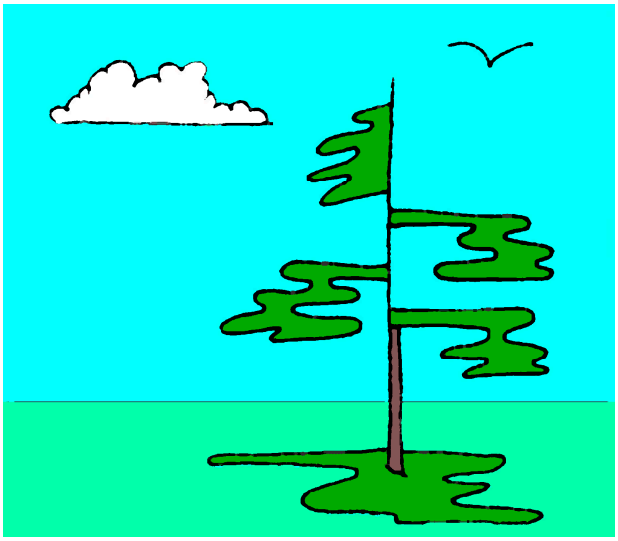
NorthWoods Software



Program Name: Prop-W

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 22.07.05

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	

Input Data

Material Property Factors:

$\varphi_s := 0.90$ Rolled Sections $\varphi_s = 0.90$

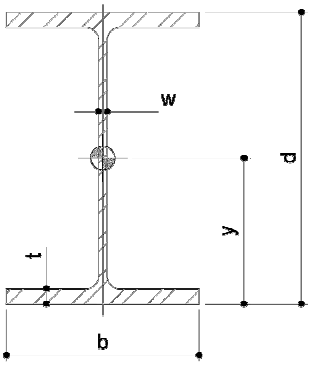
Load Factors:

$\alpha_D := 1.25$ $\alpha_D = 1.25$

$\alpha_L := 1.5$ $\alpha_L = 1.50$

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

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



Steel Properties:

Rail Properties: $st_{NDX} := 2$

$st :=$

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

$desI_1 := st_{st_{NDX},2}$ $f_{y1} := st_{st_{NDX},3}$ $F_{u1} := st_{st_{NDX},4}$

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

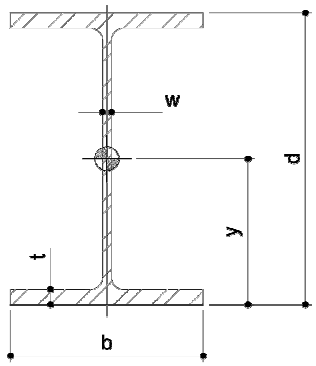
$G_s = 11154\ Ksi$ $\gamma_s := 489\ pcf$

W Section: $wi_{NDX} := 11$ c b a

NDX	desI	desM	d	b	t	w
1	"W16x36"	"W410x54"	15.86 in	6.98 in	0.43 in	0.295 in
2	"W16x31"	"W410x46"	15.9 in	5.53 in	0.44 in	0.275 in
3	"W14x90"	"W360x134"	14.0 in	14.50 in	0.71 in	0.44 in
4	"W14x61"	"W360x91"	13.9 in	10.0 in	0.645 in	0.375 in
5	"W14x53"	"W360x79"	13.9 in	8.06 in	0.66 in	0.37 in
6	"W14x30"	"W360x45"	13.8 in	6.73 in	0.385 in	0.27 in
7	"W14x22"	"W360x33"	13.7 in	5.00 in	0.335 in	0.230 in
8	"W10x26"	"W250x39"	10.3 in	5.77 in	0.44 in	0.26 in
9	"W10x22"	"W250x33"	10.2 in	5.75 in	0.36 in	0.24 in
10	"W10x15"	"W250x22"	10.0 in	4.00 in	0.27 in	0.23 in
11	"W12 Custom"	""	12 in	5 in	0.25 in	.188 in

$wi := \begin{bmatrix} 1 & \text{"W16x36"} & \text{"W410x54"} & 15.86\,\text{in} & 6.98\,\text{in} & 0.43\,\text{in} & 0.295\,\text{in} \\ 2 & \text{"W16x31"} & \text{"W410x46"} & 15.9\,\text{in} & 5.53\,\text{in} & 0.44\,\text{in} & 0.275\,\text{in} \\ 3 & \text{"W14x90"} & \text{"W360x134"} & 14.0\,\text{in} & 14.50\,\text{in} & 0.71\,\text{in} & 0.44\,\text{in} \\ 4 & \text{"W14x61"} & \text{"W360x91"} & 13.9\,\text{in} & 10.0\,\text{in} & 0.645\,\text{in} & 0.375\,\text{in} \\ 5 & \text{"W14x53"} & \text{"W360x79"} & 13.9\,\text{in} & 8.06\,\text{in} & 0.66\,\text{in} & 0.37\,\text{in} \\ 6 & \text{"W14x30"} & \text{"W360x45"} & 13.8\,\text{in} & 6.73\,\text{in} & 0.385\,\text{in} & 0.27\,\text{in} \\ 7 & \text{"W14x22"} & \text{"W360x33"} & 13.7\,\text{in} & 5.00\,\text{in} & 0.335\,\text{in} & 0.230\,\text{in} \\ 8 & \text{"W10x26"} & \text{"W250x39"} & 10.3\,\text{in} & 5.77\,\text{in} & 0.44\,\text{in} & 0.26\,\text{in} \\ 9 & \text{"W10x22"} & \text{"W250x33"} & 10.2\,\text{in} & 5.75\,\text{in} & 0.36\,\text{in} & 0.24\,\text{in} \\ 10 & \text{"W10x15"} & \text{"W250x22"} & 10.0\,\text{in} & 4.00\,\text{in} & 0.27\,\text{in} & 0.23\,\text{in} \\ 11 & \text{"W12 Custom"} & \text{""} & 12\,\text{in} & 5\,\text{in} & 0.25\,\text{in} & .188\,\text{in} \end{bmatrix}$

