NorthWoods Software

Program Name: Weld-Group_C2

Project Number: -

Project Description: -

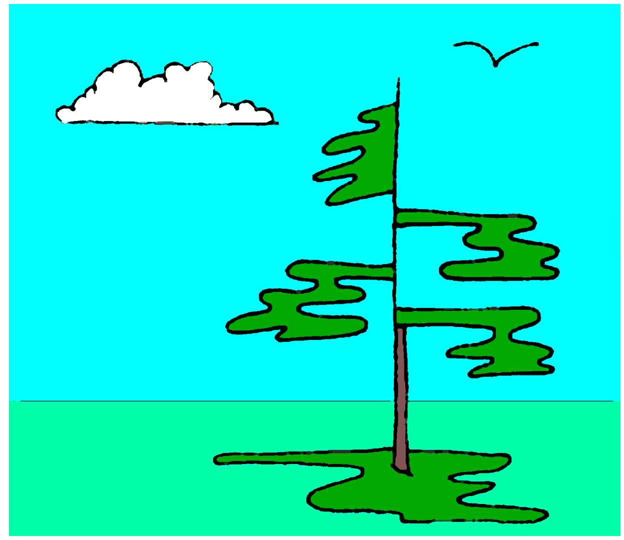
Project Designer: Dik

Last Revised (yy-mm-dd): 21.10.31

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:

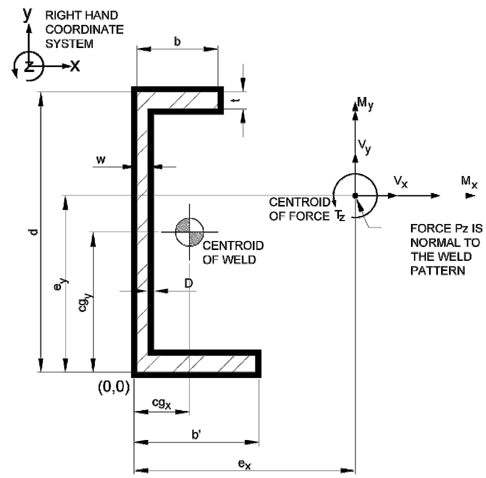
....	Input Data	....	Important Output	....	Logical Constructs	Blue	**Units**
....	Sum / For	Red	**Important Note**	Gray	**Temporary Variables**		

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:

$\alpha_L := 1.50$

$\alpha_D := 1.25$

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

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

Applied Factored Loads:

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

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

C Shape Input Data:

$d := 10\ in$	$d = 254\ mm$	Depth of Channel Secion
$b := 1\ in$	$b = 25.4\ mm$	Width of Top Flange
$b' := 2.6\ in$	$b' = 66\ mm$	Width of Bottom Flange
$t := .436\ in$	$t = 11.1\ mm$	Thickness of Flange
$w := .24\ in$	$w = 6.1\ mm$	Thickness of Web

$$pts := \begin{array}{c} \begin{array}{ccccc} s & xi & yi & xj & yj \end{array} \\ \begin{bmatrix} 1 & 0\ in & 0\ in & 0\ in & d \\ 2 & 0\ in & d & b & d \\ 3 & b & d & b & d-t \\ 4 & b & d-t & w & d-t \\ 5 & w & d-t & w & t \\ 6 & w & t & b' & t \\ 7 & b' & t & b' & 0\ in \\ 8 & b' & 0\ in & 0\ in & 0\ in \end{bmatrix} \end{array}$$

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

Used for Summary and Plotting Shape

$$\begin{aligned} &\text{for } c \in \left[1..\text{rows}\left(pts'\right)\right] \\ &\quad ptsn_{c\,1} := pts'_{c\,1} \cdot \frac{1}{in} \\ &\quad ptsn_{c\,2} := pts'_{c\,2} \cdot \frac{1}{in} \\ &\quad ptsn_{c\,3} := pts'_{c\,3} \cdot \frac{1}{in} \\ &\quad ptsn_{c\,4} := pts'_{c\,4} \cdot \frac{1}{in} \end{aligned}$$

