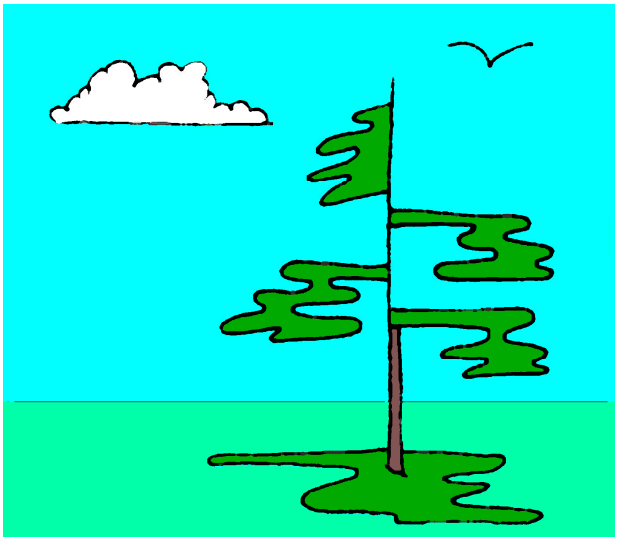
NorthWoods Software



Program Name: Prop-W_BUu

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21.11.26

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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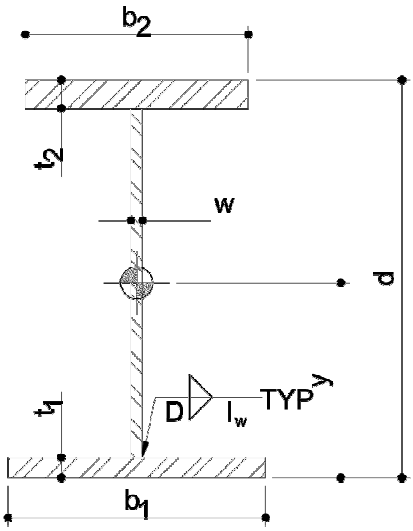
Input Data

$desI_W := "Custom"$	$desI_W = "Custom"$		Designation Imperial
$desM_W := "Custom"$	$desM_W = "Custom"$		Designation Metric
$d_W := 18.2\ in$	$d_W = 18.20\ in$	$d_W = 462.3\ mm$	W Depth
$w_W := 0.425\ in$	$w_W = 0.42\ in$	$w_W = 10.8\ mm$	W Web Thickness
$b_{1W} := 11\ in$	$b_{1W} = 11\ in$	$b_{1W} = 279.4\ mm$	W Bottom Flange Width
$t_{1W} := 0.68\ in$	$t_{1W} = 0.68\ in$	$t_{1W} = 17.3\ mm$	W Bottom Flange Thickness
$b_{2W} := 11\ in$	$b_{2W} = 11\ in$	$b_{2W} = 279.4\ mm$	W Top Flange Width
$t_{2W} := 0.68\ in$	$t_{2W} = 0.68\ in$	$t_{2W} = 17.3\ mm$	W Top Flange Thickness



c b a

Section Properties:

$A_W := b_{1W} \cdot t_{1W} + b_{2W} \cdot t_{2W} + \left(d_W - t_{1W} - t_{2W}\right) \cdot w_W$

$A_W = 22.12\ \text{in}^2$ $A_W = 14269\ \text{mm}^2$ Area

$wt_W := A_W \cdot \gamma_s$ $wt_W = 75.11\ \text{plf}$ $wt_W = 1.10\ \text{kNpm}$ Weight per Unit Length

$$y_{Wb} := \frac{t_{1W} \cdot b_{1W} \cdot \frac{t_{1W}}{2} + t_{2W} \cdot b_{2W} \cdot \left(d_W - \frac{t_{2W}}{2}\right) + + w_W \cdot \left(d_W - t_{1W} - t_{2W}\right) \cdot \left(\frac{\left(d_W - t_{1W} - t_{2W}\right)}{2} + t_{1W}\right)}{A_W}$$

$y_{Wb} = 9.10\ \text{in}$ $y_{Wb} = 231.1\ \text{mm}$ Depth to Bottom Fibre (X-Axis)

$y_{Wt} := d_W - y_{Wb}$ $y_{Wt} = 9.10\ \text{in}$ $y_{Wt} = 231.1\ \text{mm}$ Depth to Top Fibre (X-Axis)

