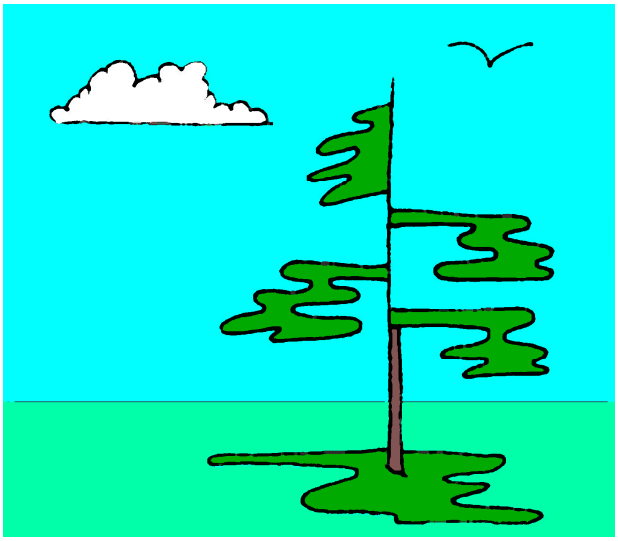
NorthWoods Software



Program Name: Steel-Equip_Support_L

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 22.04.13

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	

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Input Data:

Material Property Factors:

$\varphi_s := 0.90$ Rolled Sections

$\varphi_w := 0.67$ Weld

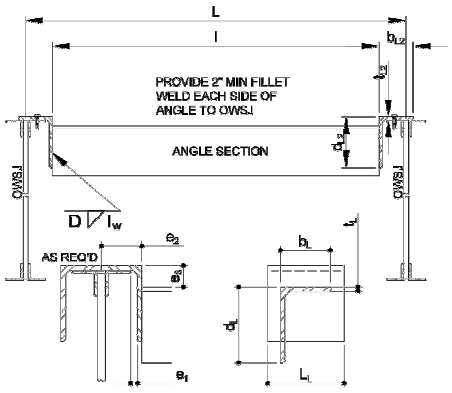
Load Factors:

$\alpha_D := 1.25$

$\alpha_L := 1.5$

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

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



Steel Properties:

Angle Section: $st_{NDX} := 1$

$st :=$

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

$desM_{st1} := st_{st_{NDX},2}$ $f_{y1} := st_{st_{NDX},3}$ $F_{u1} := st_{st_{NDX},4}$

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

Clip Angle: $st_{NDX} := 1$ $desM_{st2} := st_{st_{NDX},2}$ $f_{y2} := st_{st_{NDX},3}$ $F_{u2} := st_{st_{NDX},4}$

Welding:

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

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

Size: $ws_{NDX} := 7$

$ws :=$

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

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

Framing Geometry:

$L := 59.2\ in$	$L = 59.2\ in$	$L = 1503.7\ mm$	Support Span
$e_1 := 1.0\ in$	$e_1 = 1\ in$	$e_1 = 25.4\ mm$	Offset Dimension
$e_2 := 3.0\ in$	$e_2 = 3\ in$	$e_2 = 76.2\ mm$	Half Joist Chord Width
$e_3 := 0.3125\ in$	$e_3 = 0.3125\ in$	$e_3 = 7.9\ mm$	Depth of Channel Below Angle
$dr := 240$	$dr = 240$		Minimum Deflection Ratio

Section Properties (L Section): $an_{NDX} := 2$

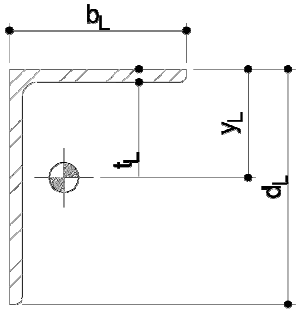
$an :=$

NDX	desI	desM	d	b	t
1	"L6x4x3/8"	"L150x100x10"	6 in	4 in	0.375 in
2	"L5x5x5/16"	"L125x125x8"	5 in	5 in	0.3125 in
3	"L4x4x5/16"	"L100x100x8"	4 in	4 in	0.3125 in

$desI_L := an_{an_{NDX},2}$ $desM_L := an_{an_{NDX},3}$

$d_L := an_{an_{NDX},4}$ $b_L := an_{an_{NDX},5}$

$t_L := an_{an_{NDX},6}$



$desI_L = "L5x5x5/16"$ Imperial Designation

$desM_L = "L125x125x8"$ Metric Designation

$d_L = 5.00\ in$	$d_L = 127\ mm$	Angle Depth
$b_L = 5.00\ in$	$b_L = 127\ mm$	Angle Width
$t_L = 0.31\ in$	$t_L = 7.9\ mm$	Angle Thickness

