

NorthWoods Software

Program Name: Chainlink_Fence

Project Number: -

Project Description: -

Project Designer: Dik

Last Revised (yy-mm-dd): 22.07.12

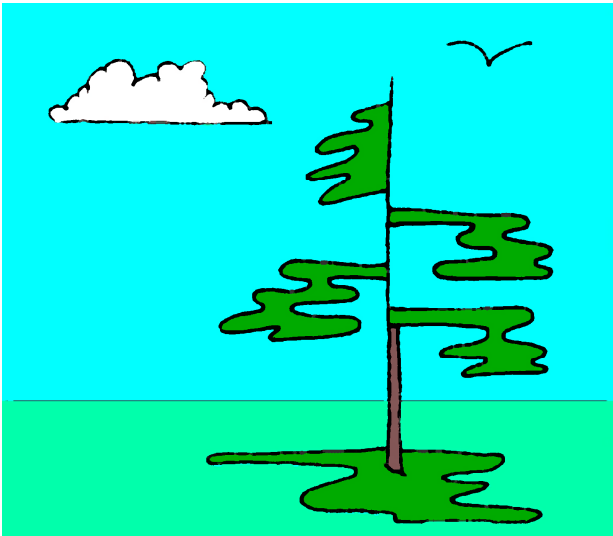
Reference: NBCC, CSA S16, CLFMI Manual

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

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Input Data:

Material Property Factors:

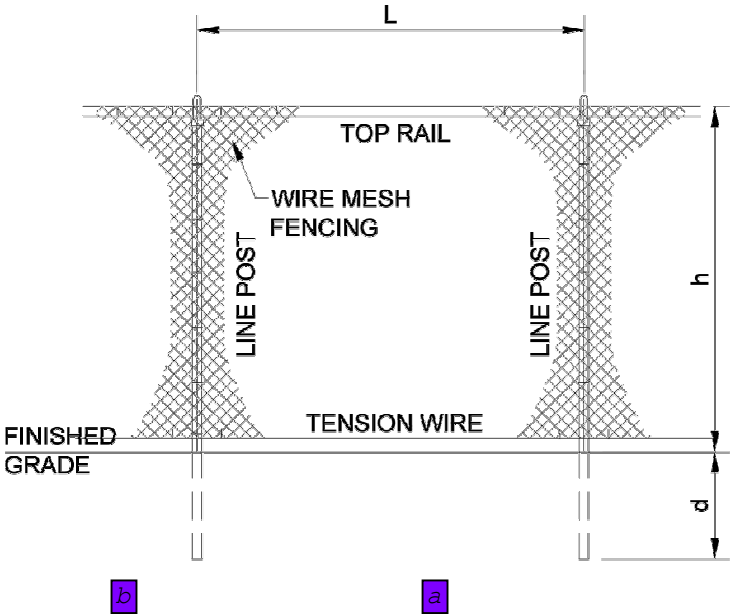
$\varphi_s := 0.90$	Steel
$\varphi_w := 0.67$	Weld
$\varphi_{sv} := 0.75$	Steel Shear

Load Factors:

$\alpha_D := 1.25$	Dead Load
$\alpha_L := 1.5$	Live Load
$SF := 1.67$	Safety Factor for ASD

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

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



Foundation Properties:

$\phi_{pile} := 12 \text{ in}$

$\phi_{pile} = 12.0 \text{ in}$

$\phi_{pile} = 304.8 \text{ mm}$

Diameter of Pile

$d := 12 \text{ in}$

$d = 12 \text{ in}$

$d = 304.8 \text{ mm}$

Length of Pile

$q_p := 200 \text{ psf}$

$q_p = 200.00 \text{ psf}$

$q_p = 9.58 \text{ kPa}$

Lateral Bearing Pressure

$F_{sa} := 1.0$

$F_{sa} = 1.00$

Soil Adjustment Factor

$q'_p := q_p \cdot F_{sa}$

$q'_p = 200 \text{ psf}$

$q'_p = 9.58 \text{ kPa}$

Adjusted Bearing Pressure

Constraint: $f_{c_{NDX}} := 1$

NDX

Constraint

$$f_c := \begin{bmatrix} 1 & \text{"Footing Constrained"} \\ 2 & \text{"Footing Not Constrained"} \end{bmatrix} \quad des_{f_c} := f_c \quad f_{c_{NDX}}^2$$

Chainlink Fence Properties:

