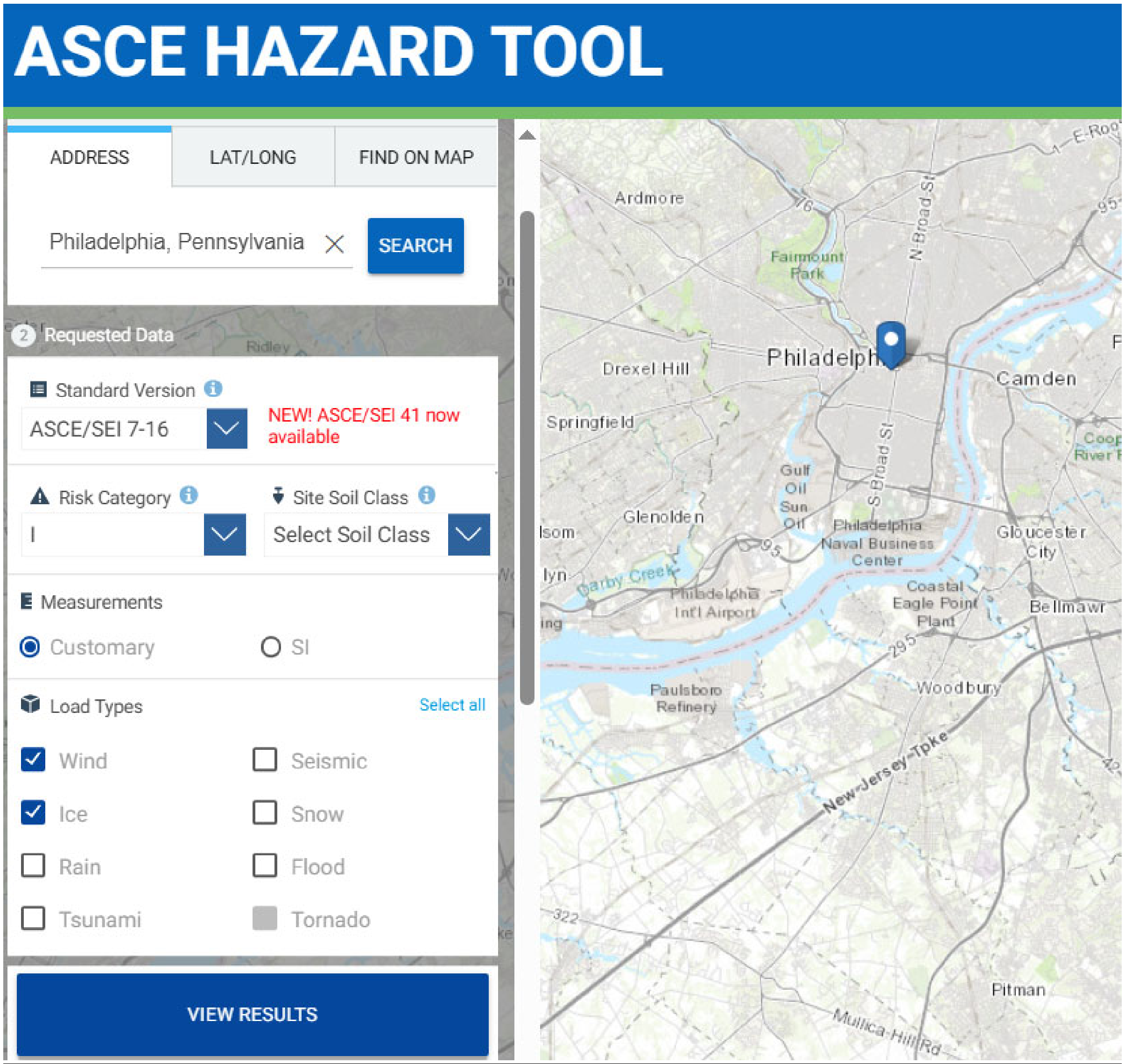
Example 3 – hand calculations – open fencing for wind loading – solid / mostly solid fencing for wind on ice loading

