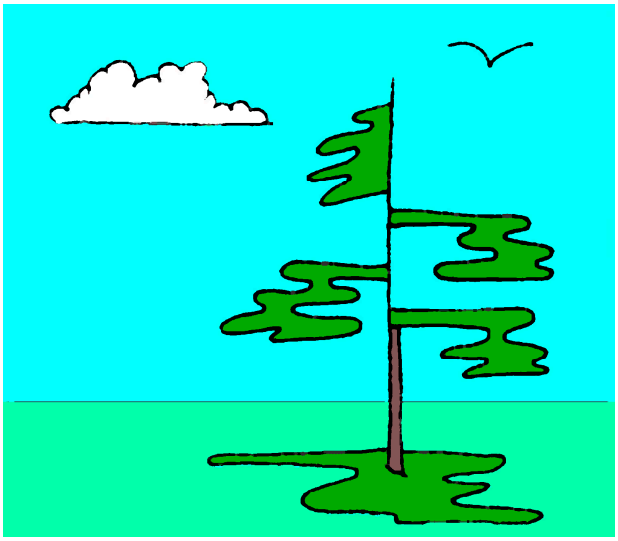
NorthWoods Software



Program Name: Beam-Max_UDL_Reactions_W

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 21.07.29

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:

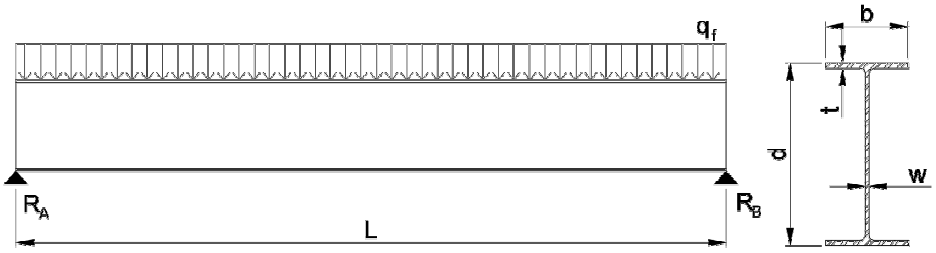
..... Input Data	..... Important Output	..... Logical Constructs	Blue **Units**
..... Sum / For	Red **Important Note**	Gray Temporary Variables	

Defined Units:

$K := kip$					Force
$K\_ft := K\ ft$	$kN\_m := kN\ m$	$K\_in := K\ in$	$kN\_mm := kN\ mm$	$lb\_in := lbf\ in$	Moment
$pcf := \frac{lbf}{ft^3}$	$kNpcm := \frac{kN}{m^3}$	$kgpcm := \frac{kg}{m^3}$			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
$mph := \frac{mi}{hr}$	$kph := \frac{km}{hr}$				Velocity
$ispf := \frac{in^2}{ft}$	$mmspm := \frac{mm^2}{m}$				Area per Unit Length

c b a

Input Data



Material Property Factors:

$\varphi_s := 0.90$ $\varphi_s = 0.90$ Steel

$\varphi_w := 0.67$ $\varphi_w = 0.67$ Weld

Load Factors:

$\alpha_L := 1.50$ $\alpha_L = 1.50$ Live Load

$\alpha_D := 1.25$ $\alpha_D = 1.25$ Dead Load

Steel Properties: $stl_{NDX} := 1$

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

$stl :=$ (above)

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

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

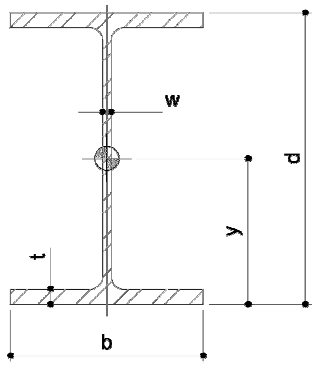
$\gamma_s := 489$ pcf

Section: $wi_{NDX} := 3$

NDX	desI	desM	d	b	t	w
1	"W16x36"	"W410x54"	15.86 in	6.98 in	0.43 in	0.295 in
2	"W8x10"	"W200x15"	7.89 in	3.94 in	0.205 in	0.170 in
3	"W6x20"	"W150x30"	6.20 in	6.02 in	0.365 in	0.26 in

