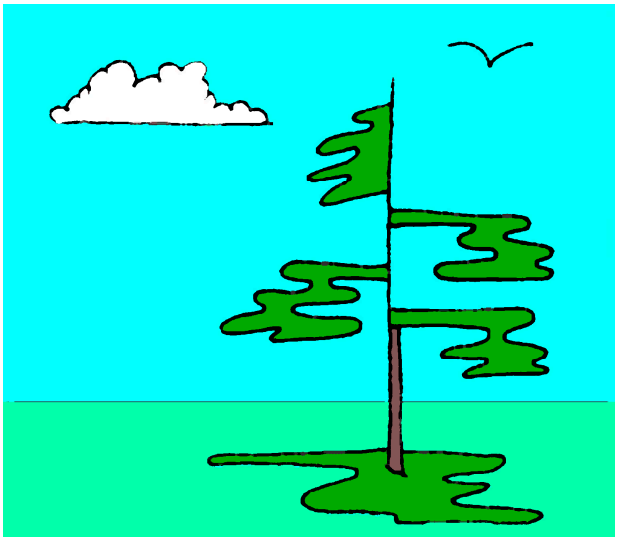
NorthWoods Software



Program Name: Gusset_HSS_e

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 22.06.25

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

$\varphi_w := 0.67$ Weld

$\varphi_b := 0.80$ Bolt

$\varphi_{br} := 0.80$ Bolt Bearing

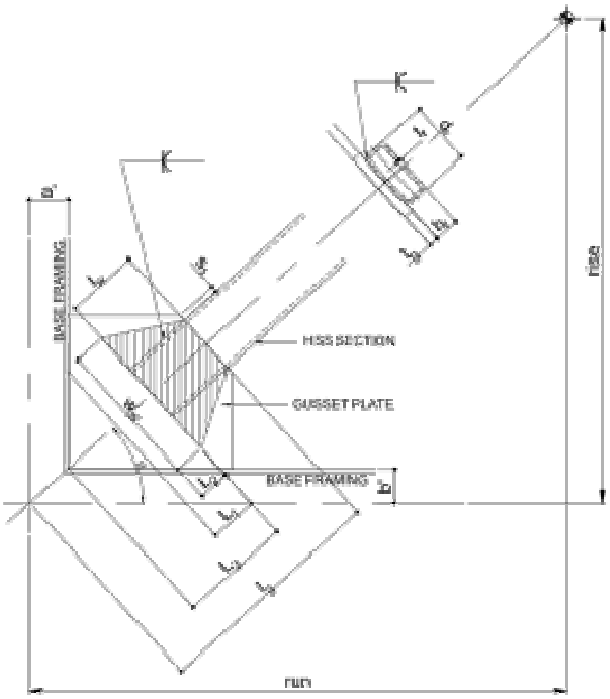
Load Factors:

$\alpha_D := 1.25$

$\alpha_L := 1.5$

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

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



Steel Properties:

HSS Sections: $st_{NDX} := 1$

$st :=$

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

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

$\nu := 0.3$ $E_s := 29000\ Ksi$ $\gamma_s := 489\ pcf$

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

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

Base Material: $st_{NDX} := 2$ $desM_3 := st_{st_{NDX},2}$ $f_{y3} := st_{st_{NDX},3}$ $F_{u3} := st_{st_{NDX},4}$

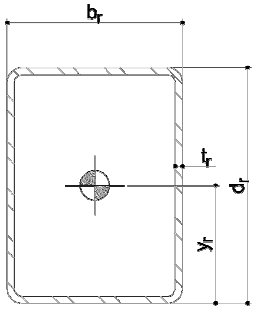
Physical Properties: c b a

HSSr: $re_{NDX} := 1$

NDX	desI	desM	d	b	t
1	"HSS 10x4x0.50"	"HSS 254x102x12.7"	10.00 in	4.00 in	0.50 in
2	"HSS 2x2x0.125"	"HSS 51x51x3.2"	2.00 in	2.00 in	0.125 in

