08/23/2023

Beam Solar Co LLC

Attn.: To Whom It May Concern

Job: Maureen McOuat

Project Address: 1011 Sweet Raspberry Lane, Lillington, NC, 27546

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: 118.0 mph
Exposure Cat: C
Ground Snow: 15.0 psf
Min Snow Roof: N/A

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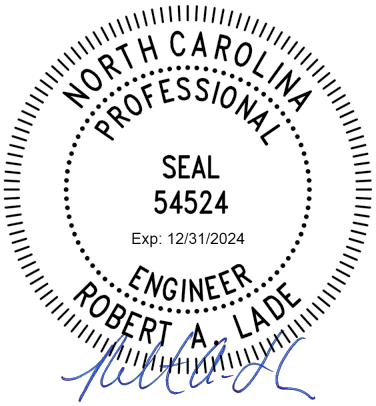

Signed on: 08/23/2023

Roof Properties:

	Check 1
Roof Type:	Shingle
Roof Pitch (deg):	21
Mean Roof Height (ft):	13.00
Attachment Trib Width (ft):	2.75
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, Sx (in^3):	3.062
Moment of Inertia, Ix (in^4):	5.359
Unsupported Span (ft):	10.00
Upper Chord Length (ft):	19.00
Deflection Limit D+L (in):	3.800
Deflection Limit S or W (in):	2.533
Framing Upgrade:	No
Sister Size:	N/A
Wood Species:	DF
Wood Fb (psi):	900.00
Wood Fv (psi):	180.00
Wood E (psi):	1,600,000.00
C_D (Wind):	1.60
C_D (Snow):	1.15
C_{LS}:	1.00
$C_M = C_t = C_L = C_i$:	1.00
C_F:	1.50
C_{fu}:	1.00
C_r:	1.15
F'b Wind (psi):	2,484.00
F'b Snow (psi):	1,785.37
F'v Wind (psi):	288.00
F'v 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:

	Check 1
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
Total Dead Load (psf):	9.60

Wind Load Calculations:

	Check 1
Ultimate Wind Speed (mph):	118.00
Directionality Factor, kd:	0.85
Topographic Factor, kzt:	1.00
Velocity Press Exp Factor, kz:	0.85
Velocity Pressure, qz (psf):	25.48
External Pressure Up, GCp_1:	-1.50
External Pressure Up, GCp_2:	-2.17
External Pressure Up, GCp_3:	-2.45
External Pressure Down, GCp:	0.46
Design Pressure Up, p_1 (psf):	-26.37
Design Pressure Up, p_2 (psf):	-38.10
Design Pressure Up, p_3 (psf):	-43.13
Design Pressure Down, p (psf):	16.00

Snow Load Calculations:

	Check 1
Ground Snow Load, pg (psf):	15.00
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):	10.40
Slope Factor, Cs:	1.00
Sloped Roof Snow, ps (psf):	10.40

Hardware Checks:

Attachment Check:

	Check 1
Attachment Type:	Deck Mount
Allowable Up Force (lbs):	210.00
Allowable Down Force (lbs):	210.00
Allowable Side Force (lbs):	115.00
Applied Uplift Force (lbs):	-132.06
Uplift DCR:	0.629
Applied Down Force (lbs):	193.07
Down DCR:	0.919
Applied Lateral Force (lbs):	52.80
Lateral DCR:	0.459

Roof Framing Checks:

Force Checks

LC1: D+S

	Check 1
Applied Moment (lb-ft):	454.9
Applied Shear (lbs):	243.8
Allowable Moment (lb-ft):	455.6
Allowable Shear (lbs):	724.5
Moment DCR:	0.998
Shear DCR:	0.336

LC2: D+0.6W

	Check 1
Applied Moment (lb-ft):	436.8
Applied Shear (lbs):	234.1
Allowable Moment (lb-ft):	633.9
Allowable Shear (lbs):	1,008.0
Moment DCR:	0.689
Shear DCR:	0.232

LC3: D+0.75(S+0.6W)

	Check 1
Applied Moment (lb-ft):	559.6
Applied Shear (lbs):	299.9
Allowable Moment (lb-ft):	633.9
Allowable Shear (lbs):	1,008.0
Moment DCR:	0.883
Shear DCR:	0.298

LC4: 0.6D+0.6W

	Check 1
Applied Moment (lb-ft):	349.4
Applied Shear (lbs):	187.3
Allowable Moment (lb-ft):	633.9
Allowable Shear (lbs):	1,008.0
Moment DCR:	0.551
Shear DCR:	0.186

Deflection Checks (Service Level):

LC1: D+L

	Check 1
Deflection (in.):	0.954
Deflection Limit (in.):	3.800
Deflection DCR:	0.251

LC2: S

	Check 1
Deflection (in.):	0.254
Deflection Limit (in.):	2.533
Deflection DCR:	0.100

LC3: W (Down)

	Check 1
Deflection (in.):	0.164
Deflection Limit (in.):	2.533
Deflection DCR:	0.065

LC4: W (Up)

	Check 1
Deflection (in.):	0.271
Deflection Limit (in.):	2.533
Deflection DCR:	0.107

Seismic Check:

Existing Weight:

Wall Weight (psf):	17.00
Tributary Wall Area (ft^2):	1,090.00
Total Wall Weight (lbs):	18,530.00
Roof Weight (psf):	6.60
Roof Area (ft^2):	2,464.00
Total Roof Weight (lbs):	16,266.25
Total Existing Weight (lbs):	34,796.25

Additional PV Weight:

PV Panel Weight (lbs):	54.45
Number of Panels:	21
Total Additional PV Weight (lbs):	**1,143.45**

Weight Increase:

(Existing W + Additional W) ÷ (Existing W) = 103.29%

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.