Mesh Size: $ms_{NDX} := 6$

NDX Opening

$$ms := \begin{bmatrix} 1 & \text{"3/8"} \\ 2 & \text{"1/2"} \\ 3 & \text{"5/8"} \\ 4 & \text{"1"} \\ 5 & \text{"1-1/4"} \\ 6 & \text{"1-3/4"} \\ 7 & \text{"2"} \\ 8 & \text{"2-1/4"} \end{bmatrix} \quad des_{ms} := ms \quad ms_{NDX}^2$$

Wire Size: $ga_{NDX} := 4$

NDX Gauge

$$ga := \begin{bmatrix} 1 & \text{"5 GA"} \\ 2 & \text{"6 GA"} \\ 3 & \text{"8 GA"} \\ 4 & \text{"9 GA"} \\ 5 & \text{"10 GA"} \\ 6 & \text{"11 GA"} \end{bmatrix} \quad des_{ga} := ga \quad ga_{NDX}^2$$

Dimensions:

$h := 10 \text{ ft}$

$h = 10.00 \text{ ft}$

$h = 3.048 \text{ m}$

Fence Height

$B := 14 \text{ ft}$

$B = 14.00 \text{ ft}$

$B = 4.267 \text{ m}$

Minimum Straight Run

$x := \frac{B}{h}$

$x = 1.40$

Ratio Min Spacing:h

$L := 9 \text{ ft}$

$L = 9.00 \text{ ft}$

$L = 2.74 \text{ m}$

Line Post Spacing

Privacy Slats: $ps_{NDX} := 1$



NDX

Privacy

$$ps := \begin{bmatrix} 1 & \text{"No Privacy Slats"} \\ 2 & \text{"Privacy Slats"} \end{bmatrix} \quad des_{ps} := ps \quad ps_{NDX}^2$$

Post and Rail Data:

NDX

Material

Yield

$$st := \begin{bmatrix} 1 & \text{"Pipe STN"} & 30 \text{ Ksi} \\ 2 & \text{"Pipe STN HS"} & 50 \text{ Ksi} \\ 3 & \text{"HSS"} & 50 \text{ Ksi} \end{bmatrix} \quad des_p := st \quad st_{NDX}^2 \quad f_{yp} := st \quad st_{NDX}^3$$

Steel Properties (Post): $st_{NDX} := 2$

Steel Properties (Rail): $st_{NDX} := 2 \quad des_r := st \quad st_{NDX}^2 \quad f_{yr} := st \quad st_{NDX}^3$

	NDX	Size	Diameter	t
$HSSc :=$	1	"1-5/8 STN"	1.66 in	0.140 in
	2	"1-7/8 STN"	1.90 in	0.145 in
	3	"2-3/8 STN"	2.375 in	0.154 in
	4	"2-7/8 STN"	2.875 in	0.203 in
	5	"3-1/2 STN"	3.50 in	0.216 in
	6	"4 STN"	4.00 in	0.226 in
	7	"4-1/2 STN"	4.50 in	0.237 in
	8	"6-5/8 STN"	6.625 in	0.280 in
	9	"8-5/8 STN"	8.625 in	0.322 in
	10	"1-5/8 HSS"	1.66 in	0.111 in
	11	"1-7/8 HSS"	1.90 in	0.120 in
	12	"2-3/8 HSS"	2.375 in	0.130 in
	13	"2-7/8 HSS"	2.875 in	0.160 in
	14	"3-1/2 HSS"	3.50 in	0.160 in
	15	"4 HSS"	4.00 in	0.160 in
	16	"4-1/2 HSS"	4.50 in	0.160 in

Post:

$$\text{Size: } HSSc_{NDX} := 4 \quad des_{\phi_p} := HSSc_{NDX} \quad 2 \quad \phi_p := HSSc_{NDX} \quad 3 \quad t_p := HSSc_{NDX} \quad 4$$

$$\text{Rail: } HSSc_{NDX} := 5 \quad des_{\phi_r} := HSSc_{NDX} \quad 2 \quad \phi_r := HSSc_{NDX} \quad 3 \quad t_r := HSSc_{NDX} \quad 4$$

Wind Loading:**Topography:**

$V := 135 \text{ mph}$	$V = 135.00 \text{ mph}$	$V = 217 \text{ kph}$	Wind Speed
$K_{zt} := 1.00$	$K_{zt} = 1.00$		26.8.2
$K_d := 0.85$	$K_d = 0.85$		Table 26.6-1
$G := 0.85$	$G = 0.85$		Table 26.9.1