$wi :=$ (above)

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



$desI_W = "W6x20"$	$desM_W = "W150x30"$	Designation
$d_W = 6.2$ in	$d_W = 157.5$ mm	W Depth
$b_W = 6$ in	$b_W = 152.9$ mm	W Width
$t_W = 0.4$ in	$t_W = 9.3$ mm	W Flange Thickness
$w_W = 0.3$ in	$w_W = 6.6$ mm	W Web Thickness

Span Informaton

$L := 11$ ft $L = 11.00$ ft $L = 3.353$ m Span Length

Reaction Factor:

$\alpha_r := 50$ %

Reaction Factor Override:

$\alpha'_r := 0$ % $\alpha'_r = 0.00$ % Reaction Factor Override

```
if α'_r = 0 %
  α_r := α_r
else
  α_r := α'_r
```

$\alpha_r = 50.00$ % Reaction as % of Total UDL

Section Properties:

$A_W := 2 \cdot b_W \cdot t_W + \left(d_W - 2 \cdot t_W\right) \cdot w_W$

$A_W = 5.8168\ \text{in}^2$ $A_W = 3753\ \text{mm}^2$ Area

$Sx_W := \frac{1}{6 \cdot d_W} \cdot \left(b_W \cdot {d_W}^3 - \left(b_W - w_W\right) \cdot \left(d_W - 2 \cdot t_W\right)^3\right)$

$Sx_W = 13.2261\ \text{in}^3$ $Sx_W = 2.1674 \cdot 10^5\ \text{mm}^3$ Elastic Section Modulus

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

$Zx_W = 14.7661\ \text{in}^3$ $Zx_W = 2.4197 \cdot 10^5\ \text{mm}^3$ Plastic Section Modulus

Section Properties Override: **Use if Calculated Section Properties Differ From Published Section Properties**

$A' := 0\ \text{in}^2$ Area Override

```
if A' = 0 in^2
  A_W := A_W
else
  A_W := A'
```

$A_W = 5.82\ \text{in}^2$ $A_W = 3753\ \text{mm}^2$

$Sx' := 0\ \text{in}^3$ Section Modulus Override

```
if Sx' = 0 in^3
  Sx_W := Sx_W
else
  Sx_W := Sx'
```

$Sx_W = 13.23\ \text{in}^3$ $Sx_W = 2.17 \cdot 10^5\ \text{mm}^3$

$Zx' := 0\ \text{in}^3$ Plastic Section Override

```
if Zx' = 0 in^3
  Zx_W := Zx_W
else
  Zx_W := Zx'
```

$Zx_W = 14.77\ \text{in}^3$ $Zx_W = 2.42 \cdot 10^5\ \text{mm}^3$

Class of Section

$bt_1 := \frac{145}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$ $bt_1 = 7.8095$ b/t Ratio Class 1

$bt_2 := \frac{170}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$ $bt_2 = 9.156$ b/t Ratio Class 2

$bt_3 := \frac{200}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$ $bt_3 = 10.7717$ b/t Ratio Class 3

$dw_1 := \frac{1600}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$ $dw_1 = 86.1738$ d/w Ratio Class 1

$dw_2 := \frac{1700}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$ $dw_2 = 91.5597$ d/w Ratio Class 2