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$A_L := \left(d_L + b_L - t_L\right) \cdot t_L$ $A_L = 3.03\ \text{in}^2$ $A_L = 1953.1211\ \text{mm}^2$ Angle Area

$x_L := \frac{t_L}{2 \cdot A_L} \cdot \left(b_L^{\,2} + d_L \cdot t_L - t_L^{\,2}\right)$ $x_L = 1.37\ \text{in}$ $x_L = 34.6946\ \text{mm}$ Angle Centroid (X-Axis)

$y_L := \frac{t_L}{2 \cdot A_L} \cdot \left(d_L^{\,2} + b_L \cdot t_L - t_L^{\,2}\right)$ $y_L = 1.37\ \text{in}$ $y_L = 34.6946\ \text{mm}$ Angle Centroid (Y-Axis)

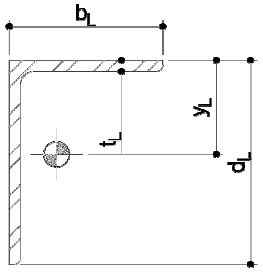
$Ix_L := \frac{1}{3} \cdot \left(t_L \cdot \left(d_L - y_L\right)^3 + b_L \cdot y_L^{\,3} - \left(b_L - t_L\right) \cdot \left(y_L - t_L\right)^3\right)$ $Ix_L = 7.4202\ \text{in}^4$ $Ix_L = 3.0885 \cdot 10^6\ \text{mm}^4$ Angle Moment of Inertia (X-Axis)

$Sx_{Lt} := \frac{Ix_L}{y_L}$ $Sx_{Lt} = 5.43\ \text{in}^3$ $Sx_{Lt} = 89020.6423\ \text{mm}^3$ Angle Section Modulus (X-Axis)

$Sx_{Lb} := \frac{Ix_L}{\left(d_L - y_L\right)}$ $Sx_{Lb} = 2.04\ \text{in}^3$ $Sx_{Lb} = 33459.9086\ \text{mm}^3$ Angle Section Modulus (X-Axis)

Section Properties (Clip Angle): $an_{NDX} := 1$ $desI_{L2} := an_{an_{NDX}\,2}$ $desM_{L2} := an_{an_{NDX}\,3}$ $d_{L2} := an_{an_{NDX}\,4}$

$b_{L2} := an_{an_{NDX}\,5}$ $t_{L2} := an_{an_{NDX}\,6}$



$desI_{L2} = \text{"L6x4x3/8"}$ Imperial Designation

$desM_{L2} = \text{"L150x100x10"}$ Metric Designation

$d_{L2} = 6.00\ \text{in}$ $d_{L2} = 152.4\ \text{mm}$ Angle Depth

$b_{L2} = 4.00\ \text{in}$ $b_{L2} = 101.6\ \text{mm}$ Angle Width

$t_{L2} = 0.38\ \text{in}$ $t_{L2} = 9.5\ \text{mm}$ Angle Thickness

$L_{L2} := 6\ \text{in}$ $L_{L2} = 6.00\ \text{in}$ $L_{L2} = 152.4\ \text{mm}$ Length of Clip Angle

$l := L - 2 \cdot \left(e_2 + t_{L2}\right)$ $l = 52.45\ \text{in}$ $l = 1332.2\ \text{mm}$ Channel Clear Span

$Zx_{L2} := \frac{L_{L2} \cdot t_{L2}^{\,2}}{4}$ $Zx_{L2} = 0.21\ \text{in}^3$ $Zx_{L2} = 3457\ \text{mm}^3$ Plastic Modulus of Support L

Effective Length of Weld Each End of L Section:

```
if d_L ≤ d_L2 − e_3
  l_w := 2·d_L − 1·t_L
else
  l_w := 2·(d_L2 − e_3) − t_L
```

$e_3 = 0.31\ \text{in}$

$l_w = 9.69\ \text{in}$ $l_w = 246.06\ \text{mm}$

$l_{w2} := 0\ \text{in}$ $l_{w2} = 0.00\ \text{in}$ $l_{w2} = 0.0\ \text{mm}$ Weld Length at OWSJ

Effective Length of Weld Each End of L Section Override:

$l'_w := 0\ \text{in}$

```
if l'_w = 0 in
  l_w := l_w
else
  l_w := l'_w
```

$l_w = 9.69\ \text{in}$ $l_w = 246.06\ \text{mm}$ Effective Weld Length

L Section Design Loads:

