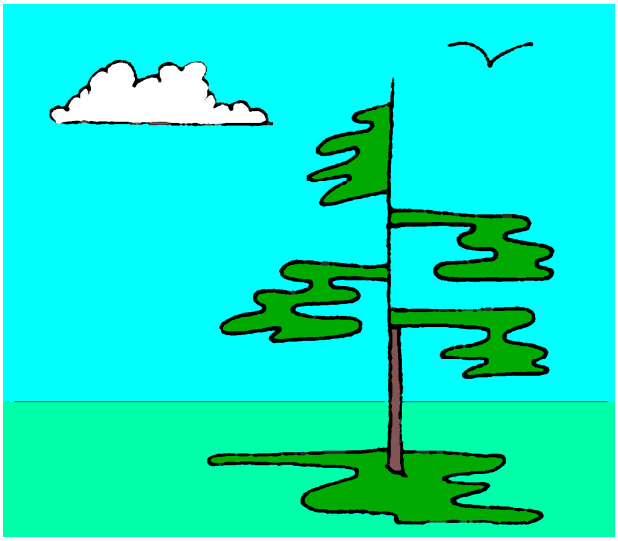
# NorthWoods Software



**Program Name:** Conn-HSS_Slotted_Gusset

**Project Name:** -

**Project Number:** -

**Project Description:** -

**Project Designer:** Dik

**Last Revised (yy-mm-dd):** 21.07.16

**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 |

## Input Data

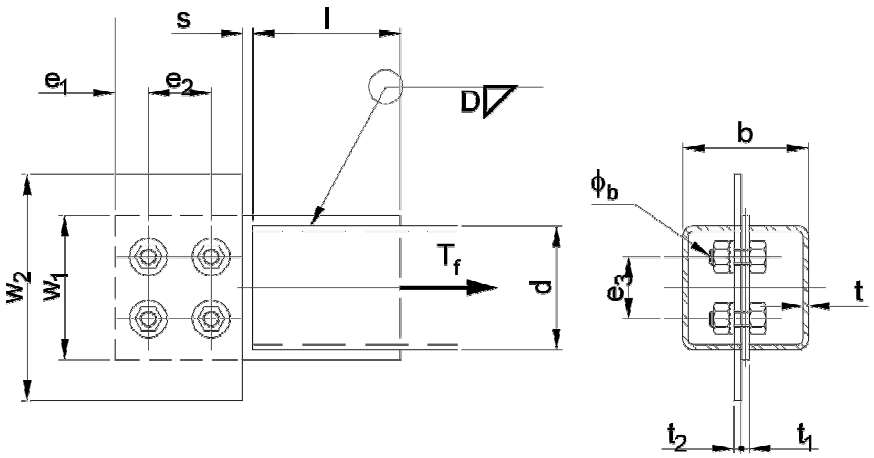
### Material Property Factors:

$\varphi_s := 0.90$ Rolled Sections
$\varphi_w := 0.67$ Weld
$\varphi_b := 0.8$ Bolts
$\varphi_{br} := 0.8$ Bolts Bearing
$\varphi_u := 0.75$ Block Shear

### Load Factors:

$\alpha_L := 1.50$

$\alpha_D := 1.25$




### Physical Properties:

**HSSr Dimensions(Rectangular):** $tu_{NDX} := 1$

NDX desI desM d b t

$tu := [\ 1\ \text{"HSS5x5x.25"}\ \text{"HSS127x127x6.4"}\ 5.00\ \text{in}\ 5.00\ \text{in}\ 0.25\ \text{in}\ ]$

$desI_s := tu_{tu_{NDX},2}$ $desM_s := tu_{tu_{NDX},3}$ $d := tu_{tu_{NDX},4}$ $b := tu_{tu_{NDX},5}$ $t := tu_{tu_{NDX},6}$

