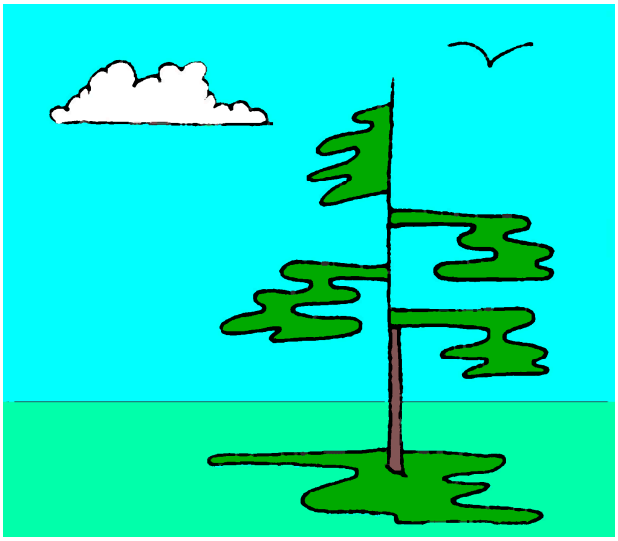
NorthWoods Software



Program Name: HSS-Shear_Tab_Connection

Project Name: -

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 20-11-13

Reference: NBCC, CSA S16, AISC

Created using SMath Studio, a MathCAD workalike from https://en.smath.info/view/SMathStudio
The User is responsible to verify output data using an alternative method

Menu:

..... Input Data ..... Important Output ..... Logical Constructs **Blue** **Units**

..... Sum / For **Red** **Important Note**

Defined Units:

$K := kip$

$K\_ft := K\ ft$ $kN\_m := kN\ m$ $K\_in := K\ in$ $kN\_mm := kN\ mm$ 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

$pci := \frac{lbf}{in^3}$ Subgrade Modulus

$psfpf := \frac{psf}{ft}$ $kPapm := \frac{kPa}{m}$ Pressure per Depth

$pmcf := \frac{lb}{ft^3}$ $lb := lbf$ Force

User Defined Functions:

```
Check(arg) := if arg = 1
                Check := "...OK"
              else
                Check := "...NG"
```

$Check(2 = 3) = "...NG"$

$Check(2 \neq 3) = "...OK"$

$Check(2 \leq 3) = "...OK"$

$Check(3 \geq 2) = "...OK"$

c b a

Input Data

Material Property Factors:

$\varphi_s := 0.90$ Steel

$\varphi_w := 0.67$ Weld

$\varphi_{sv} := 0.75$ Steel Shear

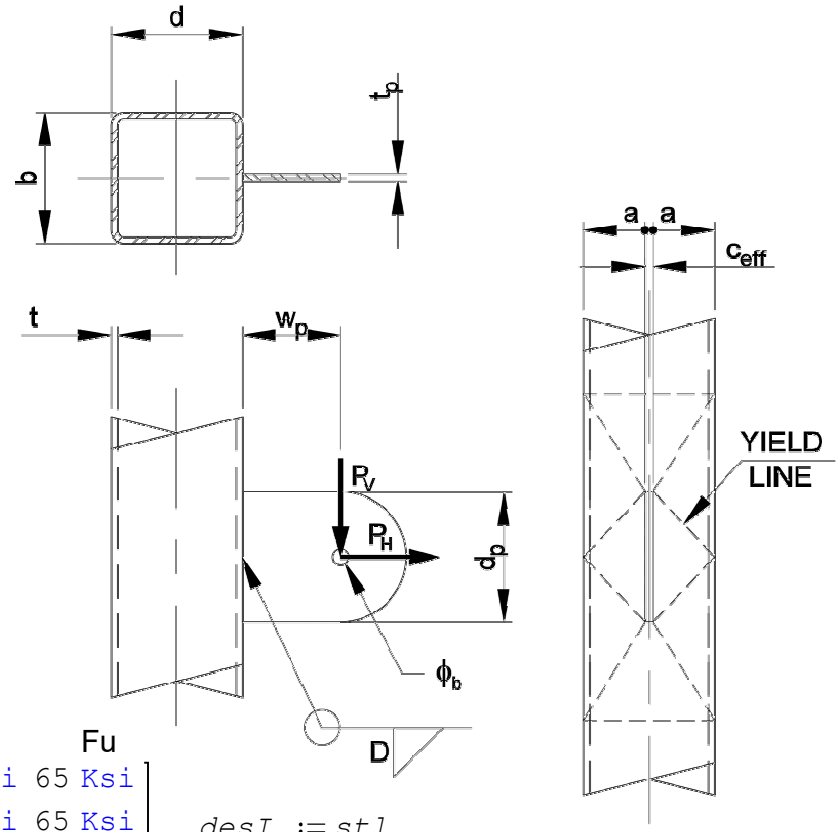
Load Factors:

$\alpha_D := 1.25$ Dead Load

$\alpha_L := 1.5$ Live Load

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

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



HSS Steel Properties:

$stl_{NDX} := 1$

$stl :=$

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
4	"Sheet"	33 Ksi	58 Ksi
5	"F1554 Grade 55-S1"	55 Ksi	75 Ksi
6	"A307 Grade A"	33 Ksi	60 Ksi
7	"Pipe A53 Grade B"	35 Ksi	60 Ksi

$desI_1 := stl_{stl_{NDX},2}$

$f_{y1} := stl_{stl_{NDX},3}$

$F_{u1} := stl_{stl_{NDX},4}$

$E_s := 29000\ Ksi$

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

Shear Tab Steel Properties:

$stl_{NDX} := 2$

$desI_2 := stl_{stl_{NDX},2}$ $f_{y2} := stl_{stl_{NDX},3}$ $F_{u2} := stl_{stl_{NDX},4}$

Welding Electrodes:

$Weld_{NDX} := 2$

$Weld :=$

NDX	DesI	DesM	Xu
1	"E60xx"	"E410xx"	60 ksi
2	"E70xx"	"E480xx"	70 ksi
3	"E80xx"	"E550xx"	80 ksi
4	"E90xx"	"E620xx"	90 ksi

$desI_{we} := Weld_{Weld_{NDX},2}$

$desM_{we} := Weld_{Weld_{NDX},3}$

$X_u := Weld_{Weld_{NDX},4}$

Weld Sizes:

$weld_{NDX} := 7$

$weld :=$

NDX	DI	DM	W
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

$desI_D := weld_{weld_{NDX}\,2}$

$desM_D := weld_{weld_{NDX}\,3}$

$D := weld_{weld_{NDX}\,4}$

HSS Properties:

$b := 5\ in$	$b = 127\ mm$	Width of HSS
$d := 5\ in$	$d = 127\ mm$	Depth of HSS
$t := .25\ in$	$t = 6.35\ mm$	Thickness of HSS
$A_s := 4.59\ in^2$	$A_s = 2961\ mm^2$	Area of HSS
$S_x := 6.78\ in^3$	$S_x = 1 \cdot 10^5\ mm^3$	Sect Mod of HSS

Shear Tab Properties:

$w_p := 7\ in$	$w_p = 177.8\ mm$	Width of Shear Tab
$d_p := 16\ in$	$d_p = 406.4\ mm$	Depth of Shear Tab
$t_p := 0.5\ in$	$t_p = 12.7\ mm$	Thickness of Shear Tab
$\phi_b := 0.5\ in$	$\phi_b = 12.7\ mm$	Diameter of Fastener
$s := 0.0625\ in$	$s = 1.5875\ mm$	Fastener Clearance
$\phi_h := \phi_b + s$	$\phi_h = 14.2875\ mm$	Diameter of Hole

Service Loading (Dead and Live):

$P_{VD} := 0.2025\ K$	$P_{VD} = 0.9\ kN$	Vertical Load (Down)
$P_{VL} := 2.43\ K$	$P_{VL} = 10.81\ kN$	Vertical Load (Down)
$P_{HD} := 0.315\ K$	$P_{HD} = 1.4\ kN$	Horizontal Load (Out)
$P_{HL} := 3.780\ K$	$P_{HL} = 16.81\ kN$	Horizontal Load (Out)

Factored Loading (Dead and Live):

