08-05-2022

Powur PBC

2683 Via De La Valle #321G

Attn.: To Whom It May Concern

re job: Lori Bednash

304 Pineridge Cove, Sanford, NC 27332, USA

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.

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: 119 mph
Exposure Cat: C
Ground Snow: 10 psf
Min Snow Roof: 0 psf

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Current Renewables Engineering Inc.
Professional Engineer
info@currentrenewableseng.com

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Roof Properties:

	Roof 1
Roof Type =	Shingle
Roof Pitch (deg) =	40.0
Mean Root Height (ft) =	23.0
Attachment Trib Width (ft) =	3.25
Attachment Spacing (ft) =	4.0
Framing Type =	Rafter
Framing Size =	2x8
Framing OC Spacing (in.) =	16.0
Section Thickness, b (in) =	1.5
Section Depth, d (in) =	7.2
Section Modulus, Sx (in^3) =	13.141
Moment of Inertia, Ix (in) =	47.635
Unsupported Span (ft) =	12.0
Upper Chord Length (ft) =	16.0
Deflection Limit D+L (in) =	3.2
Deflection Limit S or W (in) =	2.133
Attachments Pattern =	Fully Staggered
Framing Upgrade =	No
Sister Size =	NA
Wood Species =	DF
Wood Fb (psi) =	900.0
Wood Fv (psi) =	180.0
Wood E (psi) =	1600000.0
C_D (wind) =	1.6
C_d (snow) =	1.15
C_{LS} =	1.0
$C_M = C_t = C_L = C_i$ =	1.0
C_F =	1.2
C_{fu} =	1.0
C_r =	1.15
F'b wind (psi) =	1987.2
F'b snow (psi) =	1428.3
F'v wind (psi) =	288.0
F'v snow (psi) =	207.0
M allowable wind (lb-ft) =	2176.09
M allowable snow (lb-ft) =	1564.06
V allowable wind (lbs) =	2088.0
V allowable snow (lbs) =	1500.75
E' (psi) =	1600000.0

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Load Calculation:

Dead Load Calculations:

	Roof 1
Panels Dead Load (psf) =	3.0
Roofing Weight (psf) =	3.0
Decking Weight (psf) =	2.0
Framing Weight (psf) =	1.869
Misc. Additional Weight (psf) =	1.0
Existing Dead Load (psf) =	7.869
Total Dead Load (psf) =	10.869

Wind Load Calculations:

Ultimate Wind Speed (mph) =	119.0
Directionality Facto r, kd =	0.85
Topographic Factor, kzt =	1.0
Velocity Press Exp Factor, kz =	0.929
Velocity Pressure, qz (psf) =	28.621
External Pressure Up, GCp_1 =	-1.499
External Pressure Up, GCp_2 =	-1.769
External Pressure Up, GCp_3 =	-2.189
External Pressure Down, GCp =	0.78
Design Pressure Up, p_1 (psf) =	-29.602
Design Pressure Up, p_2 (psf) =	-34.927
Design Pressure Up, p_3 (psf) =	-43.229
Design Pressure Down, p (psf) =	16.0

Snow Load Calculations:

Ground Snow Load, pg (psf) =	10.0
Min Flat Snow, pf_min (psf) =	0.0
Sloped Snow, ps_min (psf) =	0.0
Snow Importance Factor, Ic =	1.0
Exposure Factor, Ce =	0.9
Thermal Factor, Ct =	1.1
Flat Roof Snow, pf (psf) =	6.93
Slope Factor, Cs =	1.0
Sloped Roof Snow, ps (psf) =	6.93

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Lag Screw Checks:

	Roof 1
Ref. Withdrawal Value, W (lb/in) =	266.0
(C_m = C_t = C_{eg} = 1.0) CD =	1.6
Adjusted Withdrawal Value, W' (lb/in) =	425.6
Lag Penetration, p (in.) =	2.5
Allowable Withdrawal Force, W'p (lbs) =	1064.0
Applied Uplift Force (lbs) =	-181.778
Uplift DCR =	0.171
Ref. Lateral Value, Z (lbs) =	266.0
(C_m = C_t = C_Δ = C_{eg} = 1.0) CD =	1.15
Adjusted Lateral Value, Z' (lbs) =	310.5
Applied Lateral Force (lbs) =	82.977
Angle of Resultant Force, α (deg) =	1.143
Adjusted Interaction Lateral Value, Z'α (lbs) =	750.106
Lateral DCR =	0.111

Roof Framing Checks:

Force Checks:

LC1: D+S

	Roof 1
Applied Moment (lb-ft) =	332.0
Applied Shear (lbs) =	169.0
Allowable Moment (lb-ft) =	1564.0
Allowable Shear (lbs) =	1501.0
Moment DCR =	0.212
Shear DCR =	0.113

LC2: D+0.6W

Applied Moment (lb-ft) =	382.0
Applied Shear (lbs) =	194.0
Allowable Moment (lb-ft) =	2176.0
Allowable Shear (lbs) =	2088.0
Moment DCR =	0.176
Shear DCR =	0.093

LC3: D+0.75(S+0.6W)

Applied Moment (lb-ft) =	434.0
Applied Shear (lbs) =	221.0
Allowable Moment (lb-ft) =	2176.0
Allowable Shear (lbs) =	2088.0
Moment DCR =	0.2
Shear DCR =	0.106

LC4: 0.6D+0.6W

Applied Moment (lb-ft) =	301.0
Applied Shear (lbs) =	153.0
Allowable Moment (lb-ft) =	2176.0
Allowable Shear (lbs) =	2088.0
Moment DCR =	0.138
Shear DCR =	0.073

Deflection Checks (Service Level):

LC1: D+L

Deflection (in.) = 0.144
Deflection Limit (in.) = 3.2
Deflection DCR = 0.045

LC2: S

Deflection (in.) = 0.031
Deflection Limit (in.) = 2.133
Deflection DCR = 0.014

LC3: W (Down)

Deflection (in.) = 0.03
Deflection Limit (in.) = 2.133
Deflection DCR = 0.014

LC4: W (Up)

Deflection (in.) = 0.055
Deflection Limit (in.) = 2.133
Deflection DCR = 0.026

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Seismic Check:

Existing Weight:

Wall Weight (psf) =	17.0
Tributary Wall Area (ft^2) =	3000.0
Total Wall Weight (lbs) =	51000.0
Roof Weight (psf) =	7.869
Roof Area (ft^2) =	2356.0
Total Roof Weight (lbs) =	18539.695
Total Existing Weight (lbs) =	69539.695

Total Additional PV Weight (lbs) = 1608.75

Weight Increase:

(Existing W + Additional W)/(Existing W) = 1.023

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.