$desI_s = \text{"HSS5x5x.25"}$ $desM_s = \text{"HSS127x127x6.4"}$

| | | |
|---|---|---|
| $d = 5.0\ \text{in}$ | $d = 127.0\ \text{mm}$ | HSS Depth |
| $b = 5\ \text{in}$ | $b = 127\ \text{mm}$ | HSS Width |
| $t = 0.3\ \text{in}$ | $t = 6.4\ \text{mm}$ | HSS Thickness |

### Section Properties: (From CISC Handbook)

$A := d \cdot b - (d - 2 \cdot t) \cdot (b - 2 \cdot t)$

$A = 4.75\ \text{in}^2$ $A = 3065\ \text{mm}^2$

$$Ix := \frac{b \cdot d^3 - (b - 2 \cdot t) \cdot (d - 2 \cdot t)^3}{12}$$

$Ix = 17.91\ \text{in}^4$ $Ix = 7.46 \cdot 10^6\ \text{mm}^4$

$$Sx := \frac{b \cdot d^3 - (b - 2 \cdot t) \cdot (d - 2 \cdot t)^3}{6 \cdot d}$$

$Sx = 7.16\ \text{in}^3$ $Sx = 1.17 \cdot 10^5\ \text{mm}^3$

$$Zx := \frac{b \cdot d^2 - (b - 2 \cdot t) \cdot (d - 2 \cdot t)^2}{4}$$

$Zx = 8.47\ \text{in}^3$ $Zx = 1.39 \cdot 10^5\ \text{mm}^3$

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

$A' := 4.59\ \text{in}^2$ Area Override

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

$A = 4.59\ \text{in}^2$ $A = 2961\ \text{mm}^2$

$Sx' := 6.78\ in^3$ Section Modulus Override

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

$Sx = 6.78\ in^3$ $Sx = 1.11 \cdot 10^5\ mm^3$

$Zx' := 8.07\ in^3$ Plastic Section Override

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

c b a

$Zx = 8.07\ in^3$ $Sx = 1.11 \cdot 10^5\ mm^3$

**Gusset Plate:**

| | | | |
|---|---|---|---|
| $w_1 := 6\ in$ | $w_1 = 6.000\ in$ | $w_1 = 152.4\ mm$ | Width of Gusset Plate |
| $t_1 := 0.375\ in$ | $t_1 = 0.375\ in$ | $t_1 = 9.5\ mm$ | Thickness of Gusset Plate |
| $l := 4\ in$ | $l = 4.000\ in$ | $l = 101.6\ mm$ | Length of Weld |
| $s := 0.5\ in$ | $s = 0.500\ in$ | $s = 12.7\ mm$ | Clearance of HSS to Conn Plate |
| $e_1 := 1.5\ in$ | $e_1 = 1.500\ in$ | $e_1 = 38.1\ mm$ | Fastener Clearance (See Image) |
| $e_2 := 3.0\ in$ | $e_2 = 3.000\ in$ | $e_2 = 76.2\ mm$ | Fastener Clearance (See Image) |
| $e_3 := 3.0\ in$ | $e_3 = 3.000\ in$ | $e_3 = 76.2\ mm$ | Fastener Clearance (See Image) |

**Connection Plate:**

| | | | |
|---|---|---|---|
| $w_2 := 9\ in$ | $w_2 = 9.000\ in$ | $w_2 = 228.6\ mm$ | Width of Connection Plate |
| $t_2 := 0.375\ in$ | $t_2 = 0.375\ in$ | $t_2 = 9.5\ mm$ | Thickness of Connection Plate |

**Factored Design Force:**

| | | | |
|---|---|---|---|
| $T_f := 20\ K$ | $T_f = 20.00\ K$ | $T_f = 88.96\ kN$ | Connection Design Force |

**Steel Properties:**

**HSS Section:** $st_{NDX} := 1$

| 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 |

$st :=$ (table above)

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

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

**Gusset Plate:** $st_{NDX} := 2$ $desM_{st2} := st_{st_{NDX},2}$ $f_{y2} := st_{st_{NDX},3}$ $F_{u2} := st_{st_{NDX},4}$