$re :=$ (above)

$desI_r := re_{re_{NDX},2}$ $desM_r := re_{re_{NDX},3}$ $d_r := re_{re_{NDX},4}$ $b_r := re_{re_{NDX},5}$ $t_r := re_{re_{NDX},6}$



$desI_r = $ "HSS 10x4x0.50"			Designation (Imperial)
$desM_r = $ "HSS 254x102x12.7"			Designation (Metric)
$d_r = 10.00$ in	$d_r = 254.00$ mm		Depth
$b_r = 4.00$ in	$b_r = 101.60$ mm		Width
$t_r = 0.50$ in	$t_r = 12.70$ mm		Wall Thickness

Gusset:

$t_g := 0.75$ in	$t_g = 0.75$ in	$t_g = 19.05$ mm	Gusset Thickness
$s_1 := 1.0$ in	$s_1 = 1$ in	$s_1 = 25.4$ mm	Gusset Plate Connection Width
$l_g := 37.107$ in	$l_g = 37.107$ in	$l_g = 942.5178$ mm	Centroid to Connection Width
$a' := 6$ in	$a' = 6$ in	$a' = 152.4$ mm	Gusset Plate Connection Width
$b' := 5.312$ in	$b' = 5.312$ in	$b' = 134.9248$ mm	Centroid to Connection Width
$l_w := 11.4227$ in	$l_w = 11.4227$ in	$l_w = 290.1366$ mm	Length of Weld
$rise := 75.824$ in	$rise = 75.824$ in	$rise = 1925.9296$ mm	Rise of Cross Bracing
$run := 84.043$ in	$run = 84.043$ in	$run = 2134.6922$ mm	Run of Cross Bracing
$\phi := \text{atan}\left(\frac{rise}{run}\right)$	$\phi = 42.0569$ °		Slope of Cross Bracing
$c_{\phi x} := \cos(\phi)$	$c_{\phi x} = 0.7425$		Slope Coefficient (X-Axis)
$c_{\phi y} := \sin(\phi)$	$c_{\phi y} = 0.6699$		Slope Coefficient (Y-Axis)

Factored Design Loads:

$T_f := 103$ K	$T_f = 103.00$ K	$T_f = 458.17$ kN	Factored Tensile Load
$C_f := 103$ K	$C_f = 103.00$ K	$C_f = 458.17$ kN	Factored Compression Load

Welding:

Electrodes: $we_{NDX} := 2$

NDX	Desl	DesM	UTS
1	"E60xx"	"E43xx"	60 ksi
2	"E70xx"	"E49xx"	70 ksi
3	"E80xx"	"E55xx-x"	80 ksi
4	"E90xx"	"E62xx-x"	90 ksi

$we :=$ (above) $desI_w := we_{we_{NDX},2}$ $desM_w := we_{we_{NDX},3}$ $X_u := we_{we_{NDX},4}$

Size: $ws_{NDX} := 12$ c b a

$ws :=$

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

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

Section Properties:

HSSr:

$A_r := d_r \cdot b_r - (d_r - 2 \cdot t_r) \cdot (b_r - 2 \cdot t_r)$

$A_r = 13.00\ in^2$ $A_r = 8387\ mm^2$ Area

$Ix_r := \frac{\left(b_r \cdot d_r^{\,3}\right) - \left((b_r - 2 \cdot t_r) \cdot (d_r - 2 \cdot t_r)^3\right)}{12}$

$Ix_r = 151.08\ in^4$ $Ix_r = 6.29 \cdot 10^7\ mm^4$ Moment of Inertia (X-Axis)

$Sx_r := \frac{2 \cdot Ix_r}{d_r}$ $Sx_r = 30.22\ in^3$ $Sx_r = 5 \cdot 10^5\ mm^3$ Section Modulus (X-Axis)

$Zx_r := \frac{b_r \cdot d_r^{\,2} - (b_r - 2 \cdot t_r) \cdot (d_r - 2 \cdot t_r)^2}{4}$

