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ENGINEERING INNOVATION

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Fiber-Reinforced Composite Lighting Pole Calculations

Project Info & Details			
Customer Name:	solar lighting international		
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)

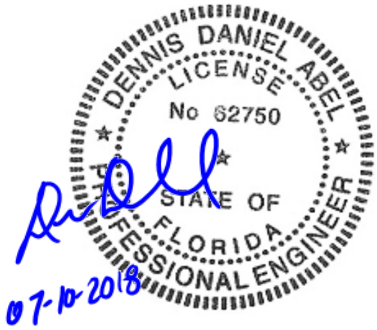
AASHTO 3.8.1 (pg. 3-05)

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.