**Connection Plate:** $st_{NDX} := 2$ $desM_{st3} := st_{st_{NDX},2}$ $f_{y3} := st_{st_{NDX},3}$ $F_{u3} := st_{st_{NDX},4}$

**Weld Design:**

**Electrodes:** $we_{NDX} := 2$

| 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 |

$we :=$ (table above)

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

**Weld 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 |

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

**Weld Strength:**

**Weld Material Strength**

$v_{rw} := \varphi_w \cdot 0.67 \cdot X_u \cdot \frac{1}{\sqrt{2}}$ $v_{rw} = 22.2$ ksi $v_{rw} = 153.2$ MPa

**Base Metal Strength**

| | | | |
|---|---|---|---|
| $v_{rb1} := \varphi_w \cdot 0.67 \cdot F_{u1}$ | $v_{rb1} = 29.2$ Ksi | $v_{rb1} = 201.2$ MPa | HSS Section |
| $v_{rb2} := \varphi_w \cdot 0.67 \cdot F_{u2}$ | $v_{rb2} = 29.2$ Ksi | $v_{rb2} = 201.2$ MPa | Gusset Plate |
| $v_{rb3} := \varphi_w \cdot 0.67 \cdot F_{u2}$ | $v_{rb3} = 29.2$ Ksi | $v_{rb3} = 201.2$ MPa | Connection Plate |

**Minimum Weld Capacity**

$V_{rw} := \min\left(\left[\begin{array}{cccc} v_{rw} & v_{rb1} & v_{rb2} & v_{rb3} \end{array}\right]\right)$

$V_{rw} = 22.2$ Ksi $V_{rw} = 153.2$ MPa

**Bolt Design:**

| | | | |
|---|---|---|---|
| $o := \frac{1}{16}$ in | $o = 0.0625$ in | $o = 1.5875$ mm | Hole Clearance on Fastener |
| $N_{wr} := 2$ | $N_{wr} = 2$ | | Rows of Bolts |
| $N_{wc} := 2$ | $N_{wc} = 2$ | | Columns of Bolts |

**Total Quantity of Bolts:**

$N_w := N_{wr} \cdot N_{wc}$ $N_w = 4$ Number of Bolts

**Grade:** $bg_{NDX} := 1$ **Add Data for 'Unknown'**

$bg :=$

| NDX | des | fy | Fu |
|---|---|---|---|
| 1 | "A325" | 92 Ksi | 120 Ksi |
| 2 | "A490" | 130 Ksi | 150 Ksi |
| 3 | "A307" | 50 Ksi | 60 Ksi |
| 4 | "Unknown" | 40 Ksi | 50 Ksi |

$des_b := bg_{bg_{NDX},2}$ $f_{yb} := bg_{bg_{NDX},3}$ $F_{ub} := bg_{bg_{NDX},4}$

**Threads:** $th_{NDX} := 1$

NDX des

$$th := \begin{bmatrix} 1 & \text{"Included"} \\ 2 & \text{"Excluded"} \end{bmatrix} \quad des_{th} := th_{th_{NDX}\,2}$$

**Diameter:** $bd_{NDX} := 3$

NDX Dia

$$bd := \begin{bmatrix} 1 & 0.5\ \text{in} \\ 2 & 0.625\ \text{in} \\ 3 & 0.75\ \text{in} \\ 4 & 0.875\ \text{in} \\ 5 & 1.00\ \text{in} \end{bmatrix} \quad \phi_b := bd_{bd_{NDX}\,2} \quad \phi_h := bd_{bd_{NDX}\,2} + o$$

```
for i ∈ [1..rows(bd)]
    bd_{i 3} := (bd_{i 2})^2 · π / 4
A_b := bd_{bd_NDX 3}
```

**Shear Strength:**

**Connection Type:** $cn_{NDX} := 1$

NDX des

$$cn := \begin{bmatrix} 1 & \text{"Snug Tight"} \\ 2 & \text{"Slip Critical"} \end{bmatrix} \quad des_{cn} := cn_{cn_{NDX}\,2}$$

