FDH Infrastructure Services -- 6521 Meridien Drive, Raleigh, NC 27616
Ph. 919.755.1012 -- Fax 919.755.1031

Fiber-Reinforced Composite Lighting Pole Calculations

Project Info & Details			
Customer Name:	Solar Lighting International, Inc.		
Job Name:	St Croix Project		
Address:			
City:		State	FL
Pole Catalog Number:	DXX28_XXDN2-ARM		
Latitude, Longitude:			
Building Code:	2015 IBC		

Referenced Codes

- *2017 Florida Building Code, 6th Edition*
- *ASCE 7-10: Minimum Design Loads for Buildings and Other Structures*
- *2013 AASHTO LTS, 6th Edition*
- *2012 ANSI C136.20*
- *ASTM D4923-01*

Site Parameters		
Exposure Category:	*C*	-
Ultimate Wind Speed:	170	mph
Nominal Wind Speed:	*131.7*	mph

Pole Geometry		
Pole Length:	28	ft
Height Above Grade:	20	ft
Embedment Depth:	*8.0*	ft
Test Height:	*19*	ft
Top Diameter:	6	in
Pole Taper:	0.14	in/ft
Bottom Diameter:	*9.92*	in
Diameter @ Embedment:	*8.80*	in
Diameter @ Centriod:	*7.49*	in
Diameter @ Test Height:	*6.14*	in

Design Parameters		
Pole Class:	II	-
Design Life :	25 yr	-
Area Type:	Proj. Area	
Proposed (Luminaire + Arm) Proj. Area:	15	ft^2
Proposed Luminaire Shape:		
Additional Proj. Area (Shroud, Antennas):	6	ft^2
Additional Proj. Area Shape:		-
Additional Proj. Area Diameter:		in
Center Height of Additional Proj. Area:	10	ft
Weight of Luminaire:	400	lbs
*Luminaire Arm Length:	0	ft
*Luminaire Arm Diameter:	0	in
Consider Embedment Design?:	Yes	-

*If luminaire flush-mounted, enter zero for arm length

Embedment Design		
S_1, Soil Class:	3	-
Embedment (Design):	*8.00*	ft
Embedment (Required):	*6.49*	ft
Embedment Check:	OK	-

Result Summary				
Max Pole Proj. Area (Testing Values):		17		ft^2
Max Test Load (**Testing Values**):		1751		lbs
Max Calculated Load:		*1036.6*		lbs
Percent Capacity:		59.2%		-
Code Specified Deflection Limit:				
Deflection Limit of Structure Height (Per ASTM D4923):		*10%*		-
Deflection <	*24*	inches @	*518*	lbs
Client Specified Deflection Limit:				
Does the Client have Deflection Requirements?				No

Tuesday, July 10, 2018
COA 28282

(a) Wind Force on Pole

Code Reference

$$F_1 = 0.00256 * K_Z * G * V^2 * I_r * C_d * A$$

where **A** = projected area of pole (ft²)
V = wind velocity (mph)

AASHTO 3.8.1 (pg. 3-05)

Height & Exposure Factor → **K_z** = 0.87 for (h ≤ 16.4 ft) *AASHTO 3.8.4 (pg. 3-12)*

K_z = $2.01 * (\frac{z}{z_g})^{\frac{2}{\alpha}}$ = 0.90 for (h > 16.4 ft)

where z_g = 906 ft, α = 9.50 — Based on Exposure Category *ASCE 7-10: C27.3.1 (pg. 547)*

z = 20 ft ← Height Above Grade

Gust Effect Factor → **G** = 1.14 *AASHTO 3.8.5 (pg. 3-13)*

Wind Importance Factor → **I_r** = 0.87 for (25 yr life) - nonhurricane region *AASHTO 3.8.3 (pg. 3-06)*

I_r = 0.77 for (25 yr life) - hurricane region

Wind Drag Coefficient → **C_d** = 1.10 If $C_v Vd$ ≤ 39 mph-ft *AASHTO 3.8.6 (pg. 3-15)*

C_d = $\frac{129}{(C_v Vd)^{1.3}}$ (Cylindrical Members) If 39 mph-ft < $C_v Vd$ < 78 mph-ft

C_d = 0.45 If $C_v Vd$ ≥ 78 mph-ft

Velocity Conversion Factor → **C_v** = 0.93 for (25 yr life) - nonhurricane region *AASHTO C3.8.6 (pg. 3-15)*

C_v = 0.88 for (25 yr life) - hurricane region

Centroid of Trapezoid → **h'** = $(\frac{h}{3})(\frac{2d_2 + d_1}{d_2 + d_1})$ = 9.37 ft

where d_2 = top diameter
d_1 = bottom diameter
h = height above grade

(b) Wind Force on Luminaire

$$F_2 = 0.00256 * K_Z * G * V^2 * I_r * C_d * E$$

where **E** = projected area of luminaire (ft²)

AASHTO 3.8.1 (pg. 3-05)

