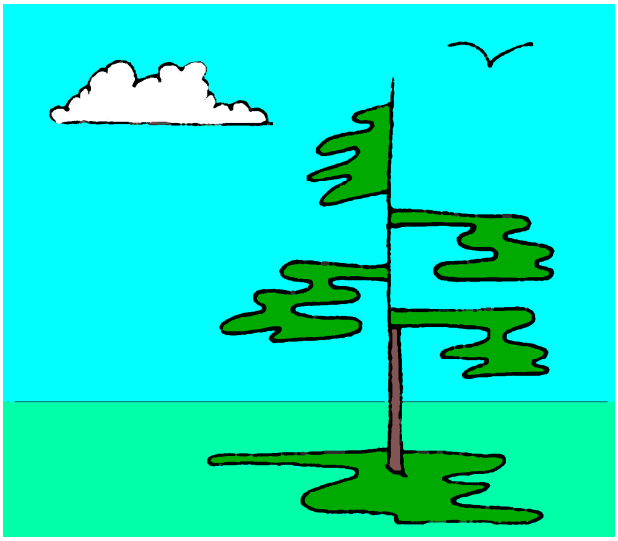
NorthWoods Software



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:

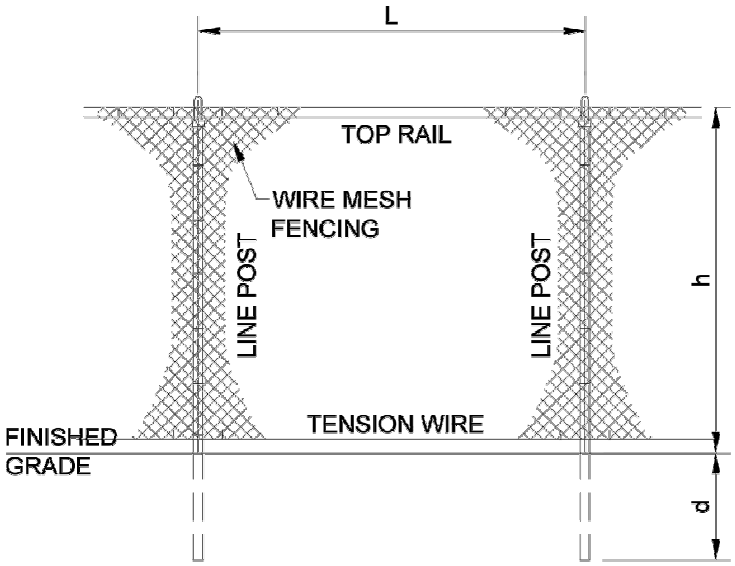
$\alpha_D := 1.25$ Dead Load

$\alpha_L := 1.5$ Live Load

$SF := 1.67$ Safety Factor for ASD

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

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



c b a

Foundation Properties:

$\phi_{pile} := 12\ in$	$\phi_{pile} = 12.0\ in$	$\phi_{pile} = 304.8\ mm$	Diameter of Pile
$d := 12\ in$	$d = 12\ in$	$d = 304.8\ mm$	Length of Pile
$q_p := 200\ psf$	$q_p = 200.00\ psf$	$q_p = 9.58\ kPa$	Lateral Bearing Pressure
$F_{sa} := 1.0$	$F_{sa} = 1.00$		Soil Adjustment Factor
$q'_p := q_p \cdot F_{sa}$	$q'_p = 200\ psf$	$q'_p = 9.58\ kPa$	Adjusted Bearing Pressure

Constraint: $fc_{NDX} := 1$

$fc :=$

NDX	Constraint
1	"Footing Constrained"
2	"Footing Not Constrained"

$des_{fc} := fc\ _{fc_{NDX}\ 2}$

Chainlink Fence Properties:

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

$ms :=$

NDX	Opening
1	"3/8"
2	"1/2"
3	"5/8"
4	"1"
5	"1-1/4"
6	"1-3/4"
7	"2"
8	"2-1/4"