*c* *b* *a*

**Cleaning (Slip Critical):** $sf_{NDX} := 1$

NDX Class Description ks cs A325 cs A490

$$sf := \begin{bmatrix} 1 & \text{"A"} & \text{"HDG, Cleaned w/ Class A Coating"} & 0.30 & 1.00 & 0.92 \\ 2 & \text{"B"} & \text{"Blast Cleaned w/ Class B Coating"} & 0.52 & 1.04 & 0.96 \end{bmatrix} \quad des_{sf} := sf_{sf_{NDX}\,3} \quad k_s := sf_{sf_{NDX}\,4}$$

```
if sf_NDX = 1
  if bg_NDX = 1
    c_s := sf_{sf_NDX 5}
  else
    if bg_NDX = 2
      c_s := sf_{sf_NDX 6}
    else
      c_s := 0
else
  if bg_NDX = 1
    c_s := sf_{sf_NDX 5}
  else
    if bg_NDX = 2
      c_s := sf_{sf_NDX 6}
    else
      c_s := 0
```

$k_s = 0.30$

$c_s = 1.00$

```
if cn_NDX = 1
  if th_NDX = 1
    v_rb := 0.70·0.6·φ_b·A_b·F_ub
  else
    v_rb := 0.6·φ_b·A_b·F_ub
else
  v_rb := 0.53·k_s·c_s·A_b·F_ub
```

$v_{rb} = 17.8$ K $\quad v_{rb} = 79.2$ kN — Shear Strength

**Tensile Strength:**

$t_{rb} := 0.75 \cdot \varphi_b \cdot A_b \cdot F_{ub}$ $\quad t_{rb} = 31.81$ K $\quad t_{rb} = 141.49$ kN — Tensile Strength

**Bearing Strength:**

$b_{rb} := 3 \cdot \varphi_{br} \cdot F_{u2} \cdot \phi_b \cdot \min\left(\left[\begin{array}{cc} t_1 & t_2 \end{array}\right]\right)$

$b_{rb} = 43.9$ K $\quad b_{rb} = 195.2$ kN — Minimum Bearing Strength

**Resistance of HSS Section:**

$T_{rtg} := \varphi_s \cdot A \cdot f_{y1}$ $\quad T_{rtg} = 206.6$ K $\quad T_{rtg} = 918.8$ kN

$T_{rtn} := \varphi_s \cdot \left(A - 2 \cdot t \cdot t_1\right) \cdot F_{u1}$ $\quad T_{rtn} = 257.5$ K $\quad T_{rtn} = 1145.6$ kN

**Resistance of HSS Weld:**

**Shear Lag:**

**HSS Half Centroid:**

$A' := \left(b - .5 \cdot t_1\right) \cdot t + \left(d - 2 \cdot t\right) \cdot t$

$A' = 2.33$ in$^2$ $\quad A' = 1502$ mm$^2$

$$x := \frac{t \cdot \left(\frac{b}{2}\right)^2 + \frac{t^2 \cdot (d - 2 \cdot t)}{2}}{A'}$$

$x = 0.732$ in $\quad x = 18.6$ mm

$x' := 0.5 \cdot (b - t) - x$ $\quad x' = 1.643$ in $\quad x' = 41.7$ mm

$l = 4.00$ in

$\frac{x'}{l} = 0.41$

**Block Shear for Weld (CSA S16 Clause 13.11 a)):**

```
if x'/l > 0.1
  A_ne := min([[ A·(1.1 - x'/l)  0.8·A ]])
else
  A_ne := A
```

$A = 4.59$ in$^2$

$A_{ne} = 3.16$ in$^2$ $\quad A_{ne} = 2041$ mm$^2$

$$T_{bs1} := \varphi_u \cdot \left(A_{ne} \cdot \frac{\left(f_{y1} + F_{u1}\right)}{2}\right)$$

$T_{bs1} = 136.4$ K $\quad T_{bs1} = 606.8$ kN

**Resistance of Gusset Plate:**

$T_{rgg} := \varphi_s \cdot w_1 \cdot t_1 \cdot f_{y1}$ $\quad T_{rgg} = 101.3$ K $\quad T_{rgg} = 450.4$ kN