Exposure: $Ex_{NDX} := 1$

NDX	Exposure	α	Zg
$Ex :=$	1 "Exposure B"	7	1200 ft
	2 "Exposure C"	9.5	900 ft
	3 "Exposure D"	11.5	700 ft

$$des_{Ex} := Ex_{NDX} \quad 2 \quad \alpha := Ex_{NDX} \quad 3 \quad z_g := Ex_{NDX} \quad 4$$
Post and Rail Section Properties:**Post:**

$$Sx_p := \pi \cdot \frac{\left(\phi_p^4 - (\phi_p - 2 \cdot t_p)^4 \right)}{32 \cdot \phi_p} \quad Sx_p = 1.06 \text{ in}^3 \quad Sx_p = 17436.45 \text{ mm}^3$$

$$Zx_p := \frac{\left(\phi_p^3 - (\phi_p - 2 \cdot t_p)^3 \right)}{6} \quad Zx_p = 1.45 \text{ in}^3 \quad Zx_p = 23796.05 \text{ mm}^3$$

c**b****a**

Class of Section:

```

if  $\frac{\phi_p}{t_p} \leq \frac{13000 \text{ MPa}}{f_{yr}}$ 
   $cl_p := 1$ 
else
  if  $\frac{\phi_p}{t_p} \leq \frac{18000 \text{ MPa}}{f_{yp}}$ 
     $cl_p := 2$ 
  else
    if  $\frac{\phi_p}{t_p} \leq \frac{66000 \text{ MPa}}{f_{yp}}$ 
       $cl_p := 3$ 
    else
       $cl_p := 4$ 

```

$$cl_p = 1$$

Rail:

$$Sx_r := \pi \cdot \frac{\left(\phi_r^4 - (\phi_r - 2 \cdot t_r)^4 \right)}{32 \cdot \phi_r} \quad Sx_r = 1.72 \text{ in}^3$$

$$Sx_r = 28252.76 \text{ mm}^3$$

$$Zx_r := \frac{\left(\phi_r^3 - (\phi_r - 2 \cdot t_r)^3 \right)}{6} \quad Zx_r = 2.33 \text{ in}^3$$

$$Zx_r = 38228.48 \text{ mm}^3$$

Class of Section:

```

if  $\frac{\phi_r}{t_r} \leq \frac{13000 \text{ MPa}}{f_{yr}}$ 
   $cl_r := 1$ 
else
  if  $\frac{\phi_r}{t_r} \leq \frac{18000 \text{ MPa}}{f_{yr}}$ 
     $cl_r := 2$ 
  else
    if  $\frac{\phi_r}{t_r} \leq \frac{66000 \text{ MPa}}{f_{yr}}$ 
       $cl_r := 3$ 
    else
       $cl_r := 4$ 

```

$$cl_r = 1$$

Wind Pressure Desgn:**Velocity Exposure Pressure Coefficient (Kz):**

```

if h < 15 ft
    
$$K_z := 2.01 \cdot \left( \frac{15}{\frac{z_g}{ft}} \right)^{\frac{2}{\alpha}}$$

else
    
$$K_z := 2.01 \cdot \left( \frac{h}{\frac{z_g}{ft}} \right)^{\frac{2}{\alpha}}$$


```

$K_z = 0.57$

Cf:

```

if x ≤ 0.05
    Cf := 1.8
else
    if x ≤ 0.1
        
$$C_f := 1.8 + (1.7 - 1.8) \cdot \frac{(x - .05)}{(.1 - .05)}$$

    else
        if x ≤ 0.2
            
$$C_f := 1.7 + (1.65 - 1.7) \cdot \frac{(x - .1)}{(.2 - .1)}$$

        else
            if x ≤ 0.5
                
$$C_f := 1.65 + (1.55 - 1.65) \cdot \frac{(x - .2)}{(.5 - .2)}$$

            else
                if x ≤ 1
                    
$$C_f := 1.55 + (1.45 - 1.55) \cdot \frac{(x - .5)}{(1 - .5)}$$

                else
                    if x ≤ 2
                        
$$C_f := 1.45 + (1.4 - 1.45) \cdot \frac{(x - 1)}{(2 - 1)}$$

                    else
                        if x ≤ 4
                            
$$C_f := 1.4 + (1.35 - 1.4) \cdot \frac{(x - 2)}{(4 - 2)}$$

                        else
                            if x ≤ 5
                                Cf := 1.35
                            else
                                if x ≤ 10
                                    
$$C_f := 1.35 + (1.3 - 1.35) \cdot \frac{(x - 5)}{(10 - 5)}$$

                                else
                                    if x ≤ 1000
                                        Cf := 1.3
                                    else
                                        dummy := 0
                                Cf = 1.43