10' high chain link fence 9Ga 1-3/4" mesh 96' long 8' post spacing

Site Location - Philadelphia, PA Exposure C Risk Category I Flat ground

PENNSYLVANIA
2018 International Building Code (at the time of this writing) For IBC 2018 & 2021 use ASCE 7-16

https://asce7hazardtool.online/



Standard:	ASCE/SEI 7-16
Risk Category:	I
Soil Class:	

Wind

105 Vmph

Ice Details

Thickness	1.00 in.
Concurrent Temperature	15 F
Gust Speed	40 mph

q_w Values	
V_w (mph)	q_w (psf)
85	8.02
90	8.99
95	10.02
100	11.10
105	12.24
110	13.43
115	14.68
120	15.98
130	18.75
140	21.75

q_i Values	
V_i (mph)	q_i (psf)
30	1.17
40	2.07
50	3.24
60	4.66
70	6.34
80	8.29

K_z Values for ASCE 7-10 & 7-16			
Fence Height, h (ft)	Exposure Class		
	B	C	D
0-15	0.57	0.85	1.03
16	0.59	0.86	1.04
17	0.60	0.87	1.05
18	0.61	0.88	1.06
19	0.61	0.89	1.07
20	0.62	0.90	1.08

K_e Values		
Site Elevation	ASCE	
	7-16 & 7-22	7-10
z_e (ft)	K_e	K_e = 1.0
0	1.00	1.00
500	0.98	1.00
1,000	0.96	1.00
1,500	0.95	1.00
2,000	0.93	1.00
2,500	0.91	1.00
3,000	0.90	1.00
3,500	0.88	1.00
4,000	0.87	1.00
4,500	0.85	1.00
5,000	0.84	1.00

K_{zt} = 1.0 for flat ground
See ASEC 7 Fig. 26.8-1 to calculate K_{zt} values for site locations on hills or escarpments

1-3/4" Chain Link Mesh Variables 11-1/2 ga to 5 ga

1-3/4" Mesh Wind & Weight Values				
Gauge	Dia (in)	ε	C_{fw}	D_m (psf)
5	0.207	0.22	1.3	1.9
6	0.192	0.21	1.3	1.6
8	0.162	0.18	1.3	1.2
9	0.148	0.16	1.3	1.0
10	0.135	0.15	1.3	0.8
11	0.120	0.13	1.3	0.6
11-½	0.113	0.12	1.3	0.6

ε = solidity ratio for chain link
ε' = solidity ratio for iced chain link
C_{fw} = wind force coefficient
C_{fi} = wind on ice force coefficient
D_m = estimated weight of chain link mesh
Check with supplier for actual weight
D_i = estimated weight of ice (includes 0.7 ASD factor)
The values below are only valid for Risk Category I and K_{zt} = 1.0
For ice thickness not shown below, round up to next nearest value

1-3/4" Mesh (all gauges) Estimated Ice Loading Risk Category I K_{zt} = 1.0												
ASCE 7-10 Nominal Ice Thickness, t (in)	Fence Height, h											
	5'			10'			15'			20'		
	ε'	C_{fi}	D_i (psf)	ε'	C_{fi}	D_i (psf)	ε'	C_{fi}	D_i (psf)	ε'	C_{fi}	D_i (psf)
0.25	0.69	1.5	1.5	0.72	See solid wall C_{fi} table below	1.7	0.73	See solid wall C_{fi} table below	1.8	0.74	See solid wall C_{fi} table below	1.8
0.50	0.95	See solid wall C_{fi} table below	4.0	0.97		4.4	0.98		4.6	0.99		4.8
0.75	1.00		6.8	1.00		7.4	1.00		7.9	1.00		8.2
1.00	1.00		9.8	1.00		10.6	1.00		11.1	1.00		11.5
1.25	1.00		12.6	1.00		13.6	1.00		14.2	1.00		14.7
1.50	1.00		15.4	1.00		16.6	1.00		17.4	1.00		17.9
ASCE 7-16 Nominal Ice Thickness, t (in)	Fence Height, h											
	5'			10'			15'			20'		
	ε'	C_{fi}	D_i (psf)	ε'	C_{fi}	D_i (psf)	ε'	C_{fi}	D_i (psf)	ε'	C_{fi}	D_i (psf)
0.25	0.47	1.5	0.6	0.49	1.5	0.6	0.50	1.5	0.7	0.51	1.5	0.7
0.50	0.69	1.5	1.5	0.72	See solid wall C_{fi}	1.7	0.73	See solid wall C_{fi}	1.8	0.74	See solid wall C_{fi}	1.8
0.75	0.85		2.7	0.88		3.0	0.89		3.1	0.90		3.3
1.00	0.95		4.0	0.97		4.4	0.98		4.6	1.00		4.8
1.25	1.00	See solid wall C_{fi}	5.3	1.00		5.8	1.00		6.1	1.00		6.4
1.50	1.00		6.8	1.00		7.4	1.00		7.9	1.00		8.2

