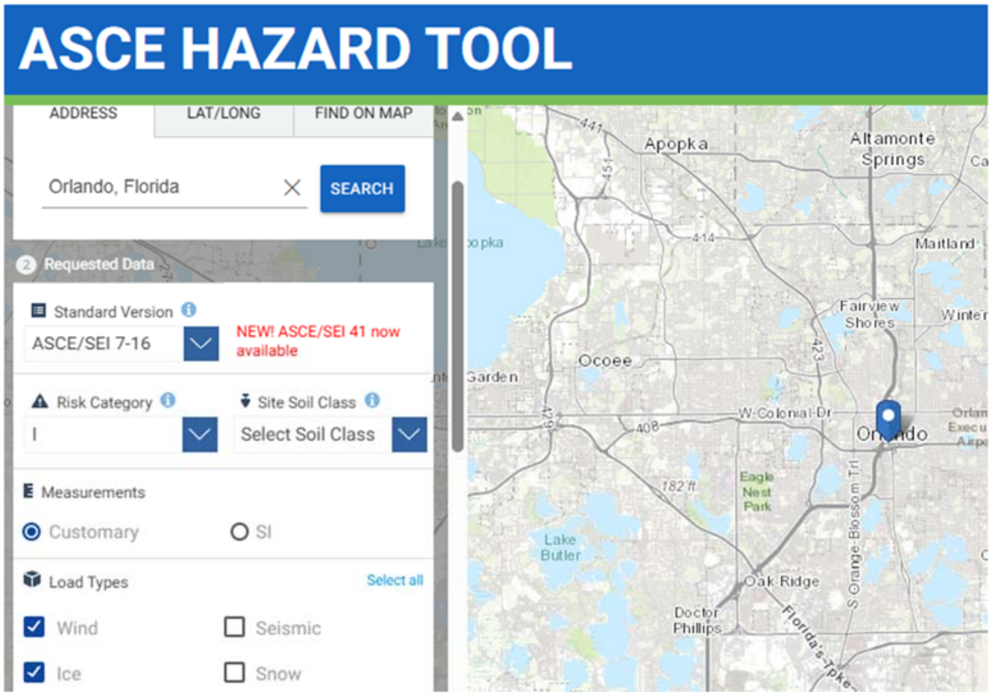
Example 1 – hand calculations – open fencing – wind only – no ice loading – chain link fence – 9 ga x 1-3/4" mesh

10' high open fence no gap at the bottom 10' post spacing Elevation - 102 ft

Site Location – Orlando Florida Exposure C Risk Category I Flat ground

2023 Florida Building Code, Building, Eighth Edition
2021 IBC Amended
Effective Date: Dec 31, 2023

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



https://ascehazardtool.org/

Standard:	ASCE/SEI 7-16
Risk Category:	I
Soil Class:	
Wind	
127 Vmph	
Ice	
0 in.	

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
125	17.34
130	18.75
135	20.23
140	21.75

K_z Values for ASCE 7-10 & 7-16			
Fence	Exposure Class		
Height, h (ft)	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	ASCE	
Elevation	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

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

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

Worksheet – Open Fencing – Wind Loading

Site Location: Orlando, FL

Customer:

Site and Geometrical Variables

IBC 2021 ASCE 7- 16 Risk Category 1 Frost Depth 0 ft

Basic Wind Speed, V_w = 127 mph

Wind Pressure, q_w = 18.75 psf wind speed rounded up to 130

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

Site Elevation, Z_e = 102 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 length doesn't affect design for open fencing

Fence Run # 1 Length of Fence, B = 100 ft Post spacing, L = 10 ft

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

Force Height Adjustment Factor, F_{hw} = 1.0 Wind Force Coefficient, C_{fw} = 1.3

Expected Post Diameter or Width, $\O_p$ = 2-7/8 in

Top Rail Diameter or Width, $\O_r$ = 1-5/8 in Mid Rail Diameter or Width, $\O_p$ = 1-5/8 in

($\O_r$ & $\O_m$ – set to Zero if not applicable for rails)

Wind Area of Post, $A_p = \O_p / 12 \times h$ = 2.875 ($\O_p$) ÷ 12 × 10 ft (h) = 2.4 (A_p) ft²

(A_p = 0 for solid / mostly solid fencing)

Wind Area of Rails, $A_r = (\O_r / 12) \times 2 \times L + (\O_m / 12) \times L$ (A_r = 0 if no rails)

A_r = (1.625 ($\O_r$) ÷ 12 × 2 × 10 ft (L)) + (1.625 ($\O_m$) ÷ 12 × 10 ft (L)) = 4.1 (A_r) ft²

Wind area tributary to the post, $A_w = \varepsilon\, s\, L + A_p + A_r$ = 0.16 (ε) × 10 (s) × 10 (L) + 2.4 (A_p) + 4.1 (A_r) = 22.5 (A_w) ft²

Dead Load of fencing materials, D_m 1.0 psf

Lateral and Axial Forces for Wind Loading

Minimum wind force to the post, $f_{min} = (0.6)\,16.0\,A_w = 9.6 \times$ 22.5 (A_w) = 216 (f_{min}) 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 = 18.75 (q_w) × 0.85 (K_z) × 1.0 (K_{zt}) × 1.0 (K_e) × 1.0 (R_{1w}) × 1.0 (F_{hw}) × 1.3 (C_{fw}) × 22.5 (A_w) = 466 (f_w) lbs