Wind Drag Coefficient → **C_d** = 0.5 (Luminaires w/ generally rounded surfaces) *AASHTO 3.8.6 (pg. 3-15)*

Wind Drag Coefficient → **C_d** = 1.2 (Luminaires with rectangular flat side shapes) *AASHTO 3.8.6 (pg. 3-15)*

(c) Wind Force on Arm

$$F_3 = 0.00256 * K_Z * G * V^2 * I_r * C_d * R$$

where **R** = projected area of arm (ft²)

AASHTO 3.8.1 (pg. 3-05)

Wind Drag Coefficient → **C_d** = 1.10 If $C_v Vd$ ≤ 39 mph-ft *AASHTO 3.8.6 (pg. 3-15)*

C_d = $\frac{129}{(C_v Vd)^{1.3}}$ (Cylindrical Members) If 39 mph-ft < $C_v Vd$ < 78 mph-ft

C_d = 0.45 If $C_v Vd$ ≥ 78 mph-ft

(d) Wind Force on Additional EPA

$$F_4 = 0.00256 * K_Z * G * V^2 * I_r * C_d * U$$

where **U** = projected area of additional EPA (ft²)

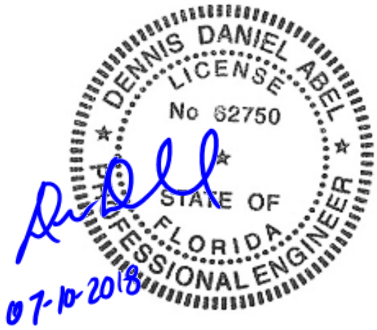
AASHTO 3.8.1 (pg. 3-05)

Wind Drag Coefficient → **C_d** = 1.10 If $C_v Vd$ ≤ 39 mph-ft *AASHTO 3.8.6 (pg. 3-15)*

C_d = $\frac{129}{(C_v Vd)^{1.3}}$ (Cylindrical Members) If 39 mph-ft < $C_v Vd$ < 78 mph-ft

C_d = 0.45 If $C_v Vd$ ≥ 78 mph-ft

Wind Drag Coefficient → **C_d** = 1.7 (Flat Members) *AASHTO 3.8.6 (pg. 3-15)*



(e) Deflection Test Force

$$F_d = \frac{M_B}{(L - L_1)}$$ →

L = 20 ft = pole length above ground line or base

L_1 = 1 ft = length from pole top to test force application point

M_B = 9848 ft-lbs = max total resultant moment at pole base

AASHTO 8.7.1 (pg. 8-05)

(f) Strength Test Force

Force Description	Bending Moment in Pole = (Pressure x Area) x Distance = Force x Distance									
	K_Z	G	V (mph)	I_r	C_vVd (mph-ft)	C_d	EPA (ft^2)	F_X (lbs)	D_X (ft)	M_{Bx} (ft-lbs)
Wind Force on Pole (F_1)	0.90	1.14	131.7	0.77	72.3	0.49	6.09	213.8	9.4	2003.16
Wind Force on Luminaire (F_2)	0.90	1.14	131.7	0.77	-	0.50	7.50	263.2	21.0*	5528.24
Wind Force on Arm (F_3)	-	-	-	-	#VALUE!	#VALUE!	-	-	-	-
Wind Force on Additional Projected Area (F_4)	0.90	1.14	131.7	0.77	0.0	1.10	6.60	231.7	10.0	2316.60
Additional Moment due to Weight of Luminaire (M_1)	-	-	-	-	-	-	-	400.0	0.0	0.00
					Total Resultant Moment at Pole Base**					**9848.00**

*Luminaire and Arm assumed height = 1 ft above top of pole

**Max M_{Bx} is calculated using the maximum of F_2 & F_3 since combined Projected Area is provided

$$F_d = \frac{M_B}{(L - L_1)} = \quad 518.32 \quad \text{lbs}$$

→ A **safety factor of 2.0** against failure in bending is specified for the test. (AASHTO C8.7.1)

$$F_s = 2 * F_d = \quad \mathbf{1036.63} \quad \mathbf{lbs}$$

(g) Embedment Checks

Code Reference

$$d = 0.5A\ \{1 + [1 + (4.36h / A)^{1/2}\}$$

2015 IBC: Equation 18-1 (pg. 427)

where **d =** depth of embedment in earth = 6.49 ft

A = $2.34P/(S_1 b)$ = 1.55 ft

b = diameter of the embedded post = 0.73 ft

h = distance from ground surface to point of application of "P" = 19.0 ft

P = applied lateral force = 518.32 lbs

S_1 = allowable lateral soil-bearing pressure (use **Table 1806.2** for a reference) = 1067 psf

→ Based on one-third the depth of embedment

TABLE 1806.2

CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	---
2. Sedimentary and foliated rock	4,000	400	0.35	---
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	---
4. Sand, silty sand, clayvey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM, GC)	2,000	150	0.25	---
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	---	130

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.

DENNIS DANIEL ABEL LICENSE No 62750 STATE OF FLORIDA PROFESSIONAL ENGINEER

07-10-2018

Solar Lighting International