```

qz and qasd:

$$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot \left(\frac{V}{\text{mph}} \right)^2 \text{ psf}$$

$$q_z = 22.79 \text{ psf} \quad q_z = 1.09 \text{ kPa}$$

$$q_{asd} := 0.6 \cdot q_z$$

$$q_{asd} = 13.68 \text{ psf} \quad q_{asd} = 0.65 \text{ kPa}$$

Cf1:

	3/8	1/2	5/8	1	1-1/4	1-3/4	2	2-1/4
1 "5 GA"	0.01	0.01	0.01	2.92	3.52	4.73	5.33	5.92
2 "6 GA"	0.01	0.01	0.01	3.3	3.75	5.06	5.71	6.37
3 "8 GA"	0.01	0.01	0.01	3.58	4.36	5.89	6.67	7.44
4 "9 GA"	1.77	2.2	2.6	3.87	4.73	6.4	7.26	8.09
5 "10 GA"	1.88	2.36	2.8	4.19	5.13	6.96	7.9	8.82
6 "11 GA"	2.06	2.6	3.1	4.65	5.71	7.77	8.83	9.86
7 "12 GA"	2.16	2.72	3.25	4.91	6.04	8.22	9.35	10.44

$$C'_{f1} := C'_{f1} \cdot g a_{NDX} m s_{NDX} + 2$$

$$C_{f1} = 6.40$$

Design of Post and Rail (ASD):**Post:**

$A_{tp} := L \cdot h$	$A_{tp} = 90.00 \text{ ft}^2$	$A_{tp} = 8.36 \text{ m}^2$	Tributary Area on Post
$P := A_{tp} \cdot q_{asd} \cdot G \cdot C_f$	$P = 1.50 \text{ K}$	$P = 6.65 \text{ kN}$	F on Post (Solid Wall)
$F_{wl} := \frac{1}{C_{f1}}$	$F_{wl} = 0.16$		Wind Load Factor
$P' := F_{wl} \cdot P$	$P' = 0.23 \text{ K}$	$P' = 1.04 \text{ kN}$	F on Post (Perf Wall)
$c := 0.55 \cdot h$	$c = 5.50 \text{ ft}$	$c = 1.68 \text{ m}$	Ht of Result Force Fig. 29.4-1
if $p s_{NDX} = 1$ $M_p := c \cdot P'$ else $M_p := c \cdot P$	$M_p = 1.29 \text{ K_ft}$	$M_p = 1.74 \text{ kN_m}$	Overtaking Moment at Grade
$M_{rp} := \frac{f_{yp} \cdot S x_p}{SF}$	$M_{rp} = 2.65 \text{ K_ft}$	$M_{rp} = 3.60 \text{ kN_m}$	Safe Resisting Moment

Rail:

$w_{tr} := \frac{h}{2}$	$w_{tr} = 5.00 \text{ ft}$	$w_{tr} = 1.524 \text{ m}$	Tributary Width on Rail
$q_r := w_{tr} \cdot q_{asd}$	$q_r = 68.38 \text{ plf}$	$q_r = 1.00 \text{ kNpm}$	
$M_r := \frac{q_r \cdot L^2}{8}$	$M_r = 0.69 \text{ K_ft}$	$M_r = 0.94 \text{ kN_m}$	
$M_{rr} := \frac{f_{yr} \cdot S x_r}{SF}$	$M_{rr} = 4.30 \text{ K_ft}$	$M_{rr} = 5.83 \text{ kN_m}$	Safe Resisting Moment

