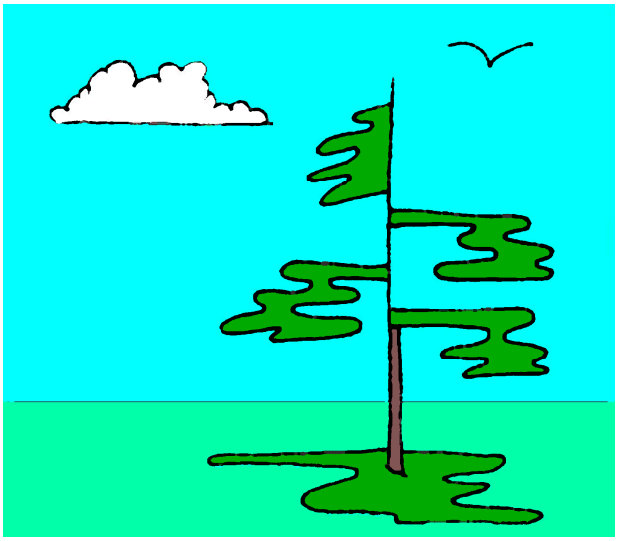
NorthWoods Software



Program Name: Weld-Group_W

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21.11.05

Reference: NBCC, CSA S16

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

Menu:

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..... Sum / For	Red Important Note	Gray Temporary Variables	

Defined Units:

$grav := 9.80665 \frac{m}{sec^2}$ Acceleration

$K := kip$ Force

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

$kNmpm := \frac{kN\_m}{m}$ $iKpi := \frac{K\_in}{in}$ Moment per Unit Length

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

$Npsmm := \frac{N}{mm^2}$ 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

$mph := \frac{mi}{hr}$ $kph := \frac{km}{hr}$ $mps := \frac{m}{sec}$ Velocity/Speed

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

$ppf := \frac{lbf}{ft}$ $Npm := \frac{N}{m}$ Stiffness

c b a

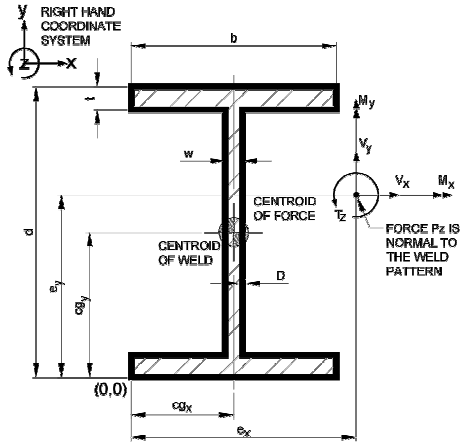
Input Data

Material Property Factors:

$\varphi_s := 0.90$

$\varphi_w := 0.67$

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



Load Factors:

$\alpha_L := 1.50$

$\alpha_D := 1.25$

Applied Factored Loads:

$P_{fz} := 0\ K$	$P_{fz} = 0.00\ K$	$P_{fz} = 0.00\ kN$	Axial Load
$V_{fx} := 0\ K$	$V_{fx} = 0.00\ K$	$V_{fx} = 0.00\ kN$	Shear (X-Axis)
$V_{fy} := 0\ K$	$V_{fy} = 0.00\ K$	$V_{fy} = 0.00\ kN$	Shear (Y-Axis)
$M_{fx} := 0\ K\_ft$	$M_{fx} = 0\ K\_ft$	$M_{fx} = 0\ kN\_m$	Moment (X-Axis)
$M_{fy} := 0\ K\_ft$	$M_{fy} = 0.00\ K\_ft$	$M_{fy} = 0.00\ kN\_m$	Moment (Y-Axis)
$T_{fz} := 14\ K\_ft$	$T_{fz} = 14.00\ K\_ft$	$T_{fz} = 18.98\ kN\_m$	Torsion (Z-Axis)

Load Eccentricity:

			X-Axis Direction
			Y-Axis Direction
$e_x := 3\ in$	$e_x = 3.0\ in$	$e_x = 76.2\ mm$	Z-Axis Direction
$e_y := 5\ in$	$e_y = 5\ in$	$e_y = 127\ mm$	
$e_z := 0\ in$	$e_z = 0.0\ in$	$e_z = 0.0\ mm$	

W Shape Input Data:

$d := 11.9\ in$	$d = 11.9\ in$	$d = 302.3\ mm$
$b := 8.01\ in$	$b = 8\ in$	$b = 203.5\ mm$
$t := .515\ in$	$t = 0.5\ in$	$t = 13.1\ mm$
$w := .295\ in$	$w = 0.3\ in$	$w = 7.5\ mm$
$d' := d - 2 \cdot t$	$d' = 10.87\ in$	$d' = 276.10\ mm$
$b' := 0.5 \cdot (b - w)$	$b' = 3.8575\ in$	$b' = 97.9805\ mm$

$pts :=$

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

$pts' := \text{submatrix}(pts, 1, \text{rows}(pts), 2, 5)$ 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 $c \in [1..\text{rows}(ptsn)]$

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

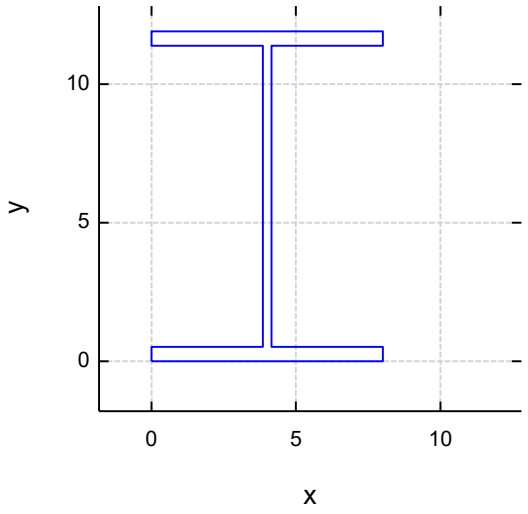
$weld_{c,2} := ptsn_{c,2}$

$c := c + 1$

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

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

Weld Pattern



$weld$

Steel Properties:

Part: $st_{NDX} := 1$

$st :=$

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

$desM_1 := st_{st_{NDX},2}$ $f_{y1} := st_{st_{NDX},3}$ $F_{u1} := st_{st_{NDX},4}$

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

Base: $st_{NDX} := 2$ $desM_2 := st_{st_{NDX},2}$ $f_{y2} := st_{st_{NDX},3}$ $F_{u2} := st_{st_{NDX},4}$

Weld Design:

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

$we :=$

NDX	DesI	DesM	UTS
1	"E60xx"	"E43xx"	60 ksi
2	"E70xx"	"E49xx"	70 ksi
3	"E80xx"	"E55xx-x"	80 ksi
4	"E90xx"	"E62xx-x"	90 ksi

$desI_w := we_{we_{NDX},2}$ $desM_w := we_{we_{NDX},3}$ $X_u := we_{we_{NDX},4}$

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	""	"10mm"	0.3937 in	
14	""	"11mm"	0.4331 in	
15	"7/16"	""	0.4375 in	
16	""	"12mm"	0.4724 in	
17	"1/2"	""	0.50 in	

$desI_D := ws_{ws_{NDX},2}$ $desM_D := ws_{ws_{NDX},3}$ $D := ws_{ws_{NDX},4}$

Weld Material Strength

$v_{rw} := \varphi_w \cdot 0.67 \cdot X_u \cdot \frac{1}{\sqrt{2}}$ $v_{rw} = 22.2$ ksi $v_{rw} = 153.2$ MPa Weld Strength

Part Metal Strength

$v_{rb1} := \varphi_w \cdot 0.67 \cdot F_{u1}$ $v_{rb1} = 29.2$ Ksi $v_{rb1} = 201.2$ MPa Part to be Welded Strength

Base Metal Strength

$v_{rb2} := \varphi_w \cdot 0.67 \cdot F_{u1}$ $v_{rb2} = 29.2$ Ksi $v_{rb2} = 201.2$ MPa Base Metal Strength

Minimum Weld Capacity

$V_{rw} := \min\left(\left[\begin{array}{ccc} v_{rw} & v_{rb1} & v_{rb2} \end{array}\right]\right)$ $V_{rw} = 22.2$ Ksi $V_{rw} = 153.2$ MPa Weld Resistance

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

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

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

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

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for r ∈ [1..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} · pts_{r,16}^2
    pts_{r,18} := pts_{r,12} + pts_{r,10} · (pts_{r,15})^2
    pts_{r,19} := pts_{r,10} · pts_{r,15} · 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}

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

Load Distance from Centroid:

$e'_x := e_x - cg_x$	$e'_x = -1.01\ \text{in}$	$e'_x = -25.527\ \text{mm}$	X-Axis Direction
$e'_y := e_y - cg_y$	$e'_y = -0.95\ \text{in}$	$e'_y = -24.13\ \text{mm}$	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
$\sigma_{fz} := \frac{P_{fz}}{A}$	$\sigma_{fz} = 0\ \text{Kpi}$	$\sigma_{fz} = 0\ \text{kNpmm}$	Z-Axis Direction

Load at Weld Group Centroid:

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

```
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
```

```
for r ∈ [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} := (pts_{r,39} + σ_fz)                     Σσz
    pts_{r,41} := 0 pli                                   σx from T
    pts_{r,42} := pts_{r,41} + σ_fx                       Σσx
    pts_{r,43} := 0 pli                                   σy from T
    pts_{r,44} := pts_{r,43} + σ_fy                       Σσy
    pts_{r,45} := sqrt((pts_{r,40})^2 + (pts_{r,42})^2 + (pts_{r,44})^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} := pts_{r,23} · M'_fy · I'_xy / I'_prod                  σz y from My
    pts_{r,37} := (−1 · pts_{r,22}) · M'_fx · I'_xy / I'_prod           σz x from Mx
    pts_{r,38} := (−1 · pts_{r,22}) · M'_fy · 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} := (pts_{r,39} + σ_fz)                                   Σσz
    pts_{r,41} := (−1 · pts_{r,23} · T'_fz / I'_p)                      σx from T
    pts_{r,42} := pts_{r,41} + σ_fx                                     Σσx
    pts_{r,43} := pts_{r,22} · T'_fz / I'_p                             σy from T
    pts_{r,44} := pts_{r,43} + σ_fy                                     Σσy
    pts_{r,45} := sqrt((pts_{r,40})^2 + (pts_{r,42})^2 + (pts_{r,44})^2)   σy combined   Stress at End of Segment
    pts_{r,46} := pts_{r,16} · M'_fx · I'_yy / I'_prod                  σz y from Mx   Stress at Midpoint of Segment
    pts_{r,47} := pts_{r,16} · M'_fy · I'_xy / I'_prod                  σz y from My
    pts_{r,48} := (−1 · pts_{r,15} · M'_fx · I'_xy) / I'_prod
```

```
for r ∈ [1..rows(pts)]
  if pts_{r 10} = 0 in
    pts_{r 49} := 0 pli                                              σz x from Mx
    pts_{r 50} := pts_{r 46} + pts_{r 47} + pts_{r 48} + pts_{r 49}  σz x from My
    pts_{r 51} := pts_{r 50} + σ_fz                                  σz frin M
    pts_{r 52} := 0 pli                                              σz Total
    pts_{r 53} := pts_{r 52} · σ_fx                                  σx from T
    pts_{r 54} := 0 pli                                              σx Combined
    pts_{r 55} := pts_{r 54} + σ_fy                                  σy from T
    pts_{r 56} := √((pts_{r 51})^2 + (pts_{r 53})^2 + (pts_{r 55})^2)  σy Combined
                                                                     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:

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

Max and Min Stress in Welds:

$op_{max} := \max([\sigma'_x \ \sigma'_y \ \sigma'_z])$	$op_{max} = 0.8$ Kpi	$op_{max} = 0.14$ kNpmm	Maximum Stress in Segment
$op'_{min} := \min([op'_1 \ op'_2 \ op'_3])$	$op'_{min} = 0.0164$ Kpi	$op'_{min} = 0.0029$ kNpmm	Minimum Stress in Segment
$v_r := v_{rw} \cdot D$	$v_r = 8.75$ Kpi	$v_r = 1.532$ kNpmm	Weld Resistance per Unit Length

Summary:

Material Property Factors

Rolled Sections $\varphi_s = 0.9$

Weld $\varphi_w = 0.67$

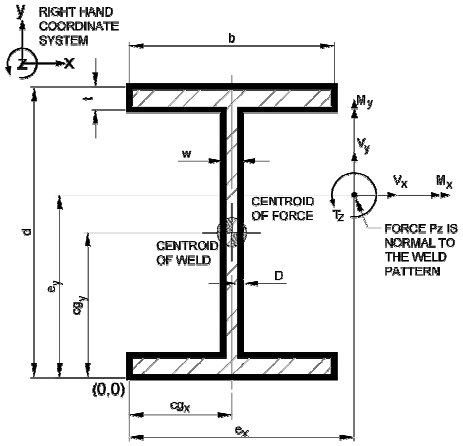
Dead Load Factor $\alpha_D = 1.25$

Live Load Factor $\alpha_L = 1.5$

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

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

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



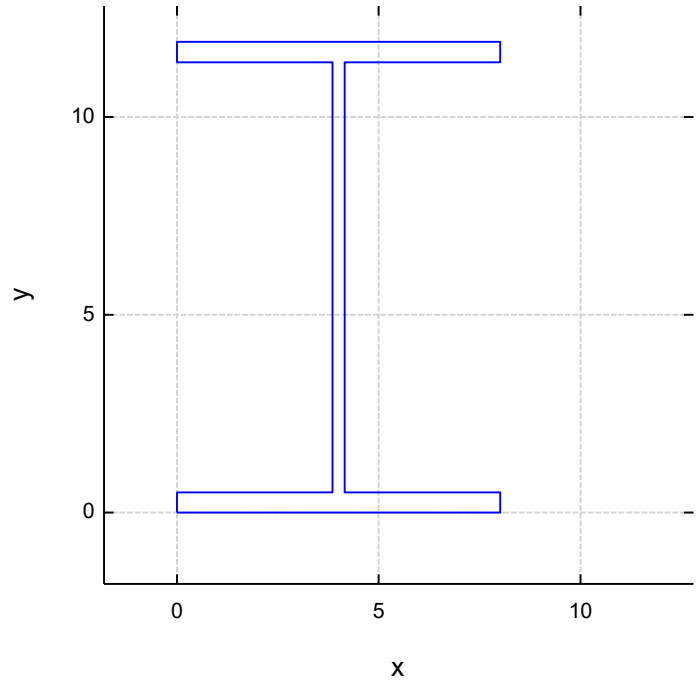
Applied Factored Loads:

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 Properties

Part

Designation	$desM_1 = \text{"G40.21-350W"}$	
Yield Strength	$f_{y1} = 50\ \text{Ksi}$	$f_{y1} = 345\ \text{MPa}$
Ultimate Strength	$F_{u1} = 65\ \text{Ksi}$	$F_{u1} = 448\ \text{MPa}$

Base

Designation	$desM_2 = \text{"G40.21-300W"}$	
Yield Strength	$f_{y2} = 44\ \text{Ksi}$	$f_{y2} = 303\ \text{MPa}$
Ultimate Strength	$F_{u2} = 65\ \text{Ksi}$	$F_{u2} = 448\ \text{MPa}$
Young's Modulus	$E_s = 29000\ \text{Ksi}$	$E_s = 1.9995 \cdot 10^{5}\ \text{MPa}$
Shear Modulus	$G_s = 11153.8462\ \text{Ksi}$	$G_s = 76903\ \text{MPa}$
Density	$\gamma_s = 489\ \text{pcf}$	$\gamma_s = 76.8158\ \text{kNpcm}$

Welding Electrodes

Imperial Designation	$desI_w = \text{"E70xx"}$	
Metric Designation	$desM_w = \text{"E49xx"}$	
Ultimate Strength	$X_u = 70\ \text{ksi}$	$X_u = 483\ \text{MPa}$

Weld Size

Imperial Designation	$desI_D = \text{""}$	
Metric Designation	$desM_D = \text{"10mm"}$	
Size	$D = 0.3937\ \text{in}$	$D = 10\ \text{mm}$
Weld Strength	$v_{rw} = 22.2\ \text{ksi}$	$v_{rw} = 153.2\ \text{MPa}$
Part to be Welded Strength	$v_{rb1} = 29.2\ \text{Ksi}$	$v_{rb1} = 201.2\ \text{MPa}$
Base Metal Strength	$v_{rb2} = 29.2\ \text{Ksi}$	$v_{rb2} = 201.2\ \text{MPa}$
Weld Resistance	$V_{rw} = 22.2\ \text{Ksi}$	$V_{rw} = 153.2\ \text{MPa}$

Weld Properties

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

Weld Force from Direct Loads

X-Axis Direction	$\sigma_{fx} = 0.00\ \text{Kpi}$	$\sigma_{fx} = 0.00\ \text{kNpmm}$
Y-Axis Direction	$\sigma_{fy} = 0.00\ \text{Kpi}$	$\sigma_{fy} = 0.00\ \text{kNpmm}$
Z-Axis Direction	$\sigma_{fz} = 0.00\ \text{Kpi}$	$\sigma_{fz} = 0.00\ \text{kNpmm}$

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:	$v_r = 8.748$ Kpi	$v_r = 1.53$ kNpmm

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

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

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