$des_{ms} := ms\ _{ms_{NDX}\ 2}$

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

$ga :=$

NDX	Gauge
1	"5 GA"
2	"6 GA"
3	"8 GA"
4	"9 GA"
5	"10 GA"
6	"11 GA"

$des_{ga} := ga\ _{ga_{NDX}\ 2}$

Dimensions:

$h := 10\ ft$	$h = 10.00\ ft$	$h = 3.048\ m$	Fence Height
$B := 14\ ft$	$B = 14.00\ ft$	$B = 4.267\ m$	Minimum Straight Run
$x := \frac{B}{h}$	$x = 1.40$		Ratio Min Spacing:h
$L := 9\ ft$	$L = 9.00\ ft$	$L = 2.74\ m$	Line Post Spacing

Privacy Slats: $ps_{NDX} := 1$ c b a

$ps :=$

NDX	Privacy
1	"No Privacy Slats"
2	"Privacy Slats"

$des_{ps} := ps\ _{ps_{NDX}\ 2}$

Post and Rail Data:

$st :=$

NDX	Material	Yield
1	"Pipe STN"	30 Ksi
2	"Pipe STN HS"	50 Ksi
3	"HSS"	50 Ksi

$des_p := st\ _{st_{NDX}\ 2}$ $f_{yp} := st\ _{st_{NDX}\ 3}$

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

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

$HSSc :=$

	NDX	Size	Diameter	t
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:

Size: $HSSc_{NDX} := 4$ $des_{\phi p} := HSSc_{HSSc_{NDX},2}$ $\phi_p := HSSc_{HSSc_{NDX},3}$ $t_p := HSSc_{HSSc_{NDX},4}$

Rail: $HSSc_{NDX} := 5$ $des_{\phi r} := HSSc_{HSSc_{NDX},2}$ $\phi_r := HSSc_{HSSc_{NDX},3}$ $t_r := HSSc_{HSSc_{NDX},4}$

Wind Loading:

Topography:

$V := 135$ mph	$V = 135.00$ mph	$V = 217$ 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: $Ex_{NDX} := 1$

$Ex :=$

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

$des_{Ex} := Ex_{Ex_{NDX},2}$ $\alpha := Ex_{Ex_{NDX},3}$ $z_g := Ex_{Ex_{NDX},4}$

Post and Rail Section Properties:

Post:

$$Sx_p := \pi \cdot \frac{\left(\phi_p^{\,4} - \left(\phi_p - 2 \cdot t_p\right)^4\right)}{32 \cdot \phi_p}$$

$Sx_p = 1.06\ \text{in}^3$ $Sx_p = 17436.45\ \text{mm}^3$

$$Zx_p := \frac{\left(\phi_p^{\,3} - \left(\phi_p - 2 \cdot t_p\right)^3\right)}{6}$$

$Zx_p = 1.45\ \text{in}^3$ $Zx_p = 23796.05\ \text{mm}^3$

c b a

Class of Section:

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

$cl_p = 1$

Rail:

$$Sx_r := \pi \cdot \frac{\left(\phi_r^{\,4} - \left(\phi_r - 2 \cdot t_r\right)^4\right)}{32 \cdot \phi_r}$$

$Sx_r = 1.72\ \text{in}^3$ $\quad Sx_r = 28252.76\ \text{mm}^3$

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

$Zx_r = 2.33\ \text{in}^3$ $\quad Zx_r = 38228.48\ \text{mm}^3$

Class of Section:

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

$cl_r = 1$

Wind Pressure Desgn:

Velocity Exposure Pressure Coefficient (Kz):

```
if h < 15 ft
    K_z := 2.01 · (15 / (z_g / ft))^(2/α)
else
    K_z := 2.01 · (h / (z_g / ft))^(2/α)
```