ε = 0.16 C_{fw} = 1.3 D_w = 1.0 psf ε' = 0.97 C_{fi} value determined on following pages D_i = 4.4 psf

For wind, R_{1w} = 1.0 For an open fence (e.g. chain link) with a Solidity Ratio, ε or ε′ ≤ 0.7, R_1 = 1.0.

For wind on ice, R_{1i} = 1.01 (see below)

Case C Reduction Factor R_{2i} = 0.8 Return Corner Reduction Factor, F_{3i} = 1.0 as there is no return corner

Case C does not apply to the un-iced condition as the solidity ratio, ε ≤ 0.7, so R_{2w} & R_{3w} are N/A

Inverted Fence Opening Reduction Factor, R_1

ε or ε'	R_1	ε or ε'	R_1
0.71	1.19	0.86	1.06
0.72	1.17	0.87	1.05
0.73	1.16	0.88	1.04
0.74	1.15	0.89	1.04
0.75	1.14	0.90	1.03
0.76	1.13	0.91	1.03
0.77	1.12	0.92	1.02
0.78	1.12	0.93	1.02
0.79	1.11	0.94	1.01
0.80	1.10	0.95	1.01
0.81	1.09	0.96	1.01
0.82	1.08	0.97	1.01
0.83	1.08	0.98	1.00
0.84	1.07	0.99	1.00
0.85	1.06	1.00	1.00

$R_{1w} = 1 / (1 - (1 - \varepsilon)^{1.5})$

$R_{1i} = 1 / (1 - (1 - \varepsilon')^{1.5})$

Case C Reduction Factor, R_2	
s/h	R_2
1.000	0.80
0.975	0.83
0.950	0.85
0.925	0.88
0.900	0.90
0.875	0.93
0.850	0.95
0.825	0.98
≥ 0.800	1.00
$R_2 = (1.8 - s/h) \leq 1.0$	

For wind loading, F_{hw} = 1.0 For an open fence (e.g. chain link) with a Solidity Ratio, ε or ε' ≤ 0.7, F_h = 1.0

Force Height Adjustment Factor, F_h		
s/h	F_h	Notes
1.000	1.100	Per Solid Wall Table, Note 3
0.975	1.025	F_h = 2 - s/h
0.950	1.050	
0.925	1.075	
0.900	1.100	
0.875	1.125	
0.850	1.150	
0.825	1.175	
0.800	1.200	

