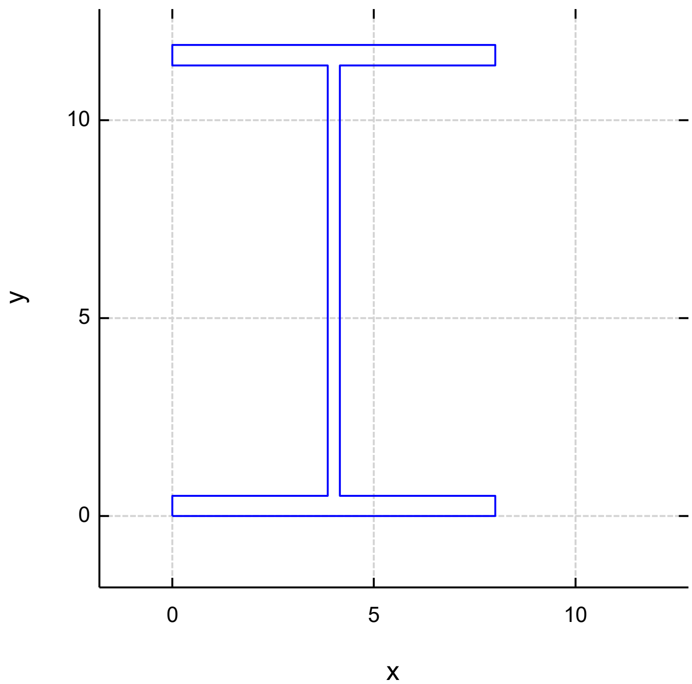
$$weld_{c\,1} := ptsn_{c\,1}$$
$$weld_{c\,2} := ptsn_{c\,2}$$

$c := c + 1$

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

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

Weld Pattern



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

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

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

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

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: $ws_{NDX} := 13$

$ws :=$

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:

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

Base Strength:

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

Maximum Strength per Unit Length:

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

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

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

Weld Properties:

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

$pts_{r\ 6} := \frac{pts_{r\ 2} + pts_{r\ 4}}{2}$ 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 for $r \in [1..\mathrm{rows}(pts)]$

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

$A := \sum \mathrm{col}(pts, 10)$	$A = 55.25\ \mathrm{in}$	$A = 1403.4\ \mathrm{mm}$	Total Length of Weld
$cg_x := \sum \left(\frac{\mathrm{col}(pts, 13)}{A}\right)$	$cg_x = 4.01\ \mathrm{in}$	$cg_x = 101.7\ \mathrm{mm}$	Centroid of Weld X-Axis
$cg_y := \sum \left(\frac{\mathrm{col}(pts, 14)}{A}\right)$	$cg_y = 5.95\ \mathrm{in}$	$cg_y = 151.1\ \mathrm{mm}$	Centroid of Weld Y-Axis
$I'_{xx} := \sum \mathrm{col}(pts, 17)$	$I'_{xx} = 1303.8\ \mathrm{in}^3$	$I'_{xx} = 2.14 \cdot 10^{7}\ \mathrm{mm}^3$	Moment of Inertia (X-Axis)
$I'_{yy} := \sum \mathrm{col}(pts, 18)$	$I'_{yy} = 204.8\ \mathrm{in}^3$	$I'_{yy} = 3.36 \cdot 10^{6}\ \mathrm{mm}^3$	Moment of Inertia (Y-Axis)
$I'_{xy} := \sum \mathrm{col}(pts, 19)$	$I'_{xy} = 3.5 \cdot 10^{-13}\ \mathrm{in}^3$	$I'_{xy} = 5.73 \cdot 10^{-9}\ \mathrm{mm}^3$	Product of Inertia
$I'_p := I'_{xx} + I'_{yy}$	$I'_p = 1508.6\ \mathrm{in}^3$	$I'_p = 2.47 \cdot 10^{7}\ \mathrm{mm}^3$	Polar Moment of Inertia
$I'_{prod} := I'_{xx} \cdot I'_{yy} - I'^{2}_{xy}$	$I'_{prod} = 2.7 \cdot 10^{5}\ \mathrm{in}^6$	$I'_{prod} = 7.17 \cdot 10^{13}\ \mathrm{mm}^6$	Product of Inertia