Maximum wind force to the post, f_w' = maximum value of either f_{mim} or f_w = 466 (f_w') lbs

Axial force supported by the post, $p_a = D_m\, s\, L$

p_w = 1.0 (D_m) × 10 ft (s) × 10 ft (L) = 100 (p_w) lbs add in weight of rails if known

$5 \times p_w$ = 500 lbs (used for stability check)

f_w = 466 lbs p_w = 100 lbs 5 x p_i = 500 lbs

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	108,47	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*
4-1/2"	7.4	F_a	2,851	2,376	2,036	1,782	1,584	1,425	1,296	1,188	1,096	1,018	950	891	838	792	750	712
		P_a	37,346	30,183	23,447	17,951	14,184	11,489	9,495	7,978	6,798*	5,861*	5,106*	4,487*	3,975*	3,546*	3,182*	2,872*

Post Selection

Using the size of the desired post and the Fence Height, h, look through the post charts for post types that have an F_a value larger than the f_w value, and a P_a value larger than the p_w value. If the post has an * next to the P_a value, only use it if the P_a value is $\geq 5 \times p_w$ due to stability requirements.

Put in the O.D or size, post type, weight per foot, D_p and fence height, h and calculate p_w' 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

If the sum of the bending strength and axial strength ratios are ≤ 1.0, the post is acceptable.

O.D.	Post Type	D_p (lb/f)	h (ft)	$p_w' = p_w + (D_p \times h)$	
2-7/8"	40 wt / 50 ksi	4.6	10	p_w' = 146	
Wind					
f_w' = 466 / F_a = 547 = 0.85			p_w' = 146 / P_a = 2,818* = 0.05		$\frac{f_w'}{F_a} + \frac{p_w'}{P_a}$ = 0.90 - OK

5 x pw = 500 < 2,818 - OK

O.D.	Post Type	D_p (lb/f)	h (ft)	$p_w' = p_w + (D_p \times h)$	
				p_w' =	
Wind					
f_w' = ____ / F_a = ____ =			p_w' = ____ / P_a = ____ =		$\frac{f_w'}{F_a} + \frac{p_w'}{P_a}$ =

O.D.	Post Type	D_p (lb/f)	h (ft)	$p_w' = p_w + (D_p \times h)$	
				p_w' =	
Wind					
f_w' = ____ / F_a = ____ =			p_w' = ____ / P_a = ____ =		$\frac{f_w'}{F_a} + \frac{p_w'}{P_a}$ =

minimum footing diameter is 7" but that results in a 6' deep footing which may be deeper than the available equipment can bore

Footing Sizing (non-constrained footings)

Design Footing Depth, D = 5 ft   Footing Diameter, b = 12 ft

assumes soil class 4

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

Maximum Wind Force, $P = f_w'$ = 446 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, $S_1 = \frac{1}{3} D\, S\, M$

$S_1 = \frac{1}{3} \times \underset{D}{5\text{ ft}} \times \underset{S}{150} \times \underset{M}{2.0} = \underset{S_1}{500}$ psf   per IBC §1807.3.2.1

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

$A = 2.34 \times \underset{P}{446} \div (\underset{S_1}{500} \times \underset{b}{1.0}) = \underset{A}{2.087}$

Minimum Depth, $d = \frac{1}{2} A \left(1 + \sqrt{1 + \frac{4.36\ \frac{1}{2}h}{A}}\right)$ per Eq. 18-1, modified for fencing

$d = \frac{1}{2} \times \underset{A}{2.087} \times \left(1 + \sqrt{1 + (4.36 \times \frac{1}{2} \times \underset{h}{10\text{ ft}} \div \underset{A}{2.087})}\right) = \underset{d}{4.6}$ ft

D < d - OK

You can run the numbers again and get down to 4' 9"

Area of the bottom of the footing, $A_f = \pi (\frac{1}{2} b)^2 = 3.14 \times (\frac{1}{2} \times \underset{b}{1.0})^2 = \underset{A_f}{0.785}$ ft^2

Footing Volume, $V = A_f\, D = \underset{A_f}{0.785} \times \underset{D}{5} = \underset{V}{3.9}$ ft^3

Weight of footing, $D_f = 150\, V = 150 \times \underset{V}{3.9} = \underset{D_f}{585}$ lbs   (Typical Concrete weight is 150 lbs / ft^3)

Axial Dead Load, $D_{max} = D_f + p_w'$

$D_{max} = \underset{D_f}{585} + \underset{p_w'}{146} = \underset{D_{max}}{731}$ lbs

assumes soil class 4

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

Maximum Axial Pressure on the soil, $s_y = D_{max} / A_f = \underset{D_{max}}{731} \div \underset{A_f}{0.785} = \underset{s_y}{931}$ psf

Actual to Allowable Soil Strength Ratio, $s_y / S_y = \underset{s_y}{931} \div \underset{S_y}{2{,}000} = 0.47 \leq 1.0$ is OK

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