$x_W := 0.5 \cdot \max\left(\left[\begin{array}{ccc} b_{1W} & b_{2W} & w_W \end{array}\right]\right)$ $x_W = 5.50\ \text{in}$ $x_W = 139.7\ \text{mm}$ Depth to Outer Fibre (Y-Axis)

$$Ix_{W1} := \frac{1}{12} \cdot \left(b_{1W} \cdot t_{1W}^{\ 3} + b_{2W} \cdot t_{2W}^{\ 3} + w_W \cdot \left(d_W - t_{2W} - t_{1W}\right)^3\right)$$

$$Ix_{W2} := Ix_{W1} + b_{1W} \cdot t_{1W} \cdot \left(y_{Wb} - \frac{t_{1W}}{2}\right)^2 + b_{2W} \cdot t_{2W} \cdot \left(y_{Wt} - \frac{t_{2W}}{2}\right)^2$$

$$Ix_W := Ix_{W2} + w_W \cdot \left(d_W - t_{1W} - t_{2W}\right) \cdot \left(y_{Wb} - \left(\frac{d_W - t_{1W} - t_{2W}}{2} + t_{1W}\right)\right)^2$$

$Ix_W = 1317.71\ \text{in}^4$ $Ix_W = 5.48 \cdot 10^8\ \text{mm}^4$ Moment of Inertia (X-Axis)

$$Iy_W := \frac{1}{12} \cdot \left(t_{1W} \cdot b_{1W}^{\ 3} + t_{2W} \cdot b_{2W}^{\ 3} + \left(d_W - t_{1W} - t_{2W}\right) \cdot w_W^{\ 3}\right)$$

$Iy_W = 150.95\ \text{in}^4$ $Iy_W = 6.28 \cdot 10^7\ \text{mm}^4$ Moment of Inertia (Y-Axis)

$Ip_W := Ix_W + Iy_W$ $Ip_W = 1468.66\ \text{in}^4$ $Ip_W = 6.11 \cdot 10^8\ \text{mm}^4$ Moment of Inertia (Polar)

$Sx_t := \frac{Ix_W}{y_{Wt}}$ $Sx_t = 144.80\ \text{in}^3$ $Sx_t = 2.37 \cdot 10^6\ \text{mm}^3$ Section Modulus (Top, X-Axis)

$Sx_b := \frac{Ix_W}{y_{Wb}}$ $Sx_b = 144.80\ \text{in}^3$ $Sx_b = 2.37 \cdot 10^6\ \text{mm}^3$ Section Modulus (Bottom, X-Axis)

$rx_W := \sqrt{\frac{Ix_W}{A_W}}$ $rx_W = 7.72\ \text{in}$ $rx_W = 196.1\ \text{mm}$ Radius of Gyration (X-Axis)

$ry_W := \sqrt{\frac{Iy_W}{A_W}}$ $ry_W = 2.61\ \text{in}$ $ry_W = 66.4\ \text{mm}$ Radius of Gyration (Y-Axis)

$Sy_W := \frac{Iy_W}{x_W}$ $Sy_W = 27.45\ \text{in}^3$ $Sy_W = 4.50 \cdot 10^5\ \text{mm}^3$ Section Modulus (X-Axis)

$$Zx_{W1} := b_{2W} \cdot t_{2W} \cdot \left(y_{Wt} - \frac{t_{2W}}{2}\right) + b_{1W} \cdot t_{1W} \cdot \left(y_{Wb} - \frac{t_{1W}}{2}\right)$$

$Zx_{W1} = 131.05\ \text{in}^3$ $Zx_{W1} = 2.15 \cdot 10^6\ \text{mm}^3$

$$Zx_W := Zx_{W1} + w_W \cdot \frac{\left(y_{Wt} - t_{2W}\right)^2}{4} + w_W \cdot \frac{\left(y_{Wb} - t_{1W}\right)^2}{4}$$

$Zx_W = 146.12\ \text{in}^3$ $Zx_W = 2.39 \cdot 10^6\ \text{mm}^3$ Plastic Section (X-Axis)

$$Zy_W := t_{1W} \cdot \frac{b_{1W}^2}{4} + t_{2W} \cdot \frac{b_{2W}^2}{4} + \left(d_W - t_{1W} - t_{2W}\right) \cdot \frac{w_W^2}{4}$$

$Zy_W = 41.90\ \text{in}^3$ $Zy_W = 6.87 \cdot 10^5\ \text{mm}^3$ Plastic Section (X-Axis)

$$Cw_W := \frac{\left(d_W - \left(\frac{t_{1W} + t_{2W}}{2}\right)\right)^2 \cdot \left(\frac{b_{1W} + + b_{2W}}{2}\right)^3 \cdot \left(\frac{t_{1W} + t_{2W}}{2}\right)}{24}$$

Approx (Average Properties)

$Cw_W = 11575.61\ \text{in}^6$ $Cw_W = 3.11 \cdot 10^{12}\ \text{mm}^6$ Warping Constant

$$J_W := \frac{b_{1W} \cdot t_{1W}^3}{3} + \frac{b_{2W} \cdot t_{2W}^3}{3} + \frac{\left(d_W - t_{1W} - t_{2W}\right) \cdot w_W^3}{3}$$