$Zx_r = 39.25\ in^3$ $Zx_r = 6 \cdot 10^5\ mm^3$ Plastic Modulus (X-Axis)

$Iy_r := \frac{\left(d_r \cdot b_r^{\,3}\right) - \left((d_r - 2 \cdot t_r) \cdot (b_r - 2 \cdot t_r)^3\right)}{12}$

$Iy_r = 33.08\ in^4$ $Iy_r = 1.38 \cdot 10^7\ mm^4$ Moment of Inertia (Y-Axis)

$Sy_r := \frac{2 \cdot Iy_r}{b_r}$ $Sy_r = 16.54\ in^3$ $Sy_r = 3 \cdot 10^5\ mm^3$ Section Modulus (Y-Axis)

$Zy_r := \frac{d_r \cdot b_r^{\,2} - (d_r - 2 \cdot t_r) \cdot (b_r - 2 \cdot t_r)^2}{4}$

$Zy_r = 19.75\ in^3$ $Zy_r = 3 \cdot 10^5\ mm^3$ Plastic Modulus (Y-Axis)

Section Property Override:

$A' := 11.6\ in^2$ Area Override

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

$A_r = 11.60\ in^2$ $A_r = 7484\ mm^2$ HSSs Area

$Sx' := 25.8\ in^3$ Section Modulus (X-Axis) Override

if $Sx' = 0\ in^3$
  $Sx_r := Sx_r$
else
  $Sx_r := Sx'$

$Sx_r = 25.80\ in^3$ $Sx_r = 4.23 \cdot 10^5\ mm^3$ HSSs Section Modulus (X-Axis)

$Zx' := 34.1\ in^3$ Plastic Section (X-Axis) Override

if $Zx' = 0\ in^3$
  $Zx_r := Zx_r$
else
  $Zx_r := Zx'$

$Zx_r = 34.10\ in^3$ $Zx_r = 5.59 \cdot 10^5\ mm^3$ HSSs Plastic Section (X-Axis)

$Sy' := 14.7\ in^3$ Section Modulus (Y-Axis) Override

if $Sy' = 0\ in^3$
  $Sy_r := Sy_r$
else
  $Sy_r := Sy'$

$Sy_r = 14.70\ in^3$ $Sy_r = 2.41 \cdot 10^5\ mm^3$ HSSs Section Modulus (Y-Axis)

$Zy' := 17.6\ in^3$ Plastic Section (Y-Axis) Override

if $Zy' = 0\ in^3$
  $Zy_r := Zy_r$
else
  $Zy_r := Zy'$

$Zy_r = 17.60\ in^3$ $Zy_r = 2.88 \cdot 10^5\ mm^3$ HSSs Plastic Section (Y-Axis)

Class of Section:

if $\frac{b_r}{t_r} \le \frac{525}{\sqrt{\frac{f_{y1}}{MPa}}}$
  $Class := 1$
else
  if $\frac{b_r}{t_r} \le \frac{670}{\sqrt{\frac{f_{y1}}{MPa}}}$
    $Class := 3$
  else
    $Class := 4$

$Class = 1$ Class of Section

Moment Resistance:

if $(Class = 1) \vee (Class = 2)$
  $M_r := \varphi_s \cdot f_{y1} \cdot Zx_r$
else
  $M_r := \varphi_s \cdot f_{y1} \cdot Sx_r$

$M_r = 127.88\ K\_ft$ $M_r = 173.38\ kN\_m$ HSS Moment Resistance

Connection Moment:

$M_{fr} := \max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right) \cdot \frac{\left(b_r + t_g\right)}{2}$

$M_{fr} = 244.6\ K\_in$ $M_{fr} = 27.6\ kN\_m$ HSS Factored Moment Moment

Combined Stresses (HSSr):

$$\sigma_{1r} := \frac{\max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right)}{A_r} + \frac{M_{fr}}{Sy_r}$$