$c := 0$

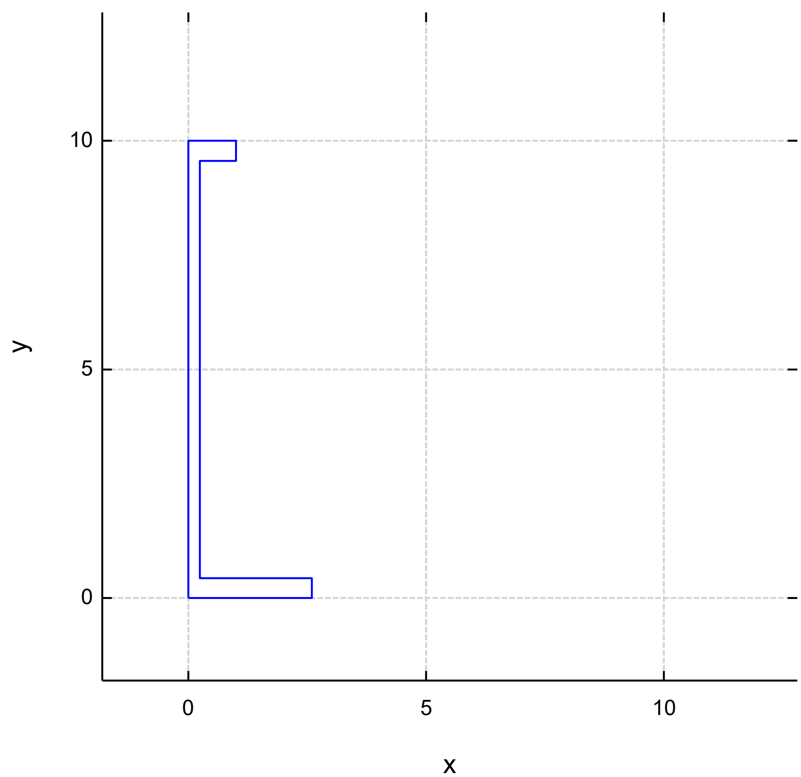
$$\text{for } c \in [1..\text{rows}(ptsn)] \; \left| \begin{array}{l} weld_{c\,1} := ptsn_{c\,1} \\ weld_{c\,2} := ptsn_{c\,2} \end{array} \right.$$

$c := c + 1$

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

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

Weld Pattern **(Adjust Size as Required)**



$weld$

Steel Properties:

Part: $st_{NDX} := 1$

$$st := \begin{array}{cccc} \text{NDX} & \text{des} & \text{fy} & \text{Fu} \end{array}$$

$$st := \begin{bmatrix} 1 & \text{"G40.21-350W"} & 50\ Ksi & 65\ Ksi \\ 2 & \text{"G40.21-300W"} & 44\ Ksi & 65\ Ksi \\ 3 & \text{"A36"} & 36\ Ksi & 58\ Ksi \end{bmatrix}$$

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

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

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

Weld Design:

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

NDX	DesI	DesM	UTS

$$we := \begin{bmatrix} 1 & \text{"E60xx"} & \text{"E43xx"} & 60\ ksi \\ 2 & \text{"E70xx"} & \text{"E49xx"} & 70\ ksi \\ 3 & \text{"E80xx"} & \text{"E55xx-x"} & 80\ ksi \\ 4 & \text{"E90xx"} & \text{"E62xx-x"} & 90\ ksi \end{bmatrix}$$

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

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	""	"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

$ws :=$ (matrix above)

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

Weld Material Strength

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

Part Metal Strength

$v_{rb1} := \varphi_w \cdot 0.67 \cdot F_{u1}$ $v_{rb1} = 29.2\ \text{Ksi}$ $v_{rb1} = 201.2\ \text{MPa}$

Base Metal Strength

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

Minimum Weld Capacity

$V_{rw} := \min\left(\left[\, v_{rw}\ v_{rb1}\ v_{rb2} \,\right]\right)$ $V_{rw} = 22.2\ \text{Ksi}$ $V_{rw} = 153.2\ \text{MPa}$

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

$$\text{for } r \in [1..\text{rows}(pts)]$$
$$pts_{r\,15} := pts_{r\,6} - cg_x \quad d_x$$
$$pts_{r\,16} := pts_{r\,7} - cg_y \quad d_y$$
$$pts_{r\,17} := pts_{r\,11} + pts_{r\,10} \cdot pts_{r\,16}^{\ 2} \quad I'_{xx}$$
$$pts_{r\,18} := pts_{r\,12} + pts_{r\,10} \cdot (pts_{r\,15})^2 \quad I'_{yy}$$
$$pts_{r\,19} := pts_{r\,10} \cdot pts_{r\,15} \cdot pts_{r\,16} \quad I'_{xy}$$
$$pts_{r\,20} := pts_{r\,2} - cg_x \quad d_{xi}$$
$$pts_{r\,21} := pts_{r\,3} - cg_y \quad d_{yi}$$
$$pts_{r\,22} := pts_{r\,4} - cg_x \quad d_{xj}$$
$$pts_{r\,23} := pts_{r\,5} - cg_y \quad d_{yj}$$