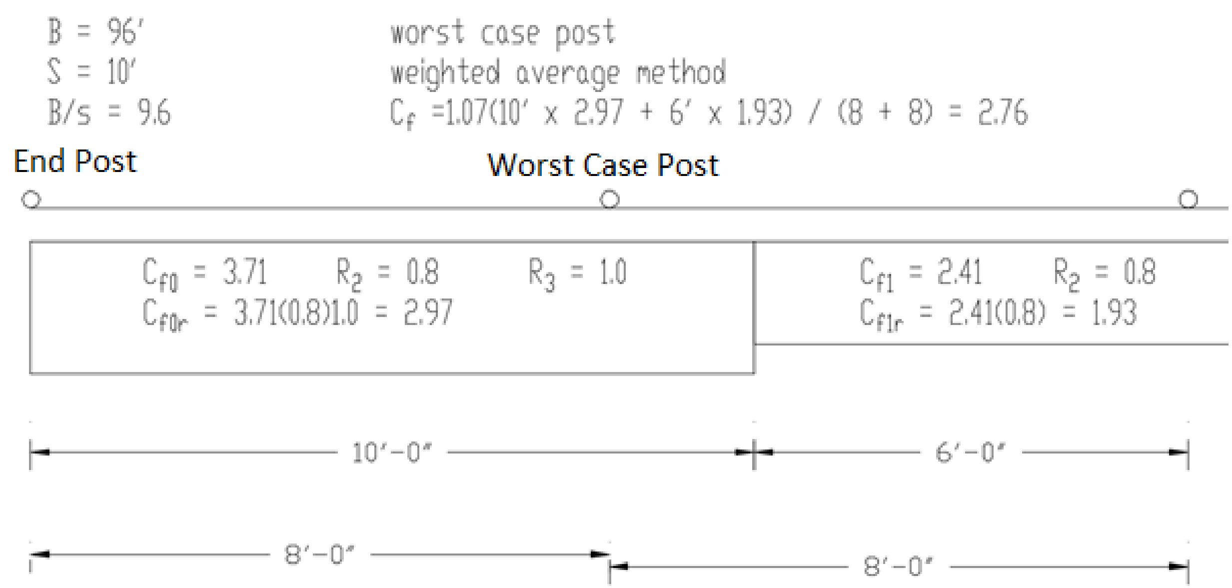
For wind on Ice Loading, F_{hi} = 1.1

Fence Length, B = 96 ft Fencing Height, s = 10' Aspect Ratio B/s = 9.6

C_f values - Solid / Mostly Solid Fencing - Case C - Posts near ends and corners											
Wind Region	Aspect Ratio, B/s										
	2	3	4	5	6	7	8	9	10	11	12
0 to s	2.25	2.60	2.90	3.10*	3.30*	3.40*	3.55*	3.65*	3.75*	3.83*	3.92*
s to 2s	1.50	1.70	1.90	2.00	2.15	2.25	2.30	2.35	2.45	2.49	2.53
2s to 3s	-	1.15	1.30	1.45	1.55	1.65	1.70	1.75	1.85	1.89	1.93
> 3s	-	-	1.10	1.05	1.05	1.05	1.05	1.00	0.95	1.13	1.32

You can conservatively use the highest C_f value of intermediate B/s values, for example, for the 0 to s Region, C_f = 3.75 is acceptable. Values on the following page are more economical interpolated C_f values.

For solid / mostly solid fencing, the post with the highest wind loading is typically the 1st post in from the end of the longest fence run. Return corners reduce the forces so for complicated fencing, multiple checks may need to be done to find the worst case post. In this case, a straight fence with no corners, the posts next to the end posts have the highest loading. End post get higer wind pressures, but only half the wind area.



C_{fi} for the worst case post = 2.76

Ice loading controls f_i = 419 lbs p_i = 432 lbs 5 x p_i = 2,160 lbs desired post diameter, 2-7/8"

Lightest post that looks possible is 40 wt, / ASTM F1043 / Group 1C / 50 ksi

Allowable Wind Force at Mid-height, F_a (lbs) & Allowable Axial Force, P_a (lbs) - Group IA and IC Posts

