

11/07/2023

**Palmetto Solar**

997 Morrison Dr, Ste 200, Charleston, SC, 29403



**Attn.:** To Whom It May Concern

**Job:** Joseph Fish

**Project Address:** 102 Coleshill Road, Angier, NC, 27501

The following calculations are for the structural engineering design of the photovoltaic panels and are valid only for the structural info referenced in the stamped plan set. I certify that the roof structure has sufficient structural capacity for the applied PV loads. All mounting equipment shall be designed and installed per manufacturer's approved installation specifications.

**Design Criteria**

**Code:** 2018 NCSBC, IBC 2018, ASCE 7-16

**Live Load:** 20 psf

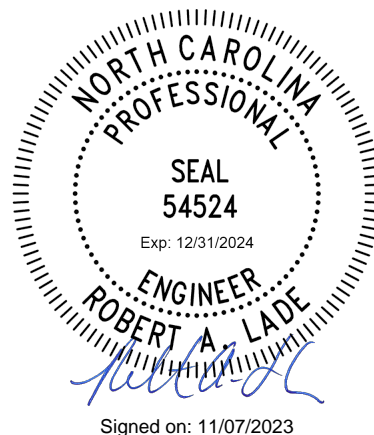
**Ult Wind Speed:** 117.0 mph

**Exposure Cat:** C

**Ground Snow:** 20.0 psf

**Min Snow Roof:** N/A

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**Roof Properties:**

	Check 1
Roof Type:	Shingle
Roof Pitch (deg):	27
Mean Roof Height (ft):	13.00
Attachment Trib Width (ft):	3.25
Attachment Spacing (ft):	4.00
Framing Type:	Rafter
Framing Size:	2x4
Framing OC Spacing (in):	24.00
Section Thickness, b (in):	1.50
Section Depth, d (in):	3.50
Section Modulus, S <sub>x</sub> (in <sup>3</sup> ):	3.062
Moment of Inertia, I <sub>x</sub> (in <sup>4</sup> ):	5.359
Unsupported Span (ft):	10.00
Upper Chord Length (ft):	22.00
Deflection Limit D+L (in):	4.400
Deflection Limit S or W (in):	2.933
Framing Upgrade:	No
Sister Size:	N/A
Wood Species:	DF
Wood F <sub>b</sub> (psi):	900.00
Wood F <sub>v</sub> (psi):	180.00
Wood E (psi):	1,600,000.00
C <sub>D</sub> (Wind):	1.60
C <sub>D</sub> (Snow):	1.15
C <sub>LS</sub> :	1.00
C <sub>M</sub> = C <sub>t</sub> = C <sub>L</sub> = C <sub>i</sub> :	1.00
C <sub>F</sub> :	1.50
C <sub>fu</sub> :	1.00
C <sub>r</sub> :	1.15
F' <sub>b</sub> Wind (psi):	2,484.00
F' <sub>b</sub> Snow (psi):	1,785.37
F' <sub>v</sub> Wind (psi):	288.00
F' <sub>v</sub> Snow (psi):	207.00
Moment Allowable Wind (lb-ft):	633.94
Moment Allowable Snow (lb-ft):	455.64
V Allowable Wind (lbs):	1,008.00
V Allowable Snow (lbs):	724.50
E' (psi):	1,600,000

**Load Calculations:****Dead Load Calculations:**

	<b>Check 1</b>
Panel Dead Load (psf):	3.00
Roofing Weight (psf):	3.00
Decking Weight (psf):	2.00
Framing Weight (psf):	0.60
Misc. Additional Weight (psf):	1.00
Existing Dead Load (psf):	6.60
<b>Total Dead Load (psf):</b>	<b>9.60</b>

**Wind Load Calculations:**

	<b>Check 1</b>
Ultimate Wind Speed (mph):	117.00
Directionality Factor, kd:	0.85
Topographic Factor, kzt:	1.00
Velocity Press Exp Factor, kz:	0.85
Velocity Pressure, qz (psf):	25.03
External Pressure Up, GCp <sub>1</sub> :	-1.50
External Pressure Up, GCp <sub>2</sub> :	-2.17
External Pressure Up, GCp <sub>3</sub> :	-2.45
External Pressure Down, GCp:	0.46
Design Pressure Up, p <sub>1</sub> :	-25.90
Design Pressure Up, p <sub>2</sub> :	-37.43
Design Pressure Up, p <sub>3</sub> :	-42.36
Design Pressure Down, p (psf):	16.00

**Snow Load Calculations:**

	<b>Check 1</b>
Ground Snow Load, pg (psf):	20.00
Min Flat Snow, pf_min (psf):	0.00
Min Sloped Snow, ps_min (psf):	0.00
Snow Importance Factor, Ic:	1.00
Exposure Factor, Ce:	0.90
Thermal Factor, Ct:	1.10
Flat Roof Snow, pf (psf):	13.86
Slope Factor, Cs:	0.72
Sloped Roof Snow, ps (psf):	9.93