$M_{rL} := \varphi_s \cdot f_{y1} \cdot \min\left(\left[\begin{array}{cc} Sx_{Lt} & Sx_{Lb} \end{array}\right]\right)$

	$M_{rL} = 7.66$ K_ft	$M_{rL} = 10.4$ kN_m	Moment Capacity of Angle
$q_{fL} := \frac{8 \cdot M_{rL}}{l^2}$	$q_{fL} = 3.21$ Klf	$q_{fL} = 46.8$ kNpm	UDL on Angle
$R_{fL} := \frac{q_{fL} \cdot l}{2}$	$R_{fL} = 7.01$ K	$R_{fL} = 31.2$ kN	Factored Load Reaction

Deflection for L Section:

$q_{sL} := \frac{q_{fL}}{\alpha_D}$	$q_{sL} = 2.6$ Klf	$q_{sL} = 37.4$ kNpm	Service Load per Foot
$\Delta_L := \frac{5}{385 \cdot E_s \cdot Ix_L} \cdot \left(q_{sL} \cdot l^4\right)$	$\Delta_L = 0.10$ in	$\Delta_L = 2.5$ mm	UDL Deflection
$dr' := \frac{l}{\Delta_L}$	$dr' = 537$		Deflection Ratio

Clip Angle:

Forces:

$R_{fL2} := R_{fL}$	$R_{fL2} = 7.01$ K	$R_{fL2} = 31.2$ kN	Support Clip Angle Reaction

Factored Load Reaction Override:

$R'_{fL2} := 0$ K

```
if R'fL2 = 0 K
    RfL2 := RfL2
else
    RfL2 := R'fL2
```

	$R_{fL2} = 7.01$ K	$R_{fL2} = 31.2$ kN	Factored Load Reaction Override

Support at OWSJ: $fx_{NDX} := 1$

$fx := \left[\begin{array}{ll} 1 & \text{"Simple Support"} \\ 2 & \text{"Fixed Support"} \end{array}\right]$ $\quad des_{fx} := fx_{fx_{NDX}\,2}$

```
if fxNDX = 1
    MfL2 := RfL2 · (e1 + tL)
    M'fL2 := 0 K_in
else
    MfL2 := RfL2 · (e1 + tL2)/2
    M'fL2 := MfL2
```

	$M_{fL2} = 9.20$ K_in	$M_{fL2} = 1039.1$ kN_mm	Support Clip Angle Moment
	$M'_{fL2} = 0.00$ K_in	$M'_{fL2} = 0.0$ kN_mm	S. Clip Angle Moment at OWSJ

Resistance:

$M_{rL2} := \varphi_s \cdot f_{y2} \cdot Zx_{L2}$	$M_{rL2} = 9.49$ K_in	$M_{rL2} = 1072.5$ kN_mm	Moment Resistance of Clip Angle

Weld Design:

$v_{rw} := \varphi_w \cdot 0.67 \cdot X_u \cdot \frac{1}{\sqrt{2}}$	$v_{rw} = 22.2$ ksi	$v_{rw} = 153.2$ MPa	Weld Material Strength
$v_{rb1} := \varphi_w \cdot 0.67 \cdot F_{u1}$	$v_{rb1} = 29.2$ Ksi	$v_{rb1} = 201.2$ MPa	Channel Strength
$v_{rb2} := \varphi_w \cdot 0.67 \cdot F_{u2}$	$v_{rb2} = 29.2$ Ksi	$v_{rb2} = 201.2$ MPa	Clip Angle Strength

Minimum Weld Resistance:

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

Minimum Fillet Weld Size based on Base Material Thickness:

$t_{conn} := \max\left(\left[\begin{array}{cc} t_L & t_{L2} \end{array}\right]\right)$

```
if t_conn < 0.25 in
  D_min := .125 in
else
  if t_conn ≤ 0.50 in
    D_min := 0.1875 in
  else
    if t_conn ≤ 0.75 in
      D_min := 0.250 in
    else
      D_min := 0.3125 in
```

$D_{min} = 0.1875\ \text{in}$ $D_{min} = 4.76\ \text{mm}$

Clip Angle to Weld L Section:

$V_r := l_w \cdot D \cdot V_{rw}$ $V_r = 53.81\ \text{K}$ $V_r = 239.37\ \text{kN}$

Clip Angle Weld to OWSJ

$Sx_w := \frac{D \cdot l_{w2}^{\,2}}{6}$ $Sx_w = 0.0000\ \text{in}^3$ $Sx_w = 0.00\ \text{mm}^3$ Section Modulus of OWSJ Weld