Post Size	Weight, D_p lbs / ft		Fence Height, H (ft) 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Schedule 40 / ASTM F1043 / Group 1A / 30 ksi																		
1-5/8"	2.3	F_a	182	152	130	114	-	-	-	-	-	-	-	-	-	-	-	-
		P_a	1,745*	1,212*	890*	681*	-	-	-	-	-	-	-	-	-	-	-	-
1-7/8"	2.7	F_a	252	210	180	157	140	-	-	-	-	-	-	-	-	-	-	-
		P_a	2,773*	1,926*	1,415*	1,083*	856*	-	-	-	-	-	-	-	-	-	-	-
2-3/8"	3.7	F_a	427	356	305	267	237	213	194	178	-	-	-	-	-	-	-	-
		P_a	5,943	4,127	3,032*	2,321*	1,834*	1,485*	1,227*	1,031*	-	-	-	-	-	-	-	-
2-7/8"	5.8	F_a	817	680	583	510	453	408	371	340	314	291	272	-	-	-	-	-
		P_a	13,272	9,494	6,975	5,340*	4,219*	3,418*	2,824*	2,373*	2,022*	1,743*	1,519*	-	-	-	-	-
3-1/2"	7.6	F_a	1,310	1,092	936	819	728	655	595	546	504	468	436	409	385	364	-	-
		P_a	22,458	17,944	13,733	10,514	8,307	6,729*	5,561*	4,673*	3,981*	3,433*	2,990*	2,628*	2,328*	2,076*	-	-
4"	9.1	F_a	1,809	1,507	1,292	1,130	1,005	904	822	753	695	646	603	565	532	502	476	452
		P_a	30,535	25,757	21,064	16,666	13,168	10,666	8,815*	7,407*	6,311*	5,442*	4,740*	4,166*	3,690*	3,292*	2,954*	2,666*
4-1/2"	10.8	F_a	2,419	2,016	1,728	1,512	1,344	1,209	1,099	1,008	930	864	806	756	711	672	636	604
		P_a	39,301	34,390	29,370	24,481	19,876	16,100	13,305	11,180	9,526*	8,214*	7,155*	6,289*	5,570*	4,969*	4,459*	4,025*
5-9/16"	14.6	F_a	4,069	3,391	2,906	2,543	2,260	2,034	1,849	1,695	1,565	1,453	1,356	1,271	1,196	1,130	1,070	1,017
		P_a	59,190	54,288	49,016	43,565	38,117	32,830	27,809	23,367	19,910	17,167	14,955*	13,144*	11,643*	10,385*	9,321*	8,412*
6-5/8"	19.0	F_a	6,319	5,266	4,514	3,949	3,511	3,159	2,872	2,633	2,430	2,257	2,106	1,974	1,858	1,755	1,663	1,579
		P_a	81,532	76,751	71,462	65,810	59,943	54,002	48,119	42,408	36,967	31,890	27,780	24,416	21,628	19,291*	17,314*	15,626*
8-5/8"	28.6	F_a	12,434	10,362	8,881	7,771	6,908	6,217	5,652	5,181	4,782	4,440	4,144	3,885	3,657	3,454	3,272	3,108
		P_a	129,849	125,342	120,217	114,564	108,477	102,056	95,401	88,609	81,773	74,982	68,314	61,841	55,623	49,640	44,552	40,208
40 Weight / ASTM F1043 / Group 1C / 50 ksi																		
1-5/8"	1.8	F_a	244	203	174	152	-	-	-	-	-	-	-	-	-	-	-	-
		P_a	1,455*	1,010*	742*	568*	-	-	-	-	-	-	-	-	-	-	-	-
1-7/8"	2.3	F_a	350	292	250	219	194	175	-	-	-	-	-	-	-	-	-	-
		P_a	2,385	1,656*	1,217*	931*	736*	596*	-	-	-	-	-	-	-	-	-	-
2-3/8"	3.1	F_a	608	507	434	380	338	304	276	253	-	-	-	-	-	-	-	-
		P_a	5,178	3,596	2,642*	2,022*	1,598*	1,294*	1,069*	899*	-	-	-	-	-	-	-	-
2-7/8"	4.6	F_a	1,095	912	782	684	608	547	497	456	421	391	365	-	-	-	-	-
		P_a	11,274	7,829	5,752	4,404*	3,479*	2,818*	2,329*	1,957*	1,667*	1,438*	1,252*	-	-	-	-	-
4"	6.6	F_a	2,222	1,852	1,587	1,389	1,234	1,111	1,010	926	854	793	740	694	653	617	584	555
		P_a	28,899	22,018	16,247	12,439	9,828	7,961	6,579*	5,528*	4,710*	4,061*	3,538*	3,109*	2,754*	2,457*	2,205*	1,990*

Hand calculations on the following pages using the worksheets provided on the "Instructions" page of FenceDesign.com

Worksheet – Open / Mostly Solid / Solid Fencing – Wind and Wind & Ice Loading

Site Location: Phladelphia, PA **FenceDesign.com**

Customer:

Site and Geometrical Variables

IBC 2018 ASCE 7- 16 Risk Category I Frost Depth 2.5 ft

Basic Wind Speed, V_w = 105 mph Nominal Ice Thickness, t = 1.0 in

Gust / Concurrent Wind Speed for Ice Loading, V_i = 40 mph

Wind Pressure, q_w = 12.24 psf Wind on Ice Pressure, q_i = 2.07 psf

Exposure Category C Topographical Factor, K_{zt} = 1.0

Site Elevation, Z_e = 44' ft Elevation Factor, K_e = 1.0

Height of fence, h = 10 ft Gap at bottom of fence, g = 0 ft (zero if no gap)

Height of fencing material, s = h - g = 10 ft

Velocity Pressure Exposure Coefficient, K_z = 0.85

Wind & Axial Loading

Fence Run # 1   Length of Fence, B = 96 ft   Post spacing, L = 8 ft

Post Type: Line Posts (X)   Post near end or corner ( )

Solidity Ratio, ε = 0.16   Inverted Fence Opening Reduction Factor, R_{1w} = 1.0

Case C Reduction Factor, R_{2w} = N/A   Return Corner Reduction Factor, R_{3w} = N/A

Force Height Adjustment Factor, F_{hw} = 1.0   Wind Force Coefficient, C_{fw} = 0.13

Expected Post Diameter or Width, $Ø_p$ = 2.875 in   (Set to Zero for solid / mostly solid fencing)

Top Rail Diameter or Width, $Ø_r$ = 1.625 in   Mid Rail Diameter or Width, $Ø_p$ = 1.625 in

($Ø_r$ & $Ø_m$ – set to Zero if not applicable for rails or for solid / mostly solid fencing)

Wind Area of Post, $A_p = Ø_p / 12 \times h = \underset{Ø_p}{2.875"} \div 12 \times \underset{h}{10'} = \underset{A_p}{2.40}$ ft²

(A_p = 0 for solid / mostly solid fencing)

Wind Area of Rails, $A_r = (Ø_r / 12) \times 2 \times L + (Ø_m / 12) \times L$ (A_r = 0 for solid / mostly solid fencing)

$$A_r = (\underset{Ø_r}{1.625"} \div 12 \times 2 \times \underset{L}{8'}) + (\underset{Ø_m}{1.625"} \div 12 \times \underset{L}{8'}) = \underset{A_r}{3.25} \text{ ft}^2$$

Wind area tributary to the post, $A_w = \varepsilon\, s\, L + A_p + A_r = \underset{\varepsilon}{0.16} \times \underset{s}{10'} \times \underset{L}{8'} + \underset{A_p}{2.4} + \underset{A_r}{3.25} = \underset{A_w}{18.45}$ ft²

Dead Load of fencing materials, D_m 1.0 psf

Lateral and Axial Forces for Wind Loading

Minimum wind force to the post, $f_{min} = (0.6)\, 16.0\, A_w = 9.6 \times \underset{A_w}{18.45} = \underset{f_{min}}{177}$ lbs

Calculated Wind Force to the post, $f_w = q_w K_z K_{zt} K_e R_{1w} F_{hw} C_{fw} A_w$

$$f_w = \underset{q_w}{12.24} \times \underset{K_z}{0.85} \times \underset{K_{zt}}{1.0} \times \underset{K_e}{1.0} \times \underset{R_{1w}}{1.0} \times \underset{F_{hw}}{1.0} \times \underset{C_{fw}}{1.3} \times \underset{A_w}{18.45} = \underset{f_w}{250} \text{ lbs}$$

Maximum wind force to the post, f_w' = maximum value of either f_{min} or f_w = $\underset{f_w'}{250}$ lbs

The Axial Force supported by the post, $p_a = D_w\, s\, L$

$$p_w = \underset{D_w}{1.0} \times \underset{s}{10'} \times \underset{L}{8'} = \underset{p_w}{80} \text{ lbs}$$ (rails neglected - can be added in later)

$5 \times p_w$ = 400 lbs (used for stability check)

Wind on Ice Loading

Fence Run # 1   Length of Fence, B = 96 ft   Post spacing, L = 8 ft

Post Type: Line Posts( )   Post near end or corner(X)

Wind on Ice Force Variables

Iced Solidity Ratio, ε' = 0.97   Inverted Fence Opening Reduction Factor, R_{1i} = 1.01