Load Distance from Centroid:

$e'_x := e_x - cg_x$	$e'_x = -1.01\ \mathrm{in}$	$e'_x = -25.527\ \mathrm{mm}$	X-Axis Direction
$e'_y := e_y - cg_y$	$e'_y = -0.95\ \mathrm{in}$	$e'_y = -24.13\ \mathrm{mm}$	Y-Axis Direction
$e'_z := e_z$	$e'_z = 0.00\ \mathrm{in}$	$e'_z = 0\ \mathrm{mm}$	Z-Axis Direction

Stress from Applied Factored Loads:

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

Load at Weld Group Centroid:

$d_x := e_x - cg_x$	$d_x = -1.01\ \mathrm{in}$	$d_x = -25.53\ \mathrm{mm}$
$d_y := e_y - cg_y$	$d_y = -0.95\ \mathrm{in}$	$d_y = -24.13\ \mathrm{mm}$
$d_z := e_z$	$d_z = 0\ \mathrm{in}$	$d_z = 0\ \mathrm{mm}$
$M'_{fx} := M_{fx} - V_{fy} \cdot d_z + P_{fz} \cdot d_y$	$M'_{fx} = 0.00\ \mathrm{K\_ft}$	$M'_{fx} = 0\ \mathrm{kN\_m}$
$M'_{fy} := M_{fy} + V_{fx} \cdot d_z - P_{fz} \cdot d_x$	$M'_{fy} = 0\ \mathrm{K\_ft}$	$M'_{fy} = 0\ \mathrm{kN\_m}$
$T'_{fz} := T_{fz} - V_{fx} \cdot d_y + V_{fy} \cdot d_x$	$T'_{fz} = 14\ \mathrm{K\_ft}$	$T'_{fz} = 18.9815\ \mathrm{kN\_m}$

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	
$pts_{r,26} := \dfrac{(-1 \cdot pts_{r,20}) \cdot M'_{fx} \cdot I'_{xy}}{I'_{prod}}$	σz x from My	
$pts_{r,27} := \dfrac{(-1 \cdot pts_{r,20}) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$	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	
$pts_{r,30} := \dfrac{(-1 \cdot pts_{r,21}) \cdot T'_{fz}}{I'_{p}}$	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	
$pts_{r,34} := \sqrt{(pts_{r,29})^{2} + (pts_{r,31})^{2} + (pts_{r,33})^{2}}$	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 $pts_{r\,10} = 0\ \text{in}$

$pts_{r\,49} := 0\ \text{pli}$	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
$pts_{r\,52} := 0\ \text{pli}$	σx from T
$pts_{r\,53} := pts_{r\,52} \cdot \sigma_{fx}$	σx Combined
$pts_{r\,54} := 0\ \text{pli}$	σy from T
$pts_{r\,55} := pts_{r\,54} + \sigma_{fy}$	σy Combined
$pts_{r\,56} := \sqrt{\left(pts_{r\,51}\right)^2 + \left(pts_{r\,53}\right)^2 + \left(pts_{r\,55}\right)^2}$	Total σ

$\quad$ else

$pts_{r\,49} := \dfrac{\left(-1 \cdot pts_{r\,15}\right) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$	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
$pts_{r\,52} := \dfrac{\left(-1 \cdot pts_{r\,16}\right) \cdot T'_{fz}}{I'_{p}}$	σx from T
$pts_{r\,53} := \left(pts_{r\,52} + \sigma_{fx}\right)$	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
$pts_{r\,56} := \sqrt{\left(pts_{r\,51}\right)^2 + \left(pts_{r\,53}\right)^2 + \left(pts_{r\,55}\right)^2}$	Total σ — Stress at Midpoint of Segment

Max and Min Stress in Segment:

$\sigma'_z := \max(\text{col}(pts, 34))$	$\sigma'_z = 0.80\ \text{Kpi}$	$\sigma'_z = 0.14\ \text{kNpmm}$	Max Stress at Start of Segment
$op'_1 := \min(\text{col}(pts, 34))$	$op'_1 = 1\ \text{Kpi}$	$op'_1 = 0\ \text{kNpmm}$	Min Stress at Start of Segment
$\sigma'_x := \max(\text{col}(pts, 45))$	$\sigma'_x = 0.8\ \text{Kpi}$	$\sigma'_x = 0.14\ \text{kNpmm}$	Max Stress at End of Segment
$op'_2 := \min(\text{col}(pts, 45))$	$op'_2 = 0.6055\ \text{Kpi}$	$op'_2 = 0.106\ \text{kNpmm}$	Min Stress at End of Segment
$\sigma'_y := \max(\text{col}(pts, 56))$	$\sigma'_y = 0.78\ \text{Kpi}$	$\sigma'_y = 0.14\ \text{kNpmm}$	Max Stress at Middle of Segment
$op'_3 := \min(\text{col}(pts, 56))$	$op'_3 = 0.0164\ \text{Kpi}$	$op'_3 = 0.0029\ \text{kNpmm}$	Min Stress at Middle of Segment

Max and Min Stress in Welds:

$op_{max} := \max([\sigma'_x\ \sigma'_y\ \sigma'_z])$	$op_{max} = 0.8\ \text{Kpi}$	$op_{max} = 0.14\ \text{kNpmm}$	Maximum Stress in Segment
$op'_{min} := \min([op'_1\ op'_2\ op'_3])$			
	$op'_{min} = 0.0164\ \text{Kpi}$	$op'_{min} = 0.0029\ \text{kNpmm}$	Minimum Stress in Segment
	$v_r = 9.72\ \text{Kpi}$	$v_r = 1.7024\ \text{kNpmm}$	Weld Resistance:

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 $\alpha_L = 1.5$

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

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

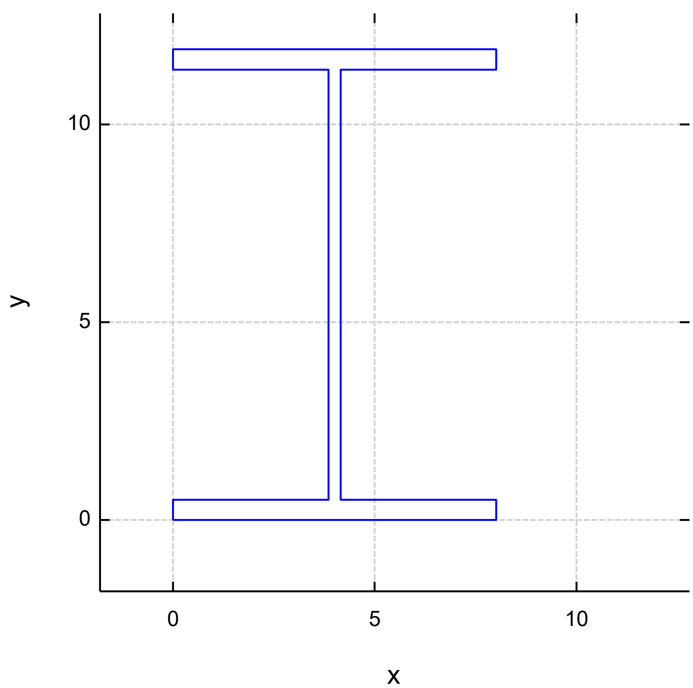
Applied Factored Loads:

Axial Load	$P_{fz} = 0$ K	$P_{fz} = 0$ 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)	$M_{fx} = 0$ K_ft	$M_{fx} = 0$ kN_m
Moment (Y-Axis)	$M_{fy} = 0$ K_ft	$M_{fy} = 0$ kN_m
Torsion (Z-Axis)	$T_{fz} = 14$ K_ft	$T_{fz} = 18.9815$ kN_m

Load Eccentricity from Origin:

X-Axis Direction	$e_x = 3$ in	$e_x = 76.2$ mm
Y-Axis Direction	$e_y = 5$ in	$e_y = 127$ mm
Z-Axis Direction	$e_z = 0$ in	$e_z = 0$ mm

Weld Pattern



weld

Segment Input Data:

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

$$pts' = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.5 \\ 0.0 & 0.5 & 3.9 & 0.5 \\ 3.9 & 0.5 & 3.9 & 11.4 \\ 3.9 & 11.4 & 0.0 & 11.4 \\ 0.0 & 11.4 & 0.0 & 11.9 \\ 0.0 & 11.9 & 8.0 & 11.9 \\ 8.0 & 11.9 & 8.0 & 11.4 \\ 8.0 & 11.4 & 4.2 & 11.4 \\ 4.2 & 11.4 & 4.2 & 0.5 \\ 4.2 & 0.5 & 8.0 & 0.5 \\ 8.0 & 0.5 & 8.0 & 0.0 \\ 8.0 & 0.0 & 0.0 & 0.0 \end{bmatrix} \text{in}$$

$$pts' = \begin{bmatrix} 0 & 0 & 0 & 13.1 \\ 0 & 13.1 & 98 & 13.1 \\ 98 & 13.1 & 98 & 289.2 \\ 98 & 289.2 & 0 & 289.2 \\ 0 & 289.2 & 0 & 302.3 \\ 0 & 302.3 & 203.5 & 302.3 \\ 203.5 & 302.3 & 203.5 & 289.2 \\ 203.5 & 289.2 & 105.5 & 289.2 \\ 105.5 & 289.2 & 105.5 & 13.1 \\ 105.5 & 13.1 & 203.5 & 13.1 \\ 203.5 & 13.1 & 203.5 & 0 \\ 203.5 & 0 & 0 & 0 \end{bmatrix} \text{mm}$$

Steel Base Properties

Designation	$desI_1 =$ "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	$desI_w =$ "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	$A = 55.25$ in	$A = 1403.4$ mm
Centroid of Weld X-Axis	$cg_x = 4.005$ in	$cg_x = 101.7$ mm
Centroid of Weld Y-Axis	$cg_y = 5.95$ in	$cg_y = 151.1$ mm
Moment of Inertia (X-Axis)	$I'_{xx} = 1303.8$ in^3	$I'_{xx} = 2.14 \cdot 10^{7}$ mm^3
Moment of Inertia (Y-Axis)	$I'_{yy} = 204.8$ in^3	$I'_{yy} = 3.36 \cdot 10^{6}$ mm^3
Product of Inertia	$I'_{xy} = 3.5 \cdot 10^{-13}$ in^3	$I'_{xy} = 5.73 \cdot 10^{-9}$ mm^3
Polar Moment of Inertia	$I'_p = 1508.6$ in^3	$I'_p = 2.47 \cdot 10^{7}$ mm^3
Prod of Moment of Inertia	$I'_{prod} = 2.7 \cdot 10^{5}$ in^6	$I'_{prod} = 7.17 \cdot 10^{13}$ mm^6

Weld Force from Direct 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	$\sigma_{fz} = 0.00$ Kpi	$\sigma_{fz} = 0.00$ kNpmm

Load at Weld Group Centroid:

Moment (X-Axis)	$M'_{fx} = 0$ K_ft	$M'_{fx} = 0$ kN_m
Moment (Y-Axis)	$M'_{fy} = 0$ K_ft	$M'_{fy} = 0$ kN_m
Torsion (Z-Axis)	$T'_{fz} = 14$ K_ft	$T'_{fz} = 18.9815$ kN_m
Max Weld Force at Start of Segment in Pattern	$\sigma'_x = 0.799$ Kpi	$\sigma'_x = 0.14$ kNpmm

Min Weld Force at Start of Segment in Pattern	$op'_1 = 0.605$ Kpi	$op'_1 = 0$ kNpmm
Max Weld Force at End of Segment in Pattern	$\sigma'_y = 0.775$ Kpi	$\sigma'_y = 0.14$ kNpmm
Min Weld Force at End of Segment in Pattern	$op'_2 = 0.605$ Kpi	$op'_2 = 0.11$ kNpmm
Max Weld Force at Mid Point of Segment in Pattern	$\sigma'_z = 0.799$ Kpi	$\sigma'_z = 0.14$ kNpmm
Min Weld Force at Mid Point of Segment in Pattern	$op'_3 = 0.016$ Kpi	$op'_3 = 0$ kNpmm
Maximum Weld Force in Pattern	$op_{max} = 0.799$ Kpi	$op_{max} = 0.14$ kNpmm
Minimum Weld Force in Pattern	$op'_{min} = 0.016$ Kpi	$op'_{min} = 0$ kNpmm
Weld Resistance:	$v_r = 9.721$ Kpi	$v_r = 1.70$ kNpmm

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

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

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