$T_{rgn} := \varphi_s \cdot \left(w_1 - 2 \cdot \phi_h\right) \cdot t_1 \cdot F_{u1}$ $\quad T_{rtn} = 257.5$ K $\quad T_{rtn} = 1145.6$ kN

**Block Shear for Gusset Plated (CSA S16 Clause 13.11 a)):**

$U_t := 0.6$

$A_g := \left(w_1 - \left(N_{wr} - 1\right) \cdot e_3\right) \cdot t_1$

$A_g = 1.13\ \text{in}^2$ $A_g = 725.81\ \text{mm}^2$

$A_n := \left(\left(N_{wc} - 1\right) \cdot e_2 + e_1 - N_{wc} \cdot \phi_h\right) \cdot t_1 \cdot 2$

$A_n = 2.16\ \text{in}^2$ $A_n = 1391.13\ \text{mm}^2$

$T_{bs1} := \varphi_u \cdot \left(U_t \cdot A_n \cdot F_{u2} + 0.6 \cdot A_g \cdot \frac{\left(f_{y2} + F_{u2}\right)}{2}\right)$

$T_{bs1} = 90.7\ \text{K}$ $T_{bs1} = 403.3\ \text{kN}$

**Resistance of Connection Plate:**

$T_{rcg} := \varphi_s \cdot w_2 \cdot t_2 \cdot f_{y1}$ $T_{rcg} = 151.9\ \text{K}$ $T_{rgg} = 450.4\ \text{kN}$

$T_{rcn} := \varphi_s \cdot \left(w_2 - 2 \cdot \phi_h\right) \cdot t_2 \cdot F_{u1}$ $T_{rcn} = 161.8\ \text{K}$ $T_{rtn} = 1145.6\ \text{kN}$

**Block Shear for Connection Plate (CSA S16 Clause 13.11 a)):**

$A_g := \left(w_2 - \left(N_{wr} - 1\right) \cdot e_3\right) \cdot t_2$

$A_g = 2.25\ \text{in}^2$ $A_g = 1451.61\ \text{mm}^2$

$A_n := \left(\left(N_{wc} - 1\right) \cdot e_2 + e_1 - N_{wc} \cdot \phi_h\right) \cdot t_2 \cdot 2$

$A_n = 2.16\ \text{in}^2$ $A_n = 1391.13\ \text{mm}^2$

$T_{bs2} := \varphi_u \cdot \left(U_t \cdot A_n \cdot F_{u3} + 0.6 \cdot A_g \cdot \frac{\left(f_{y3} + F_{u3}\right)}{2}\right)$

$T_{bs2} = 118.3\ \text{K}$ $T_{bs2} = 526.0\ \text{kN}$

**Resistance of Welds:**

$T_{rw} := 4 \cdot l \cdot V_{rw} \cdot D$ $T_{rw} = 88.9\ \text{K}$ $T_{rw} = 395.3\ \text{kN}$

**Resistance of Bolts:**

$T_{rb} := N_w \cdot \min\left(\left[\begin{array}{cc} v_{rb} & b_{rb} \end{array}\right]\right)$ $T_{rb} = 71.3\ \text{K}$ $T_{rb} = 316.9\ \text{kN}$

**Minimum Connection Resistance:**

$T_r := \min\left(\left[\begin{array}{cccccccccc} T_{rtg} & T_{rtn} & T_{rgg} & T_{rgn} & T_{rcg} & T_{rcn} & T_{rw} & T_{rb} & T_{bs1} & T_{bs2} \end{array}\right]\right)$