Case C Reduction Factor, R_{2i} = 0.8   Return Corner Reduction Factor, R_{3i} = 1.0

Force Height Adjustment Factor, F_{hi} = 1.1   Wind Force Coefficient, C_{fi} = 2.76

Dead Load of Ice, D_i = 4.4 psf

Wind area tributary to the post in the iced condition, $A_i = \varepsilon' \, s \, L$

$$A_i = \underset{\varepsilon'}{\underline{0.97}} \times \underset{s}{\underline{10'}} \times \underset{L}{\underline{8'}} = \underset{A_i}{\underline{77.6}} \text{ ft}^2$$

Wind on Ice Force to the post, $f_i = q_i \, K_z \, K_{zt} \, K_e \, R_{1i} \, F_{hi} \, C_{fi} \, A_i$

$$f_i = \underset{q_i}{\underline{2.07}} \times \underset{K_z}{\underline{0.85}} \times \underset{K_{zt}}{\underline{1.0}} \times \underset{K_e}{\underline{1.0}} \times \underset{R_{1i}}{\underline{1.01}} \times \underset{F_{hi}}{\underline{1.1}} \times \underset{C_{fi}}{\underline{2.76}} \times \underset{A_i}{\underline{77.6}} = \underset{f_i}{\underline{419}} \text{ lbs}$$

Axial Force supported by the post, $p_i = (D_w + D_i) \, s \, L$

$$p_i = (\underset{D_w}{\underline{1.0}} + \underset{D_i}{\underline{4.4}}) \times \underset{s}{\underline{10'}} \times \underset{L}{\underline{8'}} = \underset{p_i}{\underline{432}} \text{ lbs}$$

$5 \times p_i$ = 2,160 lbs (used for stability check)

Post Selection

Using the diameter of the desired post size, O.D., and the Fence Height, h, look through the post charts for post types that have F_a values larger than the f_w' & f_i values, and P_a values larger than the p_w & p_i values. If the post has an * next to the P_a value, only use it if the P_a value is ≥ 5 × p_i due to stability requirements.

Put in the O.D, post type, weight per foot, D_p and fence height, h and calculate p_w' and p_i' to include the weight of the post. Add any additional weight if needed.

f_w' / F_a is the bending strength ratio for Wind.

p_w' / P_a is the axial strength ratio for Wind.

f_i / F_a is the bending strength ratio for Wind & Ice.

p_i' / P_a is the axial strength ratio for Wind & Ice.

If the sum of the bending strength and axial strength ratios for both Wind and Wind & Ice loading are ≤ 1.0, the post is acceptable.

O.D.	Post Type	D_p (lb/f)	h (ft)	$p_w' = p_w + (D_p \times h)$	$p_i' = p_i + (D_p \times h)$
2.875	40 wt / 50 ksi	4.6	10'	p_w' = 126 lbs	p_i' = 478 lbs
Wind					
$\frac{f_w' = 250}{F_a = 547} = 0.46$			$\frac{p_w' = 126}{P_a = 2{,}818} = 0.05$		$\frac{f_w'}{F_a} + \frac{p_w'}{P_a} = 0.51$ OK
Wind & Ice					
$\frac{f_i = 419}{F_a = 547} = 0.77$			$\frac{p_i' = 478}{P_a = 2{,}818} = 0.17$		$\frac{f_i}{F_a} + \frac{p_i'}{P_a} = 0.94$ OK

The following pages show the iterative design steps for sizing the post footing. The minimum footing diameter is 2.875 + 4" or about 7". 9" is a more common auger size so that is what is used below. Soil class 4 is assumed for soil lateral and bearing strength. See Footing Design page of FenceDesign.com for IBC table 1806.2

First guess at footing depth is 5'.