$dw_3 := \frac{1900}{\sqrt{\frac{f_{y1}}{\text{MPa}}}}$ $dw_3 = 102.3314$ 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
```

$Class = 2$ — Section Class

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

$M_r = 55.4\ K\_ft$ $M_r = 75.1\ kN\_m$ — Moment Resistance

Maximum UDL (assuming full lateral support):

$q_f := \frac{8 \cdot M_r}{L^2}$ $q_f = 3.7\ Klf$ $q_f = 53.4\ kNpm$ — Maximum Load per Unit

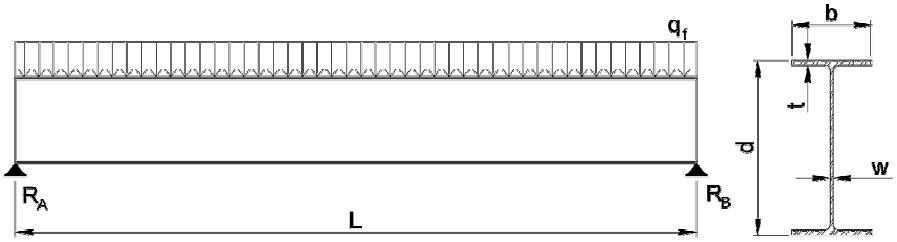
Total UDL:

$Q_f := q_f \cdot L$ $Q_f = 40.3\ K$ $Q_f = 179.1\ kN$ — Total UDL

Design Reaction:

$R_{fA} := \alpha_r \cdot Q_f$ $R_{fA} = 20.1\ K$ $R_{fA} = 89.6\ kN$ — Design Reaction UDL

Summary:



Material Property Factors

Steel	$\varphi_s = 0.9$
Weld	$\varphi_w = 0.67$
Live Load Factor	$\alpha_L = 1.5$
Dead Load Factor	$\alpha_D = 1.25$

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

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

Steel Property Factors

Steel Designation (Metric)	$desM_1 = "G40.21-350W"$	
Yield Strength	$f_{y1} = 50\ Ksi$	$f_{y1} = 345\ MPa$
Ultimate Strength	$F_{u1} = 65\ Ksi$	$F_{u1} = 448\ MPa$
Poisson Ratio	$\nu = 0.3$	$\nu = 0.3$
Young's Modulus	$E_s = 29000\ Ksi$	$E_s = 2.00 \cdot 10^5\ MPa$
Shear Modulus	$G_s = 11154\ Ksi$	$G_s = 76903\ MPa$
Density	$\gamma_s = 489\ pcf$	$\gamma_s = 76.8\ kNpcm$

Beam Properties

Beam Designation (Imperial)	$desI_W = "W6x20"$	
Beam Designation (Metric)	$desM_W = "W150x30"$	
Width	$b_W = 6.020\ in$	$b_W = 152.9\ mm$
Depth	$d_W = 6.200\ in$	$d_W = 157.5\ mm$
Flange Thickness	$t_W = 0.365\ in$	$t_W = 9.3\ mm$
Web Thickness	$w_W = 0.260\ in$	$w_W = 6.6\ mm$
Section Class	$Class = 2$	
Area	$A_W = 5.8168\ in^2$	$A_W = 3753\ mm^2$
Elastic Section Modulus	$Sx_W = 13.2261\ in^3$	$Sx_W = 2.17 \cdot 10^5\ mm^3$
Plastic Section Modulus	$Zx_W = 14.7661\ in^3$	$Zx_W = 2.42 \cdot 10^5\ mm^3$
Moment Resistance	$M_r = 55.4\ K\_ft$	$M_r = 75.1\ kN\_m$

Span Information

Span Length	$L = 11\ ft$	$L = 3.353\ m$
Load per Unit Length	$q_f = 3.7\ Klf$	$q_f = 53.4\ kNpm$
Total UDL on Span	$Q_f = 40.3\ K$	$Q_f = 179.1\ kN$
Reaction Factor as % of Total UDL	$\alpha_r = 50.00\ \%$	
Design Reaction	$R_{fA} = 20.1\ K$	$R_{fA} = 89.6\ kN$