Design of Foundation:

$$d' := \left(\frac{4.25 \cdot \frac{M_p}{\text{lb} \cdot \text{in}}}{\frac{q_p}{\text{psf}} \cdot \frac{\phi_{pile}}{\text{in}}} \right)^{\frac{1}{3}} \text{ft} \quad d' = 3.01 \text{ ft} \quad d' = 0.918 \text{ m} \quad \text{Constrained Footing Depth}$$

$$S_i := \frac{\frac{q_p}{\text{psf}} \cdot \frac{d'}{\text{ft}}}{3} \quad S_i = 200.79$$

$$A_i := \frac{\left(2.34 \cdot \frac{P'}{\text{lbf}} \cdot 12 \right)}{\frac{\frac{q_p}{\text{psf}} \cdot \frac{d'}{\text{ft}}}{3} \cdot \frac{\phi_{pile}}{\text{in}}} \quad A_i = 2.72$$

$$d_i := 0.5 \cdot A_i \cdot \left(1 + \left(1 + \left(\frac{4.36 \cdot \frac{c}{\text{ft}}}{A_i} \right) \right)^{.5} \right) \text{ft} \quad d_i = 5.63 \text{ ft}$$

$$d_i = 1.715 \text{ m}$$

$$S := \frac{\frac{q_p}{\text{psf}} \cdot \frac{d_i}{\text{ft}}}{3} \quad S = 375.11$$

$$A := \frac{\left(2.34 \cdot \frac{P'}{\text{lbf}} \cdot 12 \right)}{\frac{\frac{q_p}{\text{psf}} \cdot \frac{d_i}{\text{ft}}}{3} \cdot \frac{\phi_{pile}}{\text{in}}} \quad A = 1.46$$

$$d := 0.5 \cdot A \cdot \left(1 + \left(1 + \left(\frac{4.36 \cdot \frac{c}{\text{ft}}}{A} \right) \right)^{.5} \right) \text{ft} \quad d = 3.77 \text{ ft}$$

$$d = 1.150 \text{ m}$$

$$d_i := d$$

$$S := \frac{\frac{q_p}{\text{psf}} \cdot \frac{d_i}{\text{ft}}}{3} \quad S = 251.62$$

$$A := \frac{\left(2.34 \cdot \frac{P'}{\text{lbf}} \cdot 12 \right)}{\frac{\frac{q_p}{\text{psf}} \cdot \frac{d_i}{\text{ft}}}{3} \cdot \frac{\phi_{pile}}{\text{in}}} \quad A = 2.17$$

$$d := 0.5 \cdot A \cdot \left(1 + \left(1 + \left(\frac{4.36 \cdot \frac{c}{\text{ft}}}{A} \right) \right)^{.5} \right) \text{ft} \quad d = 4.86 \text{ ft}$$

$$d = 1.480 \text{ m}$$

```

for count ∈ [1..2]
|

$$S := \frac{\frac{q_p}{\text{psf}} \cdot \frac{d_i}{\text{ft}}}{3}$$


$$A := \frac{\left( 2.34 \cdot \frac{P'}{\text{lbf}} \cdot 12 \right)}{\frac{\frac{q_p}{\text{psf}} \cdot \frac{d_i}{\text{ft}}}{3} \cdot \frac{\phi_{pile}}{\text{in}}}$$


$$d := 0.5 \cdot A \cdot \left( 1 + \left( 1 + \left( \frac{4.36 \cdot \frac{c}{\text{ft}}}{A} \right) \right) \right)^{.5} \text{ft}$$


$$d_i := d$$


```

Summary:**Material Property Factors:**

$\phi_s = 0.90$	Steel
$\phi_w = 0.67$	Weld
$\phi_{sv} = 0.75$	Steel Shear

Load Factors:

$\alpha_D = 1.25$	Dead Load
$\alpha_L = 1.50$	Live Load
$SF = 1.67$	Safety Factor for ASD

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

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

Foundation

Diameter of Pile
Length of Pile
Lateral Bearing Pressure
Soil Adjustment Factor
Adjusted Bearing Pressure
Footing Constrained

$\phi_{pile} = 12.0 \text{ in}$ $\phi_{pile} = 304.8 \text{ mm}$
 $d = 49.6 \text{ in}$ $d = 1261 \text{ mm}$
 $q_p = 200.00 \text{ psf}$ $q_p = 9.58 \text{ kPa}$
 $F_{sa} = 1.00$
 $q'_p = 200 \text{ psf}$ $q'_p = 9.58 \text{ kPa}$
 $des_{fc} = \text{"Footing Constrained"}$