$A := \sum \text{col}(pts, 10)$	$A = 26.72$ in	$A = 678.7$ mm	Total Length of Weld
$cg_x := \sum \left(\frac{\text{col}(pts, 13)}{A}\right)$	$cg_x = 0.43$ in	$cg_x = 10.9$ mm	Centroid of Weld X-Axis
$cg_y := \sum \left(\frac{\text{col}(pts, 14)}{A}\right)$	$cg_y = 4.43$ in	$cg_y = 112.5$ mm	Centroid of Weld Y-Axis
$I'_{xx} := \sum \text{col}(pts, 17)$	$I'_{xx} = 312.9\ \text{in}^3$	$I'_{xx} = 5.13 \cdot 10^6\ \text{mm}^3$	Moment of Inertia (X-Axis)
$I'_{yy} := \sum \text{col}(pts, 18)$	$I'_{yy} = 11.4\ \text{in}^3$	$I'_{yy} = 1.86 \cdot 10^5\ \text{mm}^3$	Moment of Inertia (Y-Axis)
$I'_{xy} := \sum \text{col}(pts, 19)$	$I'_{xy} = -24.3\ \text{in}^3$	$I'_{xy} = -3.98 \cdot 10^5\ \text{mm}^3$	Product of Inertia
$I'_p := I'_{xx} + I'_{yy}$	$I'_p = 324.3\ \text{in}^3$	$I'_p = 5.31 \cdot 10^6\ \text{mm}^3$	Polar Moment of Inertia
$I'_{prod} := I'_{xx} \cdot I'_{yy} - I'^{\,2}_{xy}$	$I'_{prod} = 2965.2\ \text{in}^6$	$I'_{prod} = 7.96 \cdot 10^{11}\ \text{mm}^6$	Product of Inertia

Load Distance from Centroid:

$e'_x := e_x - cg_x$	$e'_x = 2.57$ in	$e'_x = 65.3036$ mm	X-Axis Direction
$e'_y := e_y - cg_y$	$e'_y = 0.57$ in	$e'_y = 14.5464$ 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
$\sigma_{fz} := \frac{P_{fz}}{A}$	$\sigma_{fz} = 0$ Kpi	$\sigma_{fz} = 0$ kNpmm	Z-Axis Direction

Load at Weld Group Centroid:

$d_x := e_x - cg_x$	$d_x = 2.57$ in	$d_x = 65.30$ mm
$d_y := e_y - cg_y$	$d_y = 0.5727$ in	$d_y = 14.5464$ mm
$d_z := e_z$	$d_z = 0$ in	$d_z = 0$ mm
$M'_{fx} := M_{fx} - V_{fy} \cdot d_z + P_{fz} \cdot d_y$	$M'_{fx} = 0.00$ K_ft	$M'_{fx} = 0$ kN_m
$M'_{fy} := M_{fy} + V_{fx} \cdot d_z - P_{fz} \cdot d_x$	$M'_{fy} = 0$ K_ft	$M'_{fy} = 0$ kN_m
$T'_{fz} := T_{fz} - V_{fx} \cdot d_y + V_{fy} \cdot d_x$	$T'_{fz} = 14$ K_ft	$T'_{fz} = 18.9815$ 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] := √(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] := √((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 $r \in [1..\text{rows}(pts)]$

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

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

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

$$pts_{r\,38} := \frac{\left(-1 \cdot pts_{r\,22}\right) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$$ 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

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

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

$$pts_{r\,43} := \frac{pts_{r\,22} \cdot T'_{fz}}{I'_p}$$ 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

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

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

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

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

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

$pts_{r\,49} := 0\ \text{pli}$	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

$$\quad \text{else}$$

$pts_{r\,49} := \dfrac{\left(-1 \cdot pts_{r\,15}\right) \cdot M'_{fy} \cdot I'_{xx}}{I'_{prod}}$	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:

$\sigma'_z := \max\left(\text{col}\left(pts, 34\right)\right)$	$\sigma'_z = 2.90\ \text{Kpi}$	$\sigma'_z = 0.51\ \text{kNpmm}$	Max Stress at Start of Segment
$op'_1 := \min\left(\text{col}\left(pts, 34\right)\right)$	$op'_1 = 2\ \text{Kpi}$	$op'_1 = 0\ \text{kNpmm}$	Min Stress at Start of Segment
$\sigma'_x := \max\left(\text{col}\left(pts, 45\right)\right)$	$\sigma'_x = 2.9\ \text{Kpi}$	$\sigma'_x = 0.51\ \text{kNpmm}$	Max Stress at End of Segment
$op'_2 := \min\left(\text{col}\left(pts, 45\right)\right)$	$op'_2 = 2.0702\ \text{Kpi}$	$op'_2 = 0.3626\ \text{kNpmm}$	Min Stress at End of Segment
$\sigma'_y := \max\left(\text{col}\left(pts, 56\right)\right)$	$\sigma'_y = 2.89\ \text{Kpi}$	$\sigma'_y = 0.51\ \text{kNpmm}$	Max Stress at Middle of Segment
$op'_3 := \min\left(\text{col}\left(pts, 56\right)\right)$	$op'_3 = 0.3125\ \text{Kpi}$	$op'_3 = 0.0547\ \text{kNpmm}$	Min Stress at Middle of Segment

Max and Min Stress in Welds:

$op_{max} := \max\left(\begin{bmatrix} \sigma'_x & \sigma'_y & \sigma'_z \end{bmatrix}\right)$	$op_{max} = 2.9\ \text{Kpi}$	$op_{max} = 0.51\ \text{kNpmm}$	Maximum Stress in Segment
$op'_{min} := \min\left(\begin{bmatrix} op'_1 & op'_2 & op'_3 \end{bmatrix}\right)$	$op'_{min} = 0.3125\ \text{Kpi}$	$op'_{min} = 0.0547\ \text{kNpmm}$	Minimum Stress in Segment
$v_r := v_{rw} \cdot D$	$v_r = 8.75\ \text{Kpi}$	$v_r = 1.532\ \text{kNpmm}$	Weld Resistance per Unit Length

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

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

c b a

Summary:

Material Property Factors

Rolled Sections $\varphi_s = 0.9$

Weld $\varphi_w = 0.67$

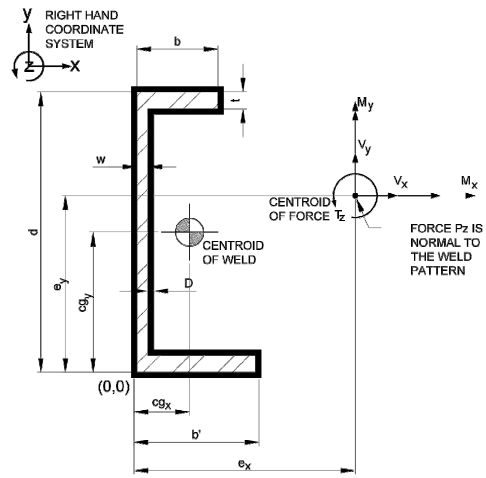
Dead Load Factor $\alpha_D = 1.25$

Live Load Factor $\alpha_L = 1.5$

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

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

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



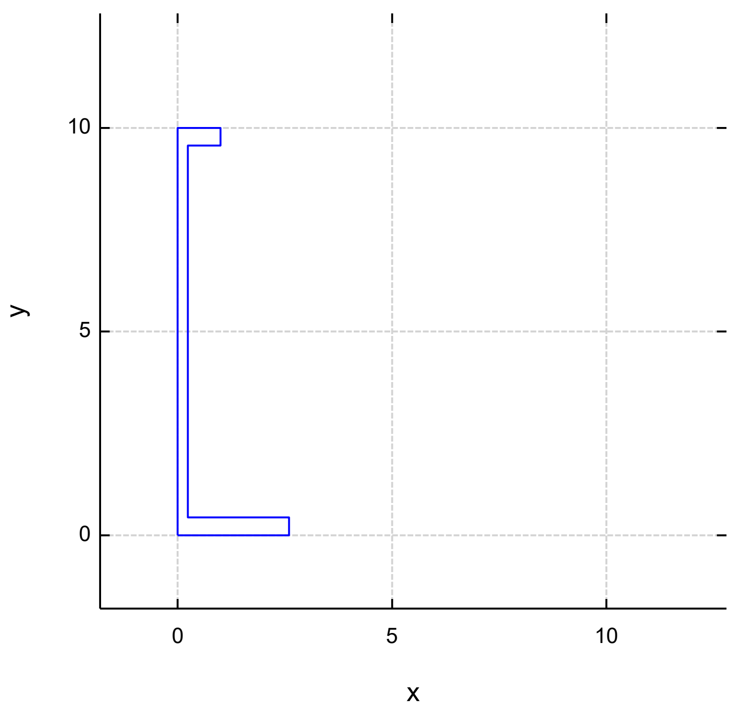
Applied Factored Loads:

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

$$pts' = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 10.0 \\ 0.0 & 10.0 & 1.0 & 10.0 \\ 1.0 & 10.0 & 1.0 & 9.6 \\ 1.0 & 9.6 & 0.2 & 9.6 \\ 0.2 & 9.6 & 0.2 & 0.4 \\ 0.2 & 0.4 & 2.6 & 0.4 \\ 2.6 & 0.4 & 2.6 & 0.0 \\ 2.6 & 0.0 & 0.0 & 0.0 \end{bmatrix}\ in$$

$$pts' = \begin{bmatrix} 0 & 0 & 0 & 254 \\ 0 & 254 & 25.4 & 254 \\ 25.4 & 254 & 25.4 & 242.9 \\ 25.4 & 242.9 & 6.1 & 242.9 \\ 6.1 & 242.9 & 6.1 & 11.1 \\ 6.1 & 11.1 & 66 & 11.1 \\ 66 & 11.1 & 66 & 0 \\ 66 & 0 & 0 & 0 \end{bmatrix}\ mm$$

Steel Base Properties

Part

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

Base

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

Welding Electrodes

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

Weld Size

Imperial Designation	$desI_D = $ ""	
Metric Designation	$desM_D = $ "10mm"	
Size	$D = 0.3937$ in	$D = 10$ mm
Base Metal Strength	$v_{rb1} = 29.2$ Ksi	$v_{rb1} = 201.2$ MPa
Minimum Weld Capacity	$V_{rw} = 22.2$ Ksi	$V_{rw} = 153.2$ MPa
Min Resistance per Unit Len	$v_r = 8.7$ Kpi	$v_r = 1.5$ kNpmm

Weld Properties

Total Length of Weld	$A = 26.72$ in	$A = 678.7$ mm
Centroid of Weld X-Axis	$cg_x = 0.429$ in	$cg_x = 10.9$ mm
Centroid of Weld Y-Axis	$cg_y = 4.4273$ in	$cg_y = 112.5$ mm
Moment of Inertia (X-Axis)	$I'_{xx} = 312.9\ in^3$	$I'_{xx} = 5.13 \cdot 10^6\ mm^3$
Moment of Inertia (Y-Axis)	$I'_{yy} = 11.4\ in^3$	$I'_{yy} = 1.86 \cdot 10^5\ mm^3$
Product of Inertia	$I'_{xy} = -24.3\ in^3$	$I'_{xy} = -3.98 \cdot 10^5\ mm^3$
Polar Moment of Inertia	$I'_p = 324.3\ in^3$	$I'_p = 5.31 \cdot 10^6\ mm^3$
Prod of Moment of Inertia	$I'_{prod} = 2965.2\ in^6$	$I'_{prod} = 7.96 \cdot 10^{11}\ mm^6$

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	$\sigma'_{x} = 2.902$ Kpi	$\sigma'_{x} = 0.51$ kNpmm
Min Weld Force at Start of Segment in Pattern	$op'_{1} = 2.07$ Kpi	$op'_{1} = 0$ kNpmm
Max Weld Force at End of Segment in Pattern	$\sigma'_{y} = 2.887$ Kpi	$\sigma'_{y} = 0.51$ kNpmm
Min Weld Force at End of Segment in Pattern	$op'_{2} = 2.07$ Kpi	$op'_{2} = 0.36$ kNpmm
Max Weld Force at Mid Point of Segment in Pattern	$\sigma'_{z} = 2.902$ Kpi	$\sigma'_{z} = 0.51$ kNpmm
Min Weld Force at Mid Point of Segment in Pattern	$op'_{3} = 0.312$ Kpi	$op'_{3} = 0.05$ kNpmm
Maximum Weld Force in Pattern	$op_{max} = 2.902$ Kpi	$op_{max} = 0.51$ kNpmm
Minimum Weld Force in Pattern	$op'_{min} = 0.312$ Kpi	$op'_{min} = 0.05$ kNpmm
Weld Resistance:	$v_r = 8.748$ Kpi	$v_r = 1.53$ 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"