$P_{fV} := P_{VD} \cdot \alpha_D + P_{VL} \cdot \alpha_L$	$P_{fV} = 3.8981\ K$	$P_{fV} = 17.34\ kN$	Vertical Load (Down)
$P_{fH} := P_{HD} \cdot \alpha_D + P_{HL} \cdot \alpha_L$	$P_{fH} = 6.0638\ K$	$P_{fH} = 26.97\ kN$	Horizontal Load (Out)
$M_f := P_{fV} \cdot w_p$	$M_f = 27.3\ K\_in$	$M_f = 3083\ kN\_mm$	Factored Moment
$P_f := P_{fV}$	$P_f = 3.8981\ K$	$P_f = 17.34\ kN$	Factored Axial Load

AISC Method

HSS Section Resistance:

$P_r := \varphi_s \cdot f_{y1} \cdot A_s$	$P_r = 206.55\ K$	$P_r = 919\ kN$	Comp Resistance
$M_r := \varphi_s \cdot f_{y1} \cdot S_x$	$M_r = 305.10\ K\_in$	$M_r = 34472\ kN\_mm$	Mom Resistance

Check Wall Thickness:

$Check\left(\frac{b}{t} \le 1.4 \cdot \sqrt{\frac{E_s}{f_{y1}}}\right) = "...OK"$

Check Punching Shear Moment:

$M_r := \frac{\varphi_{sv} \cdot F_{u1} \cdot t_p \cdot d_p^{\,2}}{5}$ $M_r = 1248.0\ K\_in$ $M_r = 1 \cdot 10^{5}\ kN\_mm$

$Check\left(M_r \ge M_f\right) = "...OK"$

Minimum HSS Wall Thickness:

$t_{min} := \frac{3.09 \cdot D \cdot 16}{\frac{F_{u1}}{Ksi}}$ $t_{min} = 0.19\ in$ $t_{min} = 4.8\ mm$

$Check\left(t_{min} \le t\right) = "...OK"$

HSS Wall Yield LIne:

P_f Factored Load
P_r Resistant Load
M_f Factored Moment
M_r Resistant Moment

$U := \frac{P_f}{P_r} + \frac{M_f}{M_r}$	$U = 0.04$		
$Q_f := 1 - 0.3 \cdot U \cdot (1 + U)$	$Q_f = 0.99$		
$c_{eff} := \frac{10 \cdot t}{b} \cdot \left(\frac{f_{y1} \cdot t}{f_{y2} \cdot t_p}\right) \cdot t_p$	$c_{eff} = 0.14\ in$	$c_{eff} = 3.6\ mm$	Equation K1-1
$a := \frac{b - c_{eff}}{2}$	$a = 2.43\ in$	$a = 61.7\ mm$	In the diagram on page 9-14 a = a b = a c = c.eff
$c := c_{eff}$			
$\rho := 2 \cdot a^{2} + 2 \cdot a \cdot c$	$\rho = 12.49\ in^{2}$	$\rho = 8058\ mm^{2}$	

$$M_n := \frac{t^2 \cdot f_{y1}}{4} \cdot \left(\frac{4 \cdot \sqrt{a^2 \cdot c \cdot b \cdot \rho} + d_p \cdot \rho}{a^2} \right) \cdot Q_f$$

Equation 9-34

$M_n = 29.9\ \text{K\_in}$ $M_n = 3379\ \text{kN\_mm}$

$Check\left(M_n \geq M_f\right) = \text{"...OK"}$

Summary:

Material Property Factor (Steel)	$\varphi_s = 0.9$	
Material Property Factor (Steel Shear)	$\varphi_{sv} = 0.75$	
Material Property Factor (Weld)	$\varphi_w = 0.67$	
Dead Load Factor	$\alpha_D = 1.25$	
Live Load Factor	$\alpha_L = 1.5$	

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

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

HSS Steel

Imperial Designation	$desI_1 = \text{"G40.21-350W"}$	
Yield Strength	$f_{y1} = 50\ Ksi$	$f_{y1} = 345\ MPa$
Ultimate Strength	$F_{u1} = 65\ Ksi$	$F_{u1} = 448\ MPa$
Young's Modulus	$E_s = 29000\ Ksi$	$E_s = 2 \cdot 10^5\ MPa$