Chainlink Fence

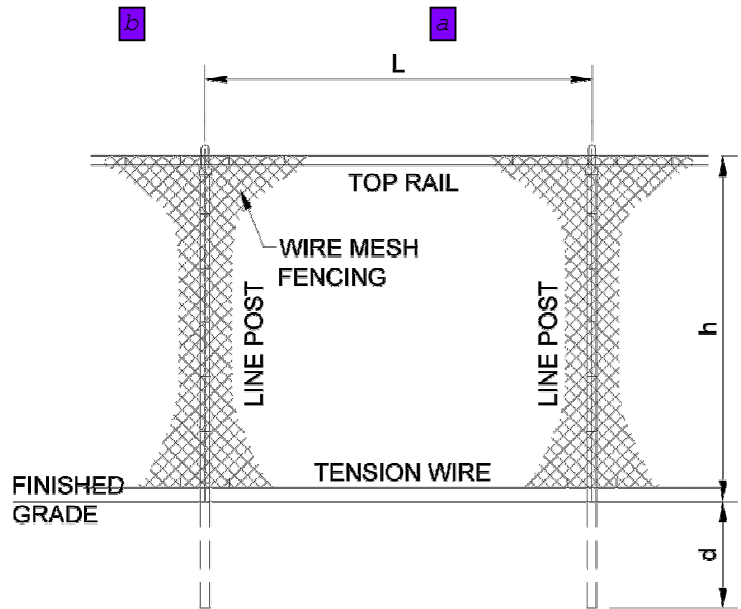
Fence Height
Minimum Straight Run
Ratio Min Spacing:h
Line Post Spacing
Mesh Size:
Wire Size:
Privacy Slats

$h = 10.00 \text{ ft}$ $h = 3.048 \text{ m}$
 $B = 14.00 \text{ ft}$ $B = 4.267 \text{ m}$
 $x = 1.40$
 $L = 9.00 \text{ ft}$ $L = 2.74 \text{ m}$
 $des_{ms} = \text{"1-3/4"}$
 $des_{ga} = \text{"9 GA"}$
 $des_{ps} = \text{"No Privacy Slats"}$

Post and Rail**Post**

Material Designation
Yield Strength
Pipe Size Designation
Outside Diameter
Wall Thickness
Section Modulus
Plastic Section Modulus

$des_p = \text{"Pipe STN HS"}$
 $f_{yp} = 50.00 \text{ Ksi}$ $f_{yp} = 344.74 \text{ MPa}$
 $des_{\phi p} = \text{"2-7/8 STN"}$
 $\phi_p = 2.88 \text{ in}$ $\phi_p = 73.0 \text{ mm}$
 $t_p = 0.20 \text{ in}$ $t_p = 5.2 \text{ mm}$
 $Sx_p = 1.06 \text{ in}^3$ $Sx_p = 17436 \text{ mm}^3$
 $Zx_p = 1.45 \text{ in}^3$ $Zx_p = 23796 \text{ mm}^3$



Rail

Material Designation	$des_r = \text{"Pipe STN HS"}$	
Yield Strength	$f_{yr} = 50.00 \text{ Ksi}$	$f_{yr} = 344.74 \text{ MPa}$
Pipe Size Designation	$des_{\phi_r} = \text{"3-1/2 STN"}$	
Outside Diameter	$\phi_r = 3.50 \text{ in}$	$\phi_r = 88.9 \text{ mm}$
Wall Thickness	$t_r = 0.22 \text{ in}$	$t_r = 5.5 \text{ mm}$
Section Modulus	$Sx_r = 1.72 \text{ in}^3$	$Sx_r = 28253 \text{ mm}^3$
Plastic Section Modulus	$Zx_r = 2.33 \text{ in}^3$	$Zx_r = 38228 \text{ mm}^3$

Wind Loading:

Wind Speed	$V = 135.00 \text{ mph}$	$V = 217 \text{ kph}$
26.8.2	$K_{zt} = 1.00$	
Table 26.6-1	$K_d = 0.85$	
Table 26.9.1	$G = 0.85$	
Wind Exposure	$des_{Ex} = \text{"Exposure B"}$	
Alpha Coefficient	$\alpha = 7$	
Table 26.6-1	$z_g = 1200 \text{ ft}$	$z_g = 365.76 \text{ m}$
Table 26.9.1		
Velocity Exposure Pressure Coefficient (Kz):	$K_z = 0.57$	
	$C_f = 1.43$	
	$q_z = 22.79 \text{ psf}$	$q_z = 1.09 \text{ kPa}$
	$q_{asd} = 13.68 \text{ psf}$	$q_{asd} = 0.65 \text{ kPa}$
	$C_{f1} = 6.40$	