$T_r = 71.3\ \text{K}$ $T_r = 316.9\ \text{kN}$

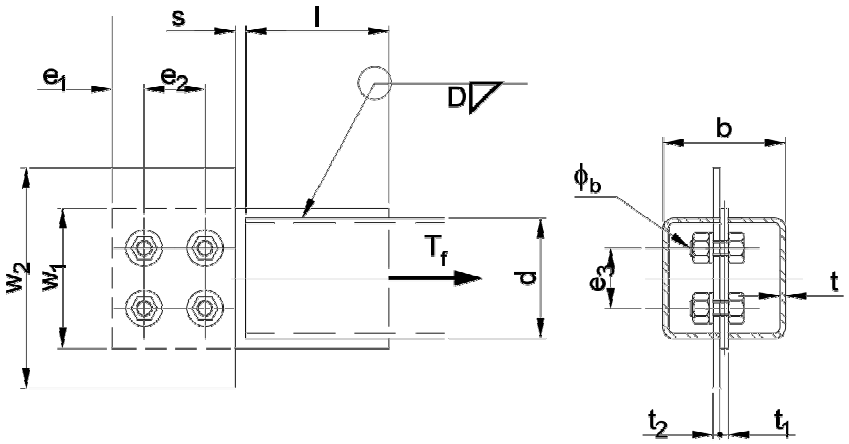
**Summary:**

**Material Property Factor**

| | |
|---|---|
| Steel | $\varphi_s = 0.90$ |
| Weld | $\varphi_w = 0.67$ |
| 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**

| | | |
|---|---|---|
| Designation (Metric) | $desM_{st1} = "G40.21-350W"$ | |
| Yield Strength | $f_{y1} = 50\ ksi$ | $f_{y1} = 345\ MPa$ |
| Ultimate Strength | $F_{u1} = 65\ ksi$ | $F_{u1} = 448\ MPa$ |

**Gusset Plate**

| | | |
|---|---|---|
| Designation (Metric) | $desM_{st2} = "G40.21-300W"$ | |
| Yield Strength | $f_{y2} = 44\ ksi$ | $f_{y2} = 303\ MPa$ |
| Ultimate Strength | $F_{u2} = 65\ ksi$ | $F_{u2} = 448\ MPa$ |

**Connection Plate**

| | | |
|---|---|---|
| Designation (Metric) | $desM_{st2} = "G40.21-300W"$ | |
| Yield Strength | $f_{y2} = 44\ ksi$ | $f_{y2} = 303\ MPa$ |
| Ultimate Strength | $F_{u2} = 65\ ksi$ | $F_{u2} = 448\ MPa$ |
| 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 | $\gamma_s = 489\ pcf$ | $\gamma_s = 76.8\ kNpcm$ |

| | | |
|---|---|---|
| **Connection Design Force** | $T_f = 20.00\ K$ | $T_f = 88.96\ kN$ |

**Connection Properties**

**HSS**

| | | |
|---|---|---|
| Designation | $desI_s = "HSS5x5x.25"$ | $desM_s = "HSS127x127x6.4"$ |
| Depth | $d = 5.0\ in$ | $d = 127.0\ mm$ |
| Width | $b = 5\ in$ | $b = 127\ mm$ |
| Wall Thickness | $t = 0.3\ in$ | $t = 6.4\ mm$ |

$Check\left(d \geq b\right) = "...OK"$

| | | |
|---|---|---|
| Area | $A = 4.59\ in^2$ | $A = 2961\ mm^2$ |
| Section Modulus | $Sx = 6.78\ in^3$ | $Sx = 1.11 \cdot 10^5\ mm^3$ |
| Plastic Modulus | $Zx = 8.07\ in^3$ | $Sx = 1.11 \cdot 10^5\ mm^3$ |

**Gusset Plate**

| | | |
|---|---|---|
| Width of Gusset Plate | $w_1 = 6.000\ in$ | $w_1 = 152.4\ mm$ |
| Thickness of Gusset Plate | $t_1 = 0.375\ in$ | $t_1 = 9.5\ mm$ |

| | | |
|---|---|---|
| Length of Weld | $l = 4.000$ in | $l = 101.6$ mm |

$Check\ (l \geq b) = "...NG"$

| | | |
|---|---|---|
| Clearance of HSS to Conn Plate | $s = 0.500$ in | $s = 12.7$ mm |
| Fastener Clearance (See Image) | $e_1 = 1.500$ in | $e_1 = 38.1$ mm |
| Fastener Clearance (See Image) | $e_2 = 3.000$ in | $e_2 = 76.2$ mm |
| Fastener Clearance (See Image) | $e_3 = 3.000$ in | $e_3 = 76.2$ mm |