$K_z = 0.57$

Cf:

```
if x ≤ 0.05
  C_f := 1.8
else
  if x ≤ 0.1
    C_f := 1.8 + (1.7 − 1.8) · (x − .05) / (.1 − .05)
  else
    if x ≤ 0.2
      C_f := 1.7 + (1.65 − 1.7) · (x − .1) / (.2 − .1)
    else
      if x ≤ 0.5
        C_f := 1.65 + (1.55 − 1.65) · (x − .2) / (.5 − .2)
      else
        if x ≤ 1
          C_f := 1.55 + (1.45 − 1.55) · (x − .5) / (1 − .5)
        else
          if x ≤ 2
            C_f := 1.45 + (1.4 − 1.45) · (x − 1) / (2 − 1)
          else
            if x ≤ 4
              C_f := 1.4 + (1.35 − 1.4) · (x − 2) / (4 − 2)
            else
              if x ≤ 5
                C_f := 1.35
              else
                if x ≤ 10
                  C_f := 1.35 + (1.3 − 1.35) · (x − 5) / (10 − 5)
                else
                  if x ≤ 1000
                    C_f := 1.3
                  else
                    dummy := 0
```

$C_f = 1.43$

qz and qasd:

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

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

$q_{asd} := 0.6 \cdot q_z$ $q_{asd} = 13.68 \text{ psf}$ $q_{asd} = 0.65 \text{ kPa}$

Cf1:

		c			b			a
		3/8	1/2	5/8	1	1-1/4	1-3/4	2	2-1/4
1	"5 GA"	.01	.01	.01	2.92	3.52	4.73	5.33	5.92
2	"6 GA"	.01	.01	.01	3.3	3.75	5.06	5.71	6.37
3	"8 GA"	.01	.01	.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

$C''_{f1} :=$ (matrix above)

$C_{f1} := C''_{f1}\ ga_{NDX}\ ms_{NDX} + 2$

$C_{f1} = 6.40$

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 $ps_{NDX} = 1$ $M_p := c \cdot P'$ else $M_p := c \cdot P$	$M_p = 1.29 \text{ K\_ft}$	$M_p = 1.74 \text{ kN\_m}$	Overturning Moment at Grade
$M_{rp} := \frac{f_{yp} \cdot Sx_p}{SF}$	$M_{rp} = 2.65 \text{ K\_ft}$	$M_{rp} = 3.60 \text{ kN\_m}$	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
$q_r := w_{tr} \cdot q_{asd}$	$q_r = 68.38 \text{ plf}$	$q_r = 1.00 \text{ kNpm}$	
$M_r := \frac{q_r \cdot L^2}{8}$	$M_r = 0.69 \text{ K\_ft}$	$M_r = 0.94 \text{ kN\_m}$	
$M_{rr} := \frac{f_{yr} \cdot Sx_r}{SF}$	$M_{rr} = 4.30 \text{ K\_ft}$	$M_{rr} = 5.83 \text{ kN\_m}$	Safe Resisting Moment

Design of Foundation:

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

Constrained Footing Depth

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

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

$$d_i := 0.5 \cdot A_i \cdot \left(1 + \left(1 + \left(\frac{4.36 \cdot \frac{c}{ft}}{A_i} \right) \right)^{.5} \right) ft \qquad d_i = 5.63\ ft \qquad d_i = 1.715\ m$$

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

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

$$d := 0.5 \cdot A \cdot \left(1 + \left(1 + \left(\frac{4.36 \cdot \frac{c}{ft}}{A} \right) \right)^{.5} \right) ft \qquad d = 3.77\ ft \qquad d = 1.150\ m$$

$$d_i := d$$

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

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

$$d := 0.5 \cdot A \cdot \left(1 + \left(1 + \left(\frac{4.36 \cdot \frac{c}{ft}}{A} \right) \right)^{.5} \right) ft \qquad d = 4.86\ ft \qquad d = 1.480\ m$$