**Hardware Checks:****Lag Screw Check:**

	<b>Check 1</b>
Ref. Withdrawal Value, W (lb/in):	266.00
( $C_m = C_t = C_{eg} = 1.0$ ) $C_D$ :	1.60
Adjusted Withdrawal Value, W' (lb/in):	425.60
Penetration, p (in.):	2.50
Allowable Withdrawal Force, W'p (lbs):	1,064.00
Applied Uplift Force (lbs):	-153.90
Uplift DCR:	0.145
Ref. Lateral Value, Z (lbs):	270.00
( $C_m = C_t = C_{\delta} = C_{eg} = 1.0$ ) $C_D$ :	1.15
Adjusted Lateral Value, Z' (lbs):	310.50
Applied Lateral Force (lbs):	76.32
Angle of Resultant Force, alpha (deg):	63.62
Adjusted Interaction Lateral Value, Z'alpha (lbs):	719.39
Lateral DCR:	0.106

**Roof Framing Checks:****Force Checks****LC1: D+S**

	<u>Check 1</u>
Applied Moment (lb-ft):	430.6
Applied Shear (lbs):	236.8
Allowable Moment (lb-ft):	455.6
Allowable Shear (lbs):	724.5
Moment DCR:	0.945
Shear DCR:	0.327

**LC2: D+0.6W**

	<u>Check 1</u>
Applied Moment (lb-ft):	423.3
Applied Shear (lbs):	232.7
Allowable Moment (lb-ft):	633.9
Allowable Shear (lbs):	1,008.0
Moment DCR:	0.668
Shear DCR:	0.231

**LC3: D+0.75(S+0.6W)**

	<u>Check 1</u>
Applied Moment (lb-ft):	534.6
Applied Shear (lbs):	293.9
Allowable Moment (lb-ft):	633.9
Allowable Shear (lbs):	1,008.0
Moment DCR:	0.843
Shear DCR:	0.292

**LC4: 0.6D+0.6W**

	<u>Check 1</u>
Applied Moment (lb-ft):	338.6
Applied Shear (lbs):	186.2
Allowable Moment (lb-ft):	633.9
Allowable Shear (lbs):	1,008.0
Moment DCR:	0.534
Shear DCR:	0.185

**Deflection Checks (Service Level):****LC1: D+L** **Check 1**

Deflection (in.):	0.929
Deflection Limit (in.):	4.400
Deflection DCR:	0.211

**LC2: S** **Check 1**

Deflection (in.):	0.251
Deflection Limit (in.):	2.933
Deflection DCR:	0.086

**LC3: W (Down)** **Check 1**

Deflection (in.):	0.170
Deflection Limit (in.):	2.933
Deflection DCR:	0.058

**LC4: W (Up)** **Check 1**

Deflection (in.):	0.275
Deflection Limit (in.):	2.933
Deflection DCR:	0.094

**Seismic Check:**

**Existing Weight:**

Wall Weight (psf):	17.00
Tributary Wall Area (ft <sup>2</sup> ):	940.00
Total Wall Weight (lbs):	15,980.00
Roof Weight (psf):	6.60
Roof Area (ft <sup>2</sup> ):	2,145.00
Total Roof Weight (lbs):	14,160.35
Total Existing Weight (lbs):	30,140.35

**Additional PV Weight:**

PV Panel Weight (lbs):	64.35
Number of Panels:	13
Total Additional PV Weight (lbs):	<b>836.55</b>

**Weight Increase:**

**$(\text{Existing W} + \text{Additional W}) \div (\text{Existing W}) = 102.78\%$**

The increase in weight as a result of the solar system is less than 10% of the existing structure. Therefore, no further seismic analysis is required.

**Limits of Scope of Work and Liability:**

Existing structure is assumed to have been designed and constructed following appropriate codes at time of erection, and assumed to have appropriate permits. The calculations produced are only for the roof framing supporting the proposed PV installation referenced in the stamped planset and were completed according to generally recognized structural analysis standards and procedures, professional engineering and design experience, opinions and judgements. Existing deficiencies which are unknown or were not observable during time of inspection are not included in this scope of work. All PV modules, racking, and mounting equipment shall be designed and installed per manufacturer's approved installation specifications. The Engineer of Record and the engineering consulting firm assume no responsibility for misuse or improper installation. This analysis is not stamped for water leakage. Framing was determined based on information in provided plans and/or photos, along with engineering judgement. Prior to commencement of work, the contractor shall verify the framing sizes, spacings, and spans noted in the stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any discrepancies prior to starting construction. Contractor shall also verify that there is no damaged framing that was not addressed in stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any concerns prior to starting construction.