$J_W = 2.74\ \text{in}^4$ $J_W = 1 \cdot 10^6\ \text{mm}^4$ Torsional Constant

Class of Section

$$bt_1 := \frac{145}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$$ $bt_1 = 8.325$ b/t Ratio Class 1

$$bt_2 := \frac{170}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$$ $bt_2 = 9.7603$ b/t Ratio Class 2

$$bt_3 := \frac{200}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$$ $bt_3 = 11.4827$ b/t Ratio Class 3

$$dw_1 := \frac{1600}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$$ $dw_1 = 91.8616$ d/w Ratio Class 1

$$dw_2 := \frac{1700}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$$ $dw_2 = 97.603$ d/w Ratio Class 2

$$dw_3 := \frac{1900}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$$ $dw_3 = 109.0857$ d/w Ratio Class 3

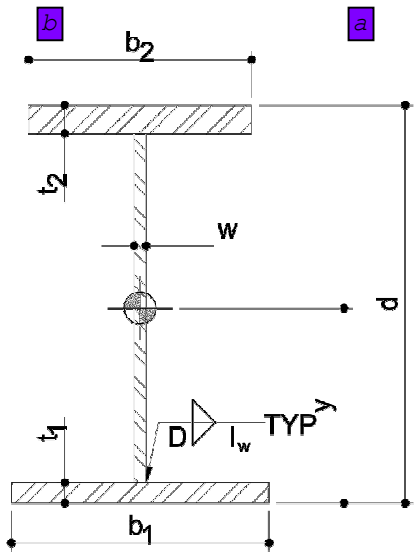
```
if (max([b1W/(2·t1W)  b2W/(2·t2W)]) ≤ bt1) ∧ (dW/wW ≤ dw1)
    Class := 1
else
    if (max([b1W/(2·t1W)  b2W/(2·t2W)]) ∧ (dW/wW ≤ dw2))
        Class := 2
    else
        if max([b1W/(2·t1W)  b2W/(2·t2W)]) ∧ (dW/wW ≤ dw3)
            Class := 3
        else
            Class := 4
```

$Class = 1$

```
if (Class = 1) ∨ (Class = 2)
    Mr := φs · Zxw · fy1
else
    Mr := φs · Sxw · fy1
```

$M_r = 482.18\ \text{K\_ft}$ $M_r = 653.75\ \text{kN\_m}$ Moment Resistance

c b a



Summary:

$\varphi_s = 0.90$

$f_{y1} = 44.00$ Ksi

Section Properties

Designation	$desI_W = \text{"Custom"}$	$desM_W = \text{"Custom"}$
W Depth	$d_W = 18.20$ in	$d_W = 462.3$ mm
W Web Thickness	$w_W = 0.42$ in	$w_W = 10.8$ mm
W Bottom Flange Width	$b_{1W} = 11$ in	$b_{1W} = 279.4$ mm
W Bottom Flange Thickness	$t_{1W} = 0.68$ in	$t_{1W} = 17.3$ mm
W Top Flange Width	$b_{2W} = 11$ in	$b_{2W} = 279.4$ mm
W Top Flange Thickness	$t_{2W} = 0.68$ in	$t_{2W} = 17.3$ mm
Area	$A_W = 22.12$ in^2	$A_W = 14269$ mm^2
Weight per Unit Length	$wt_W = 75.11$ plf	$wt_W = 1.10$ kNpm
Moment of Inertia (X-Axis)	$Ix_W = 1317.71$ in^4	$Ix_W = 5.48 \cdot 10^8$ mm^4
Section Modulus (X-Axis)	$Sx_t = 144.80$ in^3	$Sx_t = 2.37 \cdot 10^6$ mm^3
Radius of Gyration (X-Axis)	$rx_W = 7.72$ in	$rx_W = 196.1$ mm
Plastic Section (X-Axis)	$Zx_W = 146.12$ in^3	$Zx_W = 2.39 \cdot 10^6$ mm^3
Moment of Inertia (Y-Axis)	$Iy_W = 150.95$ in^4	$Iy_W = 6.28 \cdot 10^7$ mm^4
Section Modulus (Y-Axis)	$Sy_W = 27.45$ in^3	$Sy_W = 4.50 \cdot 10^5$ mm^3
Radius of Gyration (Y-Axis)	$ry_W = 2.61$ in	$ry_W = 66.4$ mm
Plastic Section (Y-Axis)	$Zy_W = 41.90$ in^3	$Zy_W = 6.87 \cdot 10^5$ mm^3
Moment of Inertia (Polar)	$Ip_W = 1468.66$ in^4	$Ip_W = 6.11 \cdot 10^8$ mm^4
Warping Constant	$Cw_W = 11575.61$ in^6	$Cw_W = 3.11 \cdot 10^{12}$ mm^6
Torsional Constant	$J_W = 2.74$ in^4	$J_W = 1 \cdot 10^6$ mm^4
Class of Section	$Class = 1$	
Moment Resistance	$M_r = 482.18$ K_ft	$M_r = 653.75$ kN_m