for $count \in [1..2]$

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

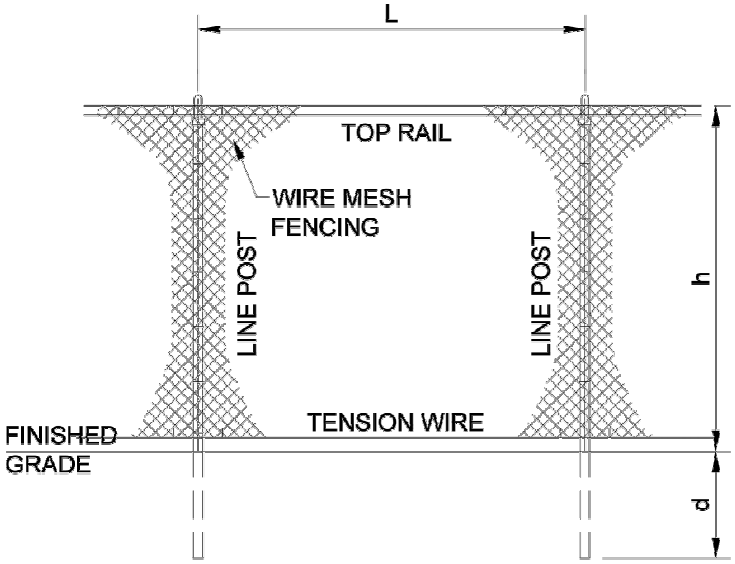
$$A := \frac{\left(2.34 \cdot \frac{P'}{lbf} \cdot 12\right)}{\frac{\frac{q_p}{psf} \cdot \frac{d_i}{ft}}{3} \cdot \frac{\phi_{pile}}{in}}$$

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

$$d_i := d$$

c b a

Summary:



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

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

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

Foundation

Diameter of Pile	$\phi_{pile} = 12.0\ in$	$\phi_{pile} = 304.8\ mm$
Length of Pile	$d = 49.6\ in$	$d = 1261\ mm$
Lateral Bearing Pressure	$q_p = 200.00\ psf$	$q_p = 9.58\ kPa$
Soil Adjustment Factor	$F_{sa} = 1.00$	
Adjusted Bearing Pressure	$q'_p = 200\ psf$	$q'_p = 9.58\ kPa$
Footing Constrained	$des_{fc} = \text{"Footing Constrained"}$	

Chainlink Fence

Fence Height	$h = 10.00\ ft$	$h = 3.048\ m$
Minimum Straight Run	$B = 14.00\ ft$	$B = 4.267\ m$
Ratio Min Spacing:h	$x = 1.40$	
Line Post Spacing	$L = 9.00\ ft$	$L = 2.74\ m$
Mesh Size:	$des_{ms} = \text{"1-3/4"}$	
Wire Size:	$des_{ga} = \text{"9 GA"}$	
Privacy Slats	$des_{ps} = \text{"No Privacy Slats"}$	

Post and Rail

Post

Material Designation	$des_p = \text{"Pipe STN HS"}$	
Yield Strength	$f_{yp} = 50.00\ Ksi$	$f_{yp} = 344.74\ MPa$
Pipe Size Designation	$des_{\phi p} = \text{"2-7/8 STN"}$	
Outside Diameter	$\phi_p = 2.88\ in$	$\phi_p = 73.0\ mm$
Wall Thickness	$t_p = 0.20\ in$	$t_p = 5.2\ mm$
Section Modulus	$Sx_p = 1.06\ in^3$	$Sx_p = 17436\ mm^3$
Plastic Section Modulus	$Zx_p = 1.45\ in^3$	$Zx_p = 23796\ mm^3$

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):	$K_z = 0.57$	
	$C_f = 1.43$	
	$q_z = 22.79\ \text{psf}$	$q_z = 1.09\ \text{kPa}$
	$q_{asd} = 13.68\ \text{psf}$	$q_{asd} = 0.65\ \text{kPa}$
	$C_{fl} = 6.40$	