$desI_W := wi_{wi_{NDX},2}$ $desM_W := wi_{wi_{NDX},3}$ $d_W := wi_{wi_{NDX},4}$ $b_W := wi_{wi_{NDX},5}$ $t_W := wi_{wi_{NDX},6}$ $w_W := wi_{wi_{NDX},7}$



$desI_W = \text{"W12 Custom"}$	$desM_W = \text{""}$		**Designation**
$d_W = 12.0\,\text{in}$	$d_W = 304.8\,\text{mm}$		W Depth
$b_W = 5\,\text{in}$	$b_W = 127\,\text{mm}$		W Width
$t_W = 0.3\,\text{in}$	$t_W = 6.4\,\text{mm}$		W Flange Thickness
$w_W = 0.2\,\text{in}$	$w_W = 4.8\,\text{mm}$		W Web Thickness

Section Properties:

$y_W := \frac{d_W}{2}$	$y_W = 6.00\,\text{in}$	$y_W = 152.4\,\text{mm}$	Depth to Outer Fibre
$A_W := 2 \cdot b_W \cdot t_W + \left(d_W - 2 \cdot t_W\right) \cdot w_W$	$A_W = 4.66\,\text{in}^2$	$A_W = 3008\,\text{mm}^2$	Area
$wt_W := A_W \cdot \gamma_s$	$wt_W = 15.8\,\text{plf}$	$wt_W = 0.23\,\text{kNpm}$	Weight
$Ix_W := \frac{1}{12} \cdot \left(b_W \cdot {d_W}^3 - \left(b_W - w_W\right) \cdot \left(d_W - 2 \cdot t_W\right)^3\right)$	$Ix_W = 110.13\,\text{in}^4$	$Ix_W = 4.58 \cdot 10^7\,\text{mm}^4$	Moment of Inertia (X-Axis)
$Sx_W := \frac{1}{6 \cdot d_W} \cdot \left(b_W \cdot {d_W}^3 - \left(b_W - w_W\right) \cdot \left(d_W - 2 \cdot t_W\right)^3\right)$	$Sx_W = 18.35\,\text{in}^3$	$Sx_W = 3.01 \cdot 10^5\,\text{mm}^3$	Section Modulus (X-Axis)
$rx_W := \sqrt{\frac{Ix_W}{A_W}}$	$rx_W = 4.86\,\text{in}$	$rx_W = 123.5\,\text{mm}$	Radius of Gyration (X-Axis)
$Zx_W := \frac{1}{4} \cdot \left(b_W \cdot {d_W}^2 - \left(b_W - w_W\right) \cdot \left(d_W - 2 \cdot t_W\right)^2\right)$	$Zx_W = 20.90\,\text{in}^3$	$Zx_W = 3.43 \cdot 10^5\,\text{mm}^3$	Plastic Section (X-Axis)
$Iy_W := \frac{1}{12} \cdot \left(2 \cdot t_W \cdot {b_W}^3 + \left(d_W - 2 \cdot t_W\right) \cdot {w_W}^3\right)$	$Iy_W = 5.21\,\text{in}^4$	$Iy_W = 2.17 \cdot 10^6\,\text{mm}^4$	Moment of Inertia (Y-Axis)
$Sy_W := \frac{1}{6 \cdot b_W} \cdot \left(2 \cdot t_W \cdot {b_W}^3 + \left(d_W - 2 \cdot t_W\right) \cdot {w_W}^3\right)$	$Sy_W = 2.09\,\text{in}^3$	$Sy_W = 34181\,\text{mm}^3$	Section Modulus (Y-Axis)
$ry_W := \sqrt{\frac{Iy_W}{A_W}}$	$ry_W = 1.06\,\text{in}$	$ry_W = 26.9\,\text{mm}$	Radius of Gyration (Y-Axis)

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

$Zy_W = 3.23\ \text{in}^3$ $Zy_W = 52875\ \text{mm}^3$ Plastic Section (Y-Axis)

$Ip_W := Ix_W + Iy_W$ $Ip_W = 115.34\ \text{in}^4$ $Ip_W = 4.80\cdot 10^7\ \text{mm}^4$ Polar Moment of Inertia