**Connection Plate:**

| | | |
|---|---|---|
| Width of Connection Plate | $w_2 = 9.000$ in | $w_2 = 228.6$ mm |
| Thickness of Connection Plate | $t_2 = 0.375$ in | $t_2 = 9.5$ mm |

**Welding:**

**Electrode**

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

**Size**

| | | |
|---|---|---|
| Designation | $desI_D = "1/4"$ | $desM_D = ""$ |
| Size | $D = 0.2500$ in | $D = 6.4$ mm |
| Minimum Weld Capacity | $V_{rw} = 22.2$ Ksi | $V_{rw} = 153.2$ MPa |

**Bolts:**

| | | |
|---|---|---|
| Designation | $des_b = "A325"$ | |
| Yield Strength | $f_{yb} = 92$ Ksi | $f_{yb} = 634.3$ MPa |
| Ultimate Strength | $F_{ub} = 120$ Ksi | $F_{ub} = 827.4$ MPa |
| Threads (Included / Excluded) | $des_{th} = "Included"$ | |
| Bolt Diameter | $\phi_b = 0.75$ in | $\phi_b = 19.1$ mm |
| Bolt Hole Diameter | $\phi_h = 0.8125$ in | $\phi_h = 20.6$ mm |
| Bolt Area | $A_b = 0.4418\ in^2$ | $A_b = 285\ mm^2$ |
| Connection Type (Snug Tight / Slip Critical) | $des_{cn} = "Snug\ Tight"$ | |
| Surface Cleaning (Slip Critical Only) | $des_{sf} = "HDG,\ Cleaned\ w/\ Class\ A\ Coating"$ | |
| ks Coefficient (Slip Critical Only) | $k_s = 0.30$ | |
| cs Coefficient (Slip Critical Only) | $c_s = 1.00$ | |

Bolt Strength

| | | |
|---|---|---|
| Shear Strength | $v_{rb} = 17.8$ K | $v_{rb} = 79.2$ kN |
| Tensile Strength | $t_{rb} = 31.81$ K | $t_{rb} = 141.49$ kN |
| Minimum Bearing Strength | $b_{rb} = 43.9$ K | $b_{rb} = 195.2$ kN |

**Connection Resistance:**

| | | |
|---|---|---|
| HSS (Gross) | $T_{rtg} = 206.6$ K | $T_{rtg} = 918.8$ kN |
| HSS (Net) | $T_{rtn} = 257.5$ K | $T_{rtn} = 1145.6$ kN |
| Gusset Plate (Gross) | $T_{rgg} = 101.3$ K | $T_{rgg} = 450.4$ kN |
| Gusset Plate (Net) | $T_{rtn} = 257.5$ K | $T_{rtn} = 1145.6$ kN |
| Gusset Plate (Block Shear) | $T_{bs1} = 90.7$ K | $T_{bs1} = 403.3$ kN |
| Connection Plate (Gross) | $T_{rcg} = 151.9$ K | $T_{rgg} = 450.4$ kN |

| | | |
|---|---|---|
| Connection Plate (Net) | $T_{rcn} = 161.8$ K | $T_{rtn} = 1145.6$ kN |
| Connection Plate (Block Shear) | $T_{bs2} = 118.3$ K | $T_{bs2} = 526.0$ kN |
| Welds | $T_{rw} = 88.9$ K | $T_{rw} = 395.3$ kN |
| Bolts | $T_{rb} = 71.3$ K | $T_{rb} = 316.9$ kN |
| Minimum Connection Resistance | $T_r = 71.3$ K | $T_r = 316.9$ kN |

$Check\left(T_r \geq T_f\right) = "...OK"$

$Check\left(\frac{T_r}{\varphi_s} \geq T_f\right) = "...OK"$ **Allow for Overload**