$M_{rw} := Sx_w \cdot V_{rw}$ $M_{rw} = 0.00\ \text{K\_in}$ $M_{rw} = 0.0\ \text{kN\_mm}$ Moment Resist of OWSJ Weld

Summary:

Material Property Factors:

Rolled Sections $\varphi_s = 0.9$

Weld $\varphi_w = 0.67$

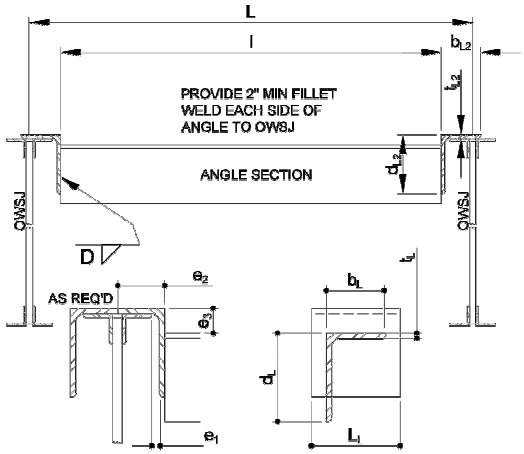
Load Factors:

Dead Load Factor $\alpha_D = 1.25$

Live Load Factor $\alpha_L = 1.5$

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

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



Material

Channel

Channel Designation (Metric)	$desM_{st1} = "G40.21-350W"$	
Channel Yield Strength	$f_{y1} = 50\ Ksi$	$f_{y1} = 50\ Ksi$
Channel Ultimate Strength	$F_{u1} = 65\ Ksi$	$F_{u1} = 65\ Ksi$

Clip Angle

Clip Angle Designation (Metric)	$desM_{st2} = "G40.21-350W"$	
Clip Angle Yield Strength	$f_{y2} = 50\ Ksi$	$f_{y2} = 50\ Ksi$
Clip Angle Ultimate Strength	$F_{u2} = 65\ Ksi$	$F_{u2} = 65\ Ksi$
Modulus of Elasticity	$E_s = 29000\ Ksi$	$E_s = 29000\ Ksi$
Poisson's Ratio	$\nu = 0.3$	$\nu = 0.3$
Shear Modulus	$G_s = 11154\ Ksi$	$G_s = 11154\ Ksi$
Density	$\gamma_s = 489\ pcf$	$\gamma_s = 489\ pcf$

Weld Material

Designation (Imperial)	$desI_w = "E70xx"$	
Designation (Metric)	$desM_w = "E49xx"$	
Ultimate Strength	$X_u = 70\ Ksi$	
Size Designation (Imperial)	$desI_D = "1/4"$	
Size Designation (Metric)	$desM_D = ""$	
Size	$D = 0.25\ in$	
Effective Weld Length Each Side	$l_w = 9.6875\ in$	$l_w = 246.0625\ mm$

L Section Properties

Designation	$desI_L = "L5x5x5/16"$	$desM_L = "L125x125x8"$
Width	$b_L = 5.00\ in$	$b_L = 127.0\ mm$
Depth	$d_L = 5.00\ in$	$d_L = 127.0\ mm$
Flange Thickness	$t_L = 0.31\ in$	$t_L = 7.9\ mm$
Area	$A_L = 3.03\ in^2$	$A_L = 1953\ mm^2$
Section Modulus (X-Axis)	$Sx_{Lt} = 5.43\ in^3$	$Sx_{Lt} = 89021\ mm^3$
Section Modulus (X-Axis)	$Sx_{Lb} = 2.04\ in^3$	$Sx_{Lb} = 33460\ mm^3$
Moment of Inertia (X-Axis)	$Ix_L = 7.42\ in^4$	$Ix_L = 3.09 \cdot 10^6\ mm^4$
Resisting Moment	$M_{rL} = 7.7\ K\_ft$	$M_{rL} = 10.4\ kN\_m$

Factored Load Reaction	$R_{fL} = 7.01\ K$	$R_{fL} = 31.17\ kN$

Clip Angle Properties

Designation	$desI_{L2} = "L6x4x3/8"$	$desM_{L2} = "L150x100x10"$
Width	$b_{L2} = 4.00\ in$	$b_{L2} = 101.6\ mm$
Depth	$d_{L2} = 6.00\ in$	$d_{L2} = 152.4\ mm$
Flange Thickness	$t_{L2} = 0.38\ in$	$t_{L} = 7.9\ mm$
Length	$L_{L2} = 6.00\ in$	$L_{L2} = 152.4\ mm$
Plastic Section Modulus (X-Axis)	$Zx_{L2} = 0.21\ in^3$	$Zx_{L2} = 3456.6\ mm^3$