$\sigma_{1r} = 25.5$ Ksi $\sigma_{1r} = 176.0$ MPa $Check\left(\varphi_s \cdot f_{y1} \geq \sigma_{1r}\right) =$ "...OK"

Gusset Plate:

Geometry:

$w_{wg} := d_r + 2 \cdot s_1$	$w_{wg} = 12.00$ in	$w_{wg} = 304.8$ mm	Gusset Plate Conn Width
$w_w := d_r + 2 \cdot l_w \cdot \tan(30°)$	$w_w = 23.19$ in	$w_w = 589.0$ mm	Whitmore Width
$AB := l_g$	$AB = 37.11$ in	$AB = 942.5$ mm	See Image
$AB_x := AB \cdot c_{\phi x}$	$AB_x = 27.55$ in	$AB_x = 699.8$ mm	See Image
$AB_y := AB \cdot c_{\phi y}$	$AB_y = 24.86$ in	$AB_y = 631.4$ mm	See Image
$BF := \frac{d_r + 2 \cdot s_1}{2}$	$BF = 6.00$ in	$BF = 152.4$ mm	See Image
$BD := BF$	$BD = 6.00$ in	$BD = 152.4$ mm	See Image
$EF := BF \cdot c_{\phi x}$	$EF = 4.45$ in	$EF = 113.2$ mm	See Image
$CD := BD \cdot c_{\phi y}$	$CD = 4.02$ in	$CD = 102.1$ mm	See Image
$l_{gx} := AB_x - a' + CD$	$l_{gx} = 25.57$ in	$l_{gx} = 649.5$ mm	Length of Gusset Plate (X-Axis)
$l_{gy} := AB_y - b' + EF$	$l_{gy} = 24.00$ in	$l_{gy} = 609.6$ mm	Length of Gusset Plate (Y-Axis)
$l'_{gx} := AB_x - CD - a'$	$l'_{gx} = 17.53$ in	$l'_{gx} = 445.3$ mm	See Image
$l'_{gy} := AB_y - EF - b'$	$l'_{gy} = 15.09$ in	$l'_{gy} = 383.3$ mm	See Image
$BG := l_w$	$BG = 11.42$ in	$BG = 290.1$ mm	See Image
$GH := \frac{d_r}{2}$	$GH = 5.00$ in	$GH = 127.0$ mm	See Image
$\phi' := \operatorname{atan}\left(\frac{GH}{BG}\right)$	$\phi' = 23.64°$		
$BH := \sqrt{BG^2 + GH^2}$	$BH = 12.47$ in	$BH = 316.7$ mm	See Image
$\phi_{HBC} := 90° - \phi - \phi'$	$\phi_{HBC} = 24.30°$		
$BH_y := BH \cdot \cos\left(\phi_{HBC}\right)$	$BH_y = 11.36$ in	$BH_y = 288.6$ mm	$Check\left(\left(AB_y - b'\right) \geq BH_y\right) =$ "...OK"
$\phi'' := \phi - \phi'$	$\phi'' = 18.42°$		
$BJ_x := BH \cdot \cos(\phi')$	$BJ_x = 11.42$ in	$BJ_x = 290.1$ mm	$Check\left(\left(AB_x - a'\right) \geq BJ_x\right) =$ "...OK"
$l''_{gx} := l_{gx} - w_{wg} \cdot \sin(\phi) + s_1 \cdot \sin(\phi) - l_w \cdot \cos(\phi)$	$l''_{gx} = 9.72$ in	$l''_{gx} = 246.9$ mm	See Image
$l''_{gy} := l_{gy} - w_{wg} \cdot \cos(\phi) + s_1 \cdot \cos(\phi) - l_w \cdot \sin(\phi)$	$l''_{gy} = 8.18$ in	$l''_{gy} = 207.8$ mm	See Image

Strength:

$K := 2$ $K = 2.00$

Effective Unsupported Length:

Approx Whitmore Length:

$l'_g := \max\left(\left[\begin{array}{cc} \frac{b'}{\sin(\phi)} & \frac{a'}{\cos(\phi)} \end{array}\right]\right)$

