11/1/2024

CAROLINA CONNECTIONS
422 HUFFMAN MILL ROAD,SUITE 105
BURLINGTON, NC 27215

Attn.: To Whom It May Concern

re job: MARK TAYLOR
406 PLACID POND DR
BROADWAY

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. The verification of such info is the responsibility of others.
After review, I certify that the roof structure has sufficient structural capacity for the proposed 19 PV modules.
All mounting equipment shall be designed and installed per manufacturer's approved installation specifications.

Design Criteria:

Code:	2018 NC Building Code		
	ASCE 7-10		
Live Load:	20	psf	
Ult Wind Speed:	117	mph	
Exposure Cat:	B		
Ground Snow:	10	psf	Min Roof Snow: NA

Exp. 12/31/2024
Stamped on 11/01/2024

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Roof Properties:

	Roof 1	Roof 2
Roof Type =	Shingle	Shingle
Roof Pitch (deg) =	10	27
Mean Roof Height (ft) =	13	13
Attachment Trib Width (ft) =	2.75	2.75
Attachment Spacing (ft) =	4	4
Framing Type =	Truss	Truss
Framing Size =	2x4	2x4
Framing OC Spacing (in.) =	24	24
Section Thickness, b (in.) =	1.5	1.5
Section Depth, d (in.) =	3.5	3.5
Section Modulus, Sx (in.^3) =	3.1	3.1
Moment of Inertia, Ix (in.^4) =	5.4	5.4
Framing Span (ft) =	9	9
Deflection Limit D+L (in.) =	1.8	1.8
Deflection Limit S or W (in.) =	1.20	1.20
Attachments Pattern =	Fully Staggered	Fully Staggered
Framing Upgrade =	Adequate	Adequate
Sister Size =	NA	NA
Wood Species =	DF #2	DF #2
Wood Fb (psi) =	900	900
Wood Fv (psi) =	180	180
Wood E (psi) =	1600000	1600000
C_D (Wind) =	1.6	1.6
C_D (Snow) =	1.15	1.15
C_{LS} =	1.15	1.15
$C_M = C_t = C_L = C_i$ =	1.0	1.0
C_F =	1.5	1.5
C_{fu} =	1.00	1.00
C_r =	1.15	1.15
F'b_wind (psi) =	2857	2857
F'b_snow (psi) =	2053	2053
F'v_wind (psi) =	288	288
F'v_snow (psi) =	207	207
M_allowable_wind (lb-ft) =	729	729
M_allowable_snow (lb-ft) =	524	524
V_allowable_wind (lbs) =	1008	1008
V_allowable_snow (lbs) =	725	725

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E' (psi) =	1600000	1600000

Load Calculation:

Dead Load Calculations:

Panels Dead Load (psf) =	3.0	
	Roof 1	**Roof 2**
Roofing Weight (psf) =	3.0	3.0
Decking Weight (psf) =	2.0	2.0
Framing Weight (psf) =	0.6	0.6
Misc. Additional Weight (psf) =	1.0	1.0
Existing Dead Load (psf) =	6.6	6.6
Total Dead Load (psf) =	9.6	9.6

Snow Load Calculations:

Ground Snow Load, pg (psf) =	10	
Min Flat Snow, pf_min (psf) =	NA	
Min Sloped Snow, ps_min (psf) =	NA	
Snow Importance Factor, Ic =	1.0	
Exposure Factor, Ce =	0.9	
	Roof 1	**Roof 2**
Thermal Factor, Ct =	1.2	1.2
Flat Roof Snow, pf (psf) =	7.56	7.56
Slope Factore, Cs =	1.00	1.00
Sloped Roof Snow, ps (psf) =	8	8

Wind Load Calculations:

Ultimate Wind Speed (mph) =	117	
Directionality Factor, kd =	0.85	
Topographic Factor, kzt =	1.0	
	Roof 1	**Roof 2**
Velocity Press Exp Factor, kz =	0.70	0.70
Solar Equalization Factor, ɣa =	1.00	1.00
External Pressure Up, GCp_1 =	-0.85	-0.85
External Pressure Up, GCp_2 =	-1.55	-1.55
External Pressure Up, GCp_3 =	-2.45	-2.45
External Pressure Down, GCp =	0.45	0.45
Design Pressure Up, p_1 (psf) =	-17.7	-17.7
Design Pressure Up, p_2 (psf) =	-32.3	-32.3
Design Pressure Up, p_3 (psf) =	-51.1	-51.1
Design Pressure Down, p (psf) =	16.0	16.0

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Hardware Checks:

Attachment Checks:

	Roof 1	Roof 2
Attachment Type =	QM HUG	QM HUG
Allowable Up Force (lbs) =	1000	1000
	2000	2000
Allowable Side Force (lbs) =	240	240
Applied Uplift Force (lbs) =	-98	-99
Uplift DCR =	**0.10**	**0.10**
Applied Down Force (lbs) =	173	164
Down DCR =	**0.09**	**0.08**
Applied Lateral Force (lbs) =	20	53
Lateral DCR =	**0.08**	**0.22**

Roof Framing Checks:

Force Checks:

	Roof 1	Roof 2
LC1: D+S		
Applied Moment (lb-ft) =	232	232
Applied Shear (lbs) =	154	154
Allowable Moment (lb-ft) =	524	524
Allowable Shear (lbs) =	725	725
Moment DCR =	**0.44**	**0.44**
Shear DCR =	**0.21**	**0.21**
LC2: D+0.6W		
Applied Moment (lb-ft) =	259	259
Applied Shear (lbs) =	173	173
Allowable Moment (lb-ft) =	729	729
Allowable Shear (lbs) =	1008	1008
Moment DCR =	**0.36**	**0.36**
Shear DCR =	**0.17**	**0.17**
LC3: D+0.75(S+0.6W)		
Applied Moment (lb-ft) =	303	303
Applied Shear (lbs) =	202	202
Allowable Moment (lb-ft) =	729	729
Allowable Shear (lbs) =	1008	1008
Moment DCR =	**0.42**	**0.42**
Shear DCR =	**0.20**	**0.20**
LC4: 0.6D+0.6W		

Applied Moment (lb-ft) =	66	66
Applied Shear (lbs) =	44	44
Allowable Moment (lb-ft) =	729	729
Allowable Shear (lbs) =	1008	1008
Moment DCR =	**0.09**	**0.09**
Shear DCR =	**0.04**	**0.04**

Deflection Checks (Service Level):

	Roof 1	Roof 2
LC1: D+L		
Deflection (in.) =	0.10	0.10
Deflection Limit (in.) =	2.07	2.07
Deflection DCR =	**0.05**	**0.05**
LC2: S		
Deflection (in.) =	0.05	0.05
Deflection Limit (in.) =	1.38	1.38
Deflection DCR =	**0.04**	**0.04**
LC3: W (Down)		
Deflection (in.) =	0.05	0.05
Deflection Limit (in.) =	1.38	1.38
Deflection DCR =	**0.03**	**0.03**
LC4: W (Up)		
Deflection (in.) =	-0.05	-0.05
Deflection Limit (in.) =	1.38	1.38
Deflection DCR =	**0.04**	**0.04**

Seismic Check:

Existing Weight:

Wall Weight (psf) =	17
Tributary Wall Area (ft^2) =	1000
Total Wall Weight (lbs) =	17000
Roof Weight (psf) =	7
Roof Area (ft^2) =	2400
Total Roof Weight (lbs) =	15844
Total Existing Weight (lbs) =	**32844**

Additional PV Weight:

PV Panel Weight (lbs) =	54
Number of Panels =	19
Total Additional PV Weight (lbs) =	**1035**

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Weight Increase:

(Existing W + Additional W)/(Existing W) = 1.03

The increase in weight as a result of the solar system is less than 10% of the existing structure and 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.