Footing Sizing (non-constrained footings)

First pass

Design Footing Depth, D = 5 ft

Footing Diameter, b = 0.75 ft

Lateral Bearing Pressure per foot of depth, S = 150 psf / ft   per geotechnical analysis or table 1806.2

Maximum Wind Force, P = maximum value of f_w' or f_i = 419 lbs

Post Height, h = ~~105~~ 10 ft

Modifier for Isolated Posts, M = 2.0   per IBC §1086.3.4

Allowable Lateral Soil Bearing Pressure for non-constrained footings, $S_1 = ⅓\ D\ S\ M$

$S_1 = ⅓ \times \underset{D}{\underline{5'}} \times \underset{S}{\underline{150}} \times \underset{M}{2.0} = \underset{S_1}{\underline{500}}$ psf   per IBC §1807.3.2.1

Soil Bearing Factor, $A = 2.34\ P / (S_1\ b)$ per IBC §1807.3.2.1

$A = 2.34 \times \underset{P}{\underline{419}} \div (\underset{S_1}{\underline{500}} \times \underset{b}{\underline{0.75}}) = \underset{A}{\underline{2.615}}$

Minimum Depth, $d = ½\ A \left(1 + \sqrt{1 + \frac{4.36\ ½h}{A}}\right)$ per Eq. 18-1, modified for fencing

$d = ½ \times \underset{A}{\underline{2.615}} \times \left(1 + \sqrt{1 + (4.36 \times ½ \times \underset{h}{\underline{10'}} \div \underset{A}{\underline{2.615}})}\right) = \underset{d}{\underline{5.3}}$ ft

d = 5.3 ft > D= 5.0 ft - start over with a larger footing depth

Calculations continue on the next page

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Footing Sizing (non-constrained footings) Second pass

Design Footing Depth, D = 5.5 ft   Footing Diameter, b = 0.75 ft

Lateral Bearing Pressure per foot of depth, S = 150 psf / ft   per geotechnical analysis or table 1806.2

Maximum Wind Force, P = maximum value of f_w or f_i = 419 lbs   Post Height, h = 10 ft

Modifier for Isolated Posts, M = 2.0   per IBC §1086.3.4

Allowable Lateral Soil Bearing Pressure for non-constrained footings, $S_1 = ⅓ D S M$

$S_1 = ⅓ \times \underset{D}{5.5'} \times \underset{S}{150} \times \underset{M}{2.0} = \underset{S_1}{549.5}$ psf   per IBC §1807.3.2.1

Soil Bearing Factor, $A = 2.34 P / (S_1 b)$ per IBC §1807.3.2.1

$A = 2.34 \times \underset{P}{419} \div (\underset{S_1}{549.5} \times \underset{b}{0.75}) = \underset{A}{2.379}$

Minimum Depth, $d = ½ A \left(1 + \sqrt{1 + \frac{4.36\ ½h}{A}}\right)$ per Eq. 18-1, modified for fencing

$d = ½ \times \underset{A}{2.379} \times \left(1 + \sqrt{1 + (4.36 \times ½ \times \underset{h}{10'} \div \underset{A}{2.379})}\right) = \underset{d}{4.98}$ ft   d < D OK

Area of the bottom of the footing, $A_f = \pi (½ b)^2 = 3.14 \times (½ \times \underset{b}{0.75})^2 = \underset{A_f}{0.44}$ ft²

Footing Volume, $V = A_f D = \underset{A_f}{0.44} \times \underset{D}{5.5} = \underset{V}{2.42}$ ft³

Weight of footing, $D_f = 150 V = 150 \times \underset{V}{2.42} = \underset{D_f}{363}$ lbs   (Typical Concrete weight is 150 lbs / ft³)

Axial Dead Load, $D_{max} = D_f + p_i'$ for fencing plus ice loading. $D_{max} = D_f + p_w'$ if there is no ice loading

$D_{max} = \underset{D_f}{363} + \underset{p_i' \text{ or } p_w'}{478} = \underset{D_{max}}{841}$ lbs

Maximum Vertical Foundation Pressure, S_y = 2,000 psf   per geotechnical analysis or table 1806.2

Maximum Axial Pressure on the soil, $s_y = D_{max} / A_f = \underset{D_{max}}{841} \div \underset{A_f}{0.44} = \underset{s_y}{1{,}911}$ psf

Actual to Allowable Soil Strength Ratio, $s_y / S_y = \underset{s_y}{1{,}911} \div \underset{S_y}{2{,}000} = 0.96 \le 1.0$ is OK

s_y / S_y must be less than 1.0. If not, start over with a larger footing diameter, b

Footing depth of 5' 6" and footing diameter of 9" are OK for this example