$l'_g = 8.08\ \text{in}$ $l'_g = 205.26\ \text{mm}$

$L_c := l_g - l'_g - l_w$ $L_c = 17.6033\ \text{in}$ $L_c = 447.1231\ \text{mm}$

Whitmore Length Override:

$L'_c := 0\ \text{in}$

```
if L'_c = 0 in
  L_c := L_c
else
  L_c := L'_c
```

$L_c = 17.6033\ \text{in}$ $L_c = 447.1231\ \text{mm}$

$\lambda := \frac{K \cdot L_c}{\pi \cdot t_g} \cdot \sqrt{\frac{12 \cdot f_{y2}}{E_s}}$ $\lambda = 2.02$

```
if λ ≤ 1.5                                   = 6.61·10^5 N
  G_r := φ_s · 0.658^(λ^2) · f_y2 · w_w · t_g
else
  G_r := φ_s · 0.877/λ^2 · f_y2 · w_w · t_g
```

$G_r = 148.6\ \text{K}$ $G_r = 661.0\ \text{kN}$

$Sx_g := \frac{w_w \cdot t_g^{\,2}}{6}$ $Sx_g = 2.174\ \text{in}^3$ $Sx_g = 35626.1908\ \text{mm}^3$

Connection Moment:

$M_{fg} := \max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right) \cdot \frac{\left(t_g\right)}{2}$

$M_{fg} = 38.6\ \text{K\_in}$ $M_{fg} = 4.4\ \text{kN\_m}$

Combined Stresses:

$\sigma_2 := \frac{\max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right)}{w_w \cdot t_g} + \frac{M_{fg}}{Sx_g}$

$\sigma_2 = 23.7\ \text{Ksi}$ $\sigma_2 = 163.3\ \text{MPa}$

Minimum Weld Size:

$t_w := \max\left(\left[\begin{array}{cc} t_r & t_g \end{array}\right]\right)$ $t_w = 0.75\ \text{in}$ $t_w = 19.05\ \text{mm}$ Maximum Plate Thickness

Plate Thickness Override (Welding):

$t'_w := 0\ \text{in}$ $t'_w = 0.00\ \text{in}$ $t'_w = 0.00\ \text{mm}$ Plate Thickness Override

```
if t'_w = 0 in
  t'_w := t_w
else
  t'_w := t'_w
```

c b a

$t'_w = 0.750\ \text{in}$ $t'_w = 19.1\ \text{mm}$ Design Plate Thickness

```
if t'_w ≤ 0.25 in
  D_min := 0.125 in
else
  if t'_w ≤ 0.5 in
    D_min := 0.1875 in
  else
    if t'_w ≤ 0.75 in
      D_min := 0.25 in
    else
      D_min := 0.3125 in
```

$D_{min} = 0.2500\ in$ $D_{min} = 6.35\ mm$ Minimum Size Fillet Weld

Weld Resistance:

$v_{rw} := \varphi_w \cdot 0.67 \cdot \frac{X_u}{\sqrt{2}}$ $v_{rw} = 22.22\ ksi$ $v_{rw} = 153.20\ MPa$ Weld Strength

$v_{rb1} := \varphi_w \cdot 0.67 \cdot F_{u1}$ $v_{rb1} = 29.18\ Ksi$ $v_{rb1} = 201.18\ MPa$ Base Metal_1 Strength

$v_{rb2} := \varphi_w \cdot 0.67 \cdot F_{u2}$ $v_{rb2} = 29.18\ Ksi$ $v_{rb2} = 201.18\ MPa$ Base Metal_2 Strength

$V_{rw} := \min\left(\left[\begin{array}{ccc} v_{rw} & v_{rb1} & v_{rb2} \end{array}\right]\right)$ $V_{rw} = 22.22\ Ksi$ $V_{rw} = 153.20\ MPa$ Minimum Weld Resistance

HSS Weld to Gusset:

Area of Weld:

$A_w := 2 \cdot D \cdot l_w$ $A_w = 8.567\ in^2$ $A_w = 5527.1018\ mm^2$

Section Modulus of Weld:

$Sx_w := \frac{2 \cdot D \cdot l_w^{\,2}}{6}$ $Sx_w = 16.3098\ in^3$ $Sx_w = 2.6727 \cdot 10^5\ mm^3$

Shear Lag for Weld (CSA S16 Clause 12.3.3.4):

$l'_w := 2 \cdot l_w$ $l'_w = 22.85\ in$ $l'_w = 580.3\ mm$ Total Length of Weld

$A_n := l'_w \cdot D$ $A_n = 8.57\ in^2$ $A_n = 5527.10\ mm^2$ Gross Area of Weld

$x_c := \frac{b_r}{2}$ $x_c = 2\ in$ $x_c = 2\ in$

```
if x_c / l_w > 0.1
  A_ne := min([ A_n · (1.1 − x_c / l_w)   0.8 · A_n ])
else
  A_ne := A_n
```

Moment of Inertia of Cleat

$A_{ne} = 6.85\ in^2$ $A_{ne} = 4422\ mm^2$ Net Area of Weld from Shear Lag

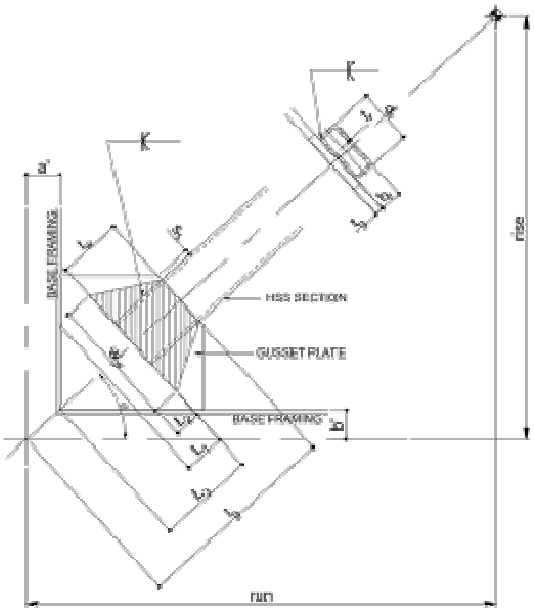
$T_{rw} := \left(A_{ne} \cdot V_{rw}\right)$ $T_{rw} = 152.28\ K$ $T_{rw} = 677.39\ kN$ Resist HSS Weld to Gusset (S16)

Combined Stresses:

$\sigma_v := \frac{\max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right)}{A_{ne}}$ $\sigma_v = 15.0\ Ksi$ $\sigma_v = 103.6\ MPa$

$\sigma_f := \frac{M_{fr}}{Sx_w}$ $\sigma_f = 15.0\ Ksi$ $\sigma_f = 103.4\ MPa$

$\sigma_3 := \sqrt{\sigma_v^{\,2} + \sigma_f^{\,2}}$ $\sigma_3 = 21.2\ Ksi$ $\sigma_3 = 146.4\ MPa$



Summary:

Material Property Factor

$\varphi_s = 0.90$ Rolled Sections

$\varphi_w = 0.67$ Weld

Dead Load Factor $\alpha_D = 1.25$

Live Load Factor $\alpha_L = 1.50$

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

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

Steel

HSS Section

Designation (Metric) $desM_1 = "G40.21\text{-}350W"$

Yield Strength $f_{y1} = 50\ ksi$ $f_{y1} = 345\ MPa$

Ultimate Strength $F_{u1} = 65\ ksi$ $F_{u1} = 448\ MPa$

Gusset

Designation (Metric) $desM_2 = "G40.21\text{-}300W"$

Yield Strength $f_{y2} = 44\ ksi$ $f_{y2} = 303\ MPa$

Ultimate Strength $F_{u2} = 65\ ksi$ $F_{u2} = 448\ MPa$

Base Framing

Designation (Metric) $desM_3 = "G40.21\text{-}300W"$

Yield Strength $f_{y3} = 44\ ksi$ $f_{y3} = 303\ MPa$

Ultimate Strength $F_{u3} = 65\ ksi$ $F_{u3} = 448\ MPa$

Young's Modulus $E_s = 29000\ Ksi$ $E_s = 2.00 \cdot 10^5\ MPa$

Shear Modulus $G_s = 11153.8462\ Ksi$ $G_s = 76903.1\ MPa$

Density $\gamma_s = 489\ pcf$ $\gamma_s = 76.8\ kNpcm$

Slope Information

Rise $rise = 75.8\ in$ $rise = 1.926\ m$

Run $run = 84\ in$ $run = 2.135\ m$

Angle of Load $\phi = 42.0569\ °$

Physical Properties

HSSr:

Designation (Imperial) $desI_r = "HSS\ \ 10x4x0.50"$

Designation (Metric) $desM_r = "HSS\ 254x102x12.7"$

Depth $d_r = 10.00\ in$ $d_r = 254.00\ mm$

Width $b_r = 4.00\ in$ $b_r = 101.60\ mm$

Wall Thickness $t_r = 0.50\ in$ $t_r = 12.70\ mm$

Gusset:

Gusset Thickness	$t_g = 0.75$ in	$t_g = 19.05$ mm
Gusset Plate Connection Width	$s_1 = 1$ in	$s_1 = 25.4$ mm
Centroid to Connection Width	$l_g = 37.107$ in	$l_g = 942.5178$ mm
Length of Weld	$l_w = 11.4227$ in	$l_w = 290.1366$ mm

Base Framing:

Gusset Plate Connection Width	$a' = 6$ in	$a' = 152.4$ mm
Centroid to Connection Width	$b' = 5.312$ in	$b' = 134.9248$ mm

Factored Design Loads

Factored Tensile Load	$T_f = 103.00$ K	$T_f = 458.17$ kN
Factored Compression Load	$C_f = 103.00$ K	$C_f = 458.17$ kN

Welding

Electrode

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

Size

Designation	$desI_D =$ "3/8"	$desM_D =$ ""
Size	$D = 0.3750$ in	$D = 9.5$ mm
Minimum Weld Capacity	$V_{rw} = 22.2$ Ksi	$V_{rw} = 153.2$ MPa
Plate Thickness Override	$t'_w = 0.75$ in	$t'_w = 19.05$ mm
Design Plate Thickness	$t_w = 0.75$ in	$t_w = 19.05$ mm
Minimum Size Fillet Weld	$D_{min} = 0.2500$ in	$D_{min} = 6.35$ mm

$Check\left(D \geq D_{min}\right) =$ "...OK"

Strength

Weld Strength	$v_{rw} = 22.22$ ksi	$v_{rw} = 153.20$ MPa
Base Metal_1 Strength	$v_{rb1} = 29.18$ Ksi	$v_{rb1} = 201.18$ MPa
Base Metal_2 Strength	$v_{rb2} = 29.18$ Ksi	$v_{rb2} = 201.18$ MPa
Minimum Weld Resistance	$V_{rw} = 22.22$ Ksi	$V_{rw} = 153.20$ MPa

Section Properties:

HSSr:

Area	$A_r = 11.60$ in^2	$A_r = 7484$ mm^2
Moment of Inertia (X-Axis)	$Ix_r = 151.08$ in^4	$Ix_r = 6.29 \cdot 10^7$ mm^4
Section Modulus (X-Axis)	$Sx_r = 25.80$ in^3	$Sx_r = 4 \cdot 10^5$ mm^3
Plastic Modulus (X-Axis)	$Zx_r = 34.10$ in^3	$Zx_r = 6 \cdot 10^5$ mm^3
Moment of Inertia (Y-Axis)	$Iy_r = 33.08$ in^4	$Iy_r = 1.38 \cdot 10^7$ mm^4
Section Modulus (Y-Axis)	$Sy_r = 14.70$ in^3	$Sy_r = 2 \cdot 10^5$ mm^3
Plastic Modulus (Y-Axis)	$Zy_r = 17.60$ in^3	$Zy_r = 3 \cdot 10^5$ mm^3
Class of Section	$Class = 1$	
HSS Moment Resistance	$M_r = 1534.50$ K_in	$M_r = 173.38$ kN_m
HSS Factored Moment	$M_{fr} = 244.6$ K_in	$M_{fr} = 27.6$ kN_m