Framing Geometry

Support Span	$L = 59.2\ in$	$L = 1503.7\ mm$
Offset Dimension	$e_1 = 1\ in$	$e_1 = 25.4\ mm$
Offset Dimension	$e_2 = 3\ in$	$e_2 = 76.2\ mm$
Offset Dimension	$e_3 = 0.3125\ in$	$e_3 = 7.9\ mm$

$Check\ (e_1 \le 1.0\ in) = "...OK"$

Clear Span	$l = 52.45\ in$	$l = 1332.2\ mm$

Design Loading

Factored Load Resistance	$q_{fL} = 3.21\ Klf$	$q_{fL} = 46.79\ kNpm$
Factored Load Reaction	$R_{fL} = 7.01\ K$	$R_{fL} = 31.17\ kN$
Support Clip Angle Reaction	$R_{fL2} = 7.01\ K$	$R_{fL2} = 31.17\ kN$
Support Clip Angle Moment	$M_{fL2} = 9.20\ K\_in$	$M_{fL2} = 1039.13\ kN\_mm$
Moment Resistance of Clip Angle	$M_{rL2} = 9.49\ K\_in$	$M_{rL2} = 1072.5\ kN\_mm$

$Check\ (M_{rL2} \ge M_{fL2}) = "...OK"$ $Check\ \left(\frac{M_{rL2}}{\varphi_s} \ge M_{fL2}\right) = "...OK"$

Deflection for L Section

Service Load per Foot	$q_{sL} = 2.57\ Klf$	$q_{sL} = 37.43\ kNpm$
UDL Deflection	$\Delta_L = 0.10\ in$	$\Delta_L = 2.48\ mm$
Deflection Ratio	$dr' = 537$	

$Check\ (dr' \ge dr) = "...OK"$

Clip Angle

Type of Support at OWSJ	$des_{fx} = "Simple\ Support"$	
Support Clip Angle Moment	$M_{fL2} = 9.20\ K\_in$	$M_{fL2} = 1039.1\ kN\_mm$
S. Clip Angle Moment at OWSJ	$M'_{fL2} = 0.00\ K\_in$	$M'_{fL2} = 0.0\ kN\_mm$
Moment Resistance of Clip Angle	$M_{rL2} = 9.49\ K\_in$	$M_{rL2} = 1072.47\ kN\_mm$

$Check\ (M_{rL2} \ge M_{fL2}) = "...OK"$ $Check\ \left(\frac{M_{rL2}}{\varphi_s} \ge M_{fL2}\right) = "...OK"$

Welding

Weld Resistance	$v_{rw} = 22.2\ ksi$	$v_{rw} = 153.2\ MPa$
Minimum Fillet Weld Size	$D_{min} = 0.1875\ in$	$D_{min} = 4.76\ mm$
Clip Angle to Channel Weld Length Each Side	$l_w = 9.69\ in$	$l_w = 246.06\ mm$
Weld Length at OWSJ	$l_{w2} = 0.00\ in$	$l_{w2} = 0.0\ mm$

Clip Angle to Channel Resistance $V_r = 53.81\ K$ $V_r = 239.37\ kN$

$Check\left(V_r \geq R_{fL}\right) = "...OK"$ $Check\left(\frac{V_r}{\varphi_s} \geq R_{fL}\right) = "...OK"$

Section Modulus of OWSJ Weld $Sx_w = 0.0000\ in^3$ $Sx_w = 0.00\ mm^3$

Moment Resist of OWSJ Weld $M_{rw} = 0.00\ K\_in$ $M_{rw} = 0.0\ kN\_mm$

Moment at OWSJ $M'_{fL2} = 0.00\ K\_in$ $M'_{fL2} = 0.0\ kN\_mm$

$Check\left(M_{rw} \geq M'_{fL2}\right) = "...OK"$ $Check\left(\frac{M_{rw}}{\varphi_s} \geq M'_{fL2}\right) = "...OK"$

Moment Resist of OWSJ Weld $M_{rw} = 0.00\ K\_in$ $M_{rw} = 0.0\ kN\_mm$

$Check\left(M_{rw} \geq M'_{fL2}\right) = "...OK"$ $Check\left(\frac{M_{rw}}{\varphi_s} \geq M'_{fL2}\right) = "...OK"$