Shear Tab Steel

Imperial Designation	$desI_2 = \text{"G40.21-300W"}$	
Yield Strength	$f_{y2} = 44\ Ksi$	$f_{y1} = 345\ MPa$
Ultimate Strength	$F_{u2} = 65\ Ksi$	$F_{u1} = 448\ MPa$
Young's Modulus	$E_s = 29000\ Ksi$	$E_s = 2 \cdot 10^5\ MPa$

Welding

Designation	$desI_{we} = \text{"E70xx"}$	$desM_{we} = \text{"E480xx"}$
Ultimate Strength	$X_u = 70\ Ksi$	$X_u = 483\ MPa$
Size Designation	$desI_D = \text{"1/4"}$	$desM_D = \text{""}$
Size Dimension	$D = 0.25\ in$	$D = 6.35\ mm$

HSS Properties:

Width of HSS	$b = 5\ in$	$b = 127\ mm$
Depth of HSS	$d = 5\ in$	$d = 127\ mm$
Thickness of HSS	$t = 0.25\ in$	$t = 6.35\ mm$
Area of HSS	$A_s = 5\ in^2$	$A_s = 2961\ mm^2$
Sect Mod of HSS	$S_x = 7\ in^3$	$S_x = 1 \cdot 10^5\ mm^3$

Shear Tab Properties:

Width of Shear Tab	$w_p = 7\ in$	$w_p = 177.8\ mm$
Depth of Shear Tab	$d_p = 16\ in$	$d_p = 406.4\ mm$
Thickness of Shear Tab	$t_p = 0.5\ in$	$t_p = 12.7\ mm$
Diameter of Fastener	$\phi_b = 0.5\ in$	$\phi_b = 12.7\ mm$
Fastener Clearance	$s = 0.0625\ in$	$s = 1.5875\ mm$
Diameter of Hole	$\phi_h = 0.5625\ in$	$\phi_h = 14.2875\ mm$

Service Loading (Dead and Live):

Service Dead Load (Vertical)	$P_{VD} = 0.2025\ K$	$P_{VD} = 0.9008\ kN$
Service Live Load (Vertical)	$P_{VL} = 2.43\ K$	$P_{VL} = 10.8092\ kN$
Service Dead Load (Horizontal)	$P_{HD} = 0.315\ K$	$P_{HD} = 1.4012\ kN$
Service Live Load (Horizontal)	$P_{HL} = 3.78\ K$	$P_{HL} = 16.8143\ kN$

Factored Loading (Dead and Live):

Factored (Load Vertical)	$P_{fV} = 3.8981\ K$	$P_{fV} = 17.3397\ kN$
Factored Load (Horizontal)	$P_{fH} = 6.0638\ K$	$P_{fH} = 26.9729\ kN$
Factored Axial Load (Vertical)	$P_{f} = 3.8981\ K$	$P_{f} = 17.3397\ kN$
Factored Moment	$M_{f} = 27.3\ K\_in$	$M_{f} = 3083\ kN\_mm$

Wall b/t Ratio

$$Check\left(\frac{b}{t} \le 1.4 \cdot \sqrt{\frac{E_s}{f_{y1}}}\right) = "...OK"$$

Punching Shear Moment Resistance	$M_r = 1248\ K\_in$	$M_r = 1 \cdot 10^{5}\ kN\_mm$

$$Check\left(M_r \ge M_f\right) = "...OK"$$

Minimum HSS Wall Thickness	$t_{min} = 0.1902\ in$	$t_{min} = 4.8\ mm$

$$Check\left(t_{min} \le t\right) = "...OK"$$

HSS Wall Yieldline Strength	$U = 0.0407$	
	$Q_f = 0.9873$	
Effective Width of Yieldline	$c_{eff} = 0.142\ in$	$c_{eff} = 3.6\ mm$
Effective Outboard Width of Yieldline	$a = 2.429\ in$	$a = 61.7\ mm$
Yieldline Parameter	$\rho = 12.4899\ in^{2}$	$\rho = 8058\ mm^{2}$
Moment Resistance of Yieldline	$M_n = 29.9\ K\_in$	$M_n = 3379\ kN\_mm$

$$Check\left(M_n \ge M_f\right) = "...OK"$$