$Cw_W := Iy_W\cdot\frac{d_W{}^2}{4}$ $Cw_W = 187.73\ \text{in}^6$ $Cw_W = 5.04\cdot 10^{10}\ \text{mm}^6$ Warping Constant

$J_W := \frac{2\cdot b_W\cdot t_W{}^3}{3} + \frac{\left(d_W - t_W\right)\cdot w_W{}^3}{3}$ $J_W = 0.08\ \text{in}^4$ $J_W = 32511\ \text{mm}^4$ Torsional Constant

$$r_{tW} := \left(\frac{\left(\frac{Iy_W}{2} - \left(\frac{\left(\left(\frac{\left(d_W - 2\cdot t_W\right)}{3}\right)\cdot w_W{}^3\right)}{12}\right)\right)}{\frac{A_W}{2} - \left(\left(\frac{\left(d_W - 2\cdot t_W\right)}{3}\right)\cdot w_W\right)}\right)^{0.5}$$

$r_{tW} = 1.27\ \text{in}$ $r_{tW} = 32.31\ \text{mm}$ rt 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 (b_W / (2·t_W)) ≤ bt_1 ∧ (d_W / w_W) ≤ dw_1
  Class := 1
else
  if (((b_W / (2·t_W)) ≤ bt_2) ∧ ((d_W / w_W) ≤ dw_2))
    Class := 2
  else
    if (b_W / (2·t_W)) ≤ bt_3 ∧ (d_W / w_W) ≤ dw_3
      Class := 3
    else
      Class := 4
```

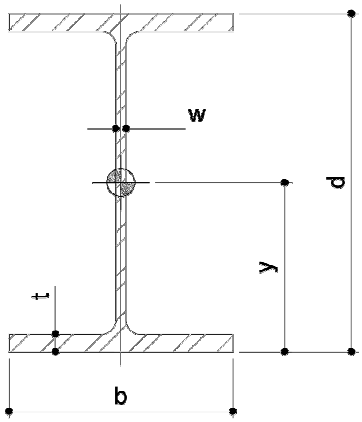
$Class = 3$

```
if (Class = 1) ∨ (Class = 2)
  M_r := φ_s · f_y1 · Zx_W
else
  M_r := φ_s · f_y1 · Sx_W
```

$M_r = 60.6\ \text{K\_ft}$ $M_r = 82.1\ \text{kN\_m}$

c b a

Summary:



Material Property Factors

Rolled Sections $\varphi_s = 0.90$

Load Factors:

Dead Load Factor $\alpha_D = 1.25$

Live Load Factor $\alpha_L = 1.50$

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

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

Material Properties

Steel Yield Strength	$f_{y1} = 44\ Ksi$	$f_{y1} = 303\ MPa$

Section Properties

W Depth	$d_W = 12.0\ in$	$d_W = 304.8\ mm$
W Width	$b_W = 5\ in$	$b_W = 127\ mm$
W Flange Thickness	$t_W = 0.250\ in$	$t_W = 6.4\ mm$
W Web Thickness	$w_W = 0.188\ in$	$w_W = 4.8\ mm$
Area	$A_W = 4.662\ in^2$	$A_W = 3008\ mm^2$
Weight	$wt_W = 15.8\ plf$	$wt_W = 0.23\ kNpm$
Moment of Inertia (X-Axis)	$Ix_W = 110.1291\ in^4$	$Ix_W = 4.5839 \cdot 10^7\ mm^4$
Section Modulus (X-Axis)	$Sx_W = 18.3549\ in^3$	$Sx_W = 3.0078 \cdot 10^5\ mm^3$
Radius of Gyration (X-Axis)	$rx_W = 4.8603\ in$	$rx_W = 123\ mm$
Plastic Section (X-Axis)	$Zx_W = 20.9033\ in^3$	$Zx_W = 3.4254 \cdot 10^5\ mm^3$
Moment of Inertia (Y-Axis)	$Iy_W = 5.2147\ in^4$	$Iy_W = 2.1705 \cdot 10^6\ mm^4$
Section Modulus (Y-Axis)	$Sy_W = 2.0859\ in^3$	$Sy_W = 34181\ mm^3$
Radius of Gyration (Y-Axis)	$ry_W = 1.0576\ in$	$ry_W = 27\ mm$
Plastic Section (Y-Axis)	$Zy_W = 3.2266\ in^3$	$Zy_W = 52875\ mm^3$
Moment of Inertia (Polar)	$Ip_W = 115.3438\ in^4$	$Ip_W = 4.801 \cdot 10^7\ mm^4$
Warping Constant	$Cw_W = 187.7292\ in^6$	$Cw_W = 5.0412 \cdot 10^{10}\ mm^6$
Torsional Constant	$J_W = 0.0781\ in^4$	$J_W = 32511\ mm^4$
rt Constant	$r_{tW} = 1.27\ in$	$r_{tW} = 32.31\ mm$
Class of Section	$Class = 3$	
Resisting Moment	$M_r = 60.6\ K\_ft$	$M_r = 82.1\ kN\_m$