$Check\left(M_r \geq M_{fr}\right) = \text{"...OK"}$ $Check\left(\frac{M_r}{\varphi_s} \geq M_{fr}\right) = \text{"...OK"}$

Combined Stresses for HSSr $\sigma_{1r} = 25.5\ Ksi$ $\sigma_{1r} = 176.0\ MPa$

$Check\left(\varphi_s \cdot f_{y1} \geq \sigma_{1r}\right) = \text{"...OK"}$

Gusset Plate

Effective Length Factor $K = 2.00$

Approx Whitmore Length: $L_c = 17.6033\ in$ $L_c = 447.1231\ mm$

Whitmore Width $w_w = 23.19\ in$ $w_w = 589.02\ mm$

Whitmore Lambda $\lambda = 2.02$

Whitmore Compression $G_r = 148.6\ K$ $G_r = 661.0\ kN$

$Check\left(G_r \geq \max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right)\right) = \text{"...OK"}$ $Check\left(\frac{G_r}{\varphi_s} \geq \max\left(\left[\left|C_f\right| \left|T_f\right|\right]\right)\right) = \text{"...OK"}$

Whitmore Section Modulus $Sx_g = 2.174\ in^3$ $Sx_g = 35626.1908\ mm^3$

Factored Gusset Moment $M_{fg} = 38.6\ K\_in$ $M_{fg} = 4.4\ kN\_m$

Combined Stresses $\sigma_2 = 23.7\ Ksi$ $\sigma_2 = 163.3\ MPa$

$Check\left(\varphi_s \cdot f_{y2} \geq \sigma_2\right) = \text{"...OK"}$

HSS Weld to Gusset:

Total Length of Weld $l'_w = 22.85\ in$ $l'_w = 580.3\ mm$

Gross Area of Weld $A_n = 8.57\ in^2$ $A_n = 5527.10\ mm^2$

Net Area of Weld from Shear Lag $A_{ne} = 6.85\ in^2$ $A_{ne} = 4422\ mm^2$

Combined Stresses: $\sigma_3 = 21.2\ Ksi$ $\sigma_3 = 146.4\ MPa$

$Check\left(V_{rw} \geq \sigma_3\right) = \text{"...OK"}$ $Check\left(\frac{V_{rw}}{\varphi_s} \geq \sigma_3\right) = \text{"...OK"}$

Gusset Geometry

Bracing Member Slope $\phi = 42.06\ °$

Offset from Joint Centroid to Gusset (X-Axis) $a' = 6.00\ in$ $a' = 152.40\ mm$

Offset from Joint Centroid to Gusset (Y-Axis) $b' = 5.31\ in$ $b' = 134.92\ mm$

Bracing Member to Gusset Offset $s_1 = 1.00\ in$ $s_1 = 25.40\ mm$

Length of Weld $l_w = 11.4227\ in$ $l_w = 290.1366\ mm$

Length of Gusset Plate (X-Axis) $l_{gx} = 25.57\ in$ $l_{gx} = 649.5\ mm$

See Image $l'_{gx} = 17.53\ in$ $l'_{gx} = 445.3\ mm$

See Image $l''_{gx} = 9.72\ in$ $l''_{gx} = 246.9\ mm$

See Image $l_{gy} = 24.00\ in$ $l_{gy} = 609.6\ mm$

See Image $l'_{gy} = 15.09\ in$ $l'_{gy} = 383.3\ mm$

Length of Gusset Plate (Y-Axis) $l''_{gy} = 8.18\ in$ $l''_{gy} = 207.8\ mm$