08-15-2022

Powur PBC

2683 Via De La Valle #321G

Subject: Structural Certification for Installation of Residential Solar
re job: Sonia Collins

110 Valley View Ct, Sanford, NC 27332, USA

Attn.: To Whom It May Concern

Observation of the condition of the existing framing system was performed by an audit team of Powur PBC

After review of the field observation data, structural capacity calculations were performed in accordance with applicable building codes to determine adequacy of the existing roof framing supporting the proposed panel layout. Please see full Structural Calculations report for details regarding calculations performed and limits of scope of work and liability. The design criteria and structural adequacy are summarized below:

Design Criteria:

Code: 2018 NCSBC, IBC 2015, ASCE 7-10, Ult Wind Speed: 117 mph, Ground Snow: 10 psf, Min Snow Roof: 0 psf

ROOF 1: Shingle roofing supported by 2x4 Truss @ 24 in. OC spacing. The roof is sloped at approximately 33 degrees and has a max beam span of 8.0 ft between supports. Roof is adequate to support the imposed loads. Therefore, no structural upgrades are required.

ROOF 2: Shingle roofing supported by 2x4 Truss @ 24 in. OC spacing. The roof is sloped at approximately 22 degrees and has a max beam span of 8.0 ft between supports. Roof is adequate to support the imposed loads. Therefore, no structural upgrades are required.

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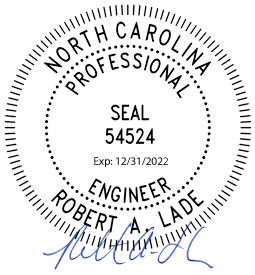

Current Renewables Engineering Inc.
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The following calculations are for the structural engineering design of the photovoltaic panels and are valid only for the structural info referenced in the stamped plan set. The verification of such info is the 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 2015, ASCE 7-10,
Live Load: 20 psf
Ult Wind Speed: 117 mph
Exposure Cat: C
Ground Snow: 10 psf
Min Snow Roof: 0 psf

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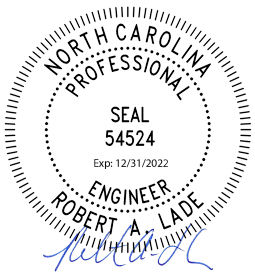

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Roof Properties:

	Roof 1	Roof 2
Roof Type =	Shingle	Shingle
Roof Pitch (deg) =	33.0	22.0
Mean Root Height (ft) =	23.0	23.0
Attachment Trib Width (ft) =	3.25	3.25
Attachment Spacing (ft) =	4.0	4.0
Framing Type =	Truss	Truss
Framing Size =	2x4	2x4
Framing OC Spacing (in.) =	24.0	24.0
Section Thickness, b (in) =	1.5	1.5
Section Depth, d (in) =	3.5	3.5
Section Modulus, Sx (in^3) =	3.062	3.062
Moment of Inertia, Ix (in) =	5.359	5.359
Unsupported Span (ft) =	8.0	8.0
Upper Chord Length (ft) =	14.0	13.0
Deflection Limit D+L (in) =	2.8	2.6
Deflection Limit S or W (in) =	1.867	1.733
Attachments Pattern =	Fully Staggered	Fully Staggered
Framing Upgrade =	No	No
Sister Size =	NA	NA
Wood Species =	DF	DF
Wood Fb (psi) =	900.0	900.0
Wood Fv (psi) =	180.0	180.0
Wood E (psi) =	1600000.0	1600000.0
C_D (wind) =	1.6	1.6
C_d (snow) =	1.15	1.15
C_{LS} =	1.0	1.0
$C_M = C_t = C_L = C_i$ =	1.0	1.0
C_F =	1.5	1.5
C_{fu} =	1.0	1.0
C_r =	1.15	1.15
F'b wind (psi) =	2484.0	2484.0
F'b snow (psi) =	1785.37	1785.37
F'v wind (psi) =	288.0	288.0
F'v snow (psi) =	207.0	207.0
M allowable wind (lb-ft) =	633.94	633.94
M allowable snow (lb-ft) =	455.64	455.64
V allowable wind (lbs) =	1008.0	1008.0
V allowable snow (lbs) =	724.5	724.5
E' (psi) =	1600000.0	1600000.0

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Load Calculation:

Dead Load Calculations:

	Roof 1	Roof 2
Panels Dead Load (psf) =	3.0	3.0
Roofing Weight (psf) =	3.0	3.0
Decking Weight (psf) =	2.0	2.0
Framing Weight (psf) =	0.602	0.602
Misc. Additional Weight (psf) =	1.0	1.0
Existing Dead Load (psf) =	6.602	6.602
Total Dead Load (psf) =	9.602	9.602

Wind Load Calculations:

Ultimate Wind Speed (mph) =	117.0	117.0
Directionality Facto r, kd =	0.85	0.85
Topographic Factor, kzt =	1.0	1.0
Velocity Press Exp Factor, kz =	0.929	0.929
Velocity Pressure, qz (psf) =	27.667	27.667
External Pressure Up, GCp_1 =	-0.94	-0.87
External Pressure Up, GCp_2 =	-1.14	-1.549
External Pressure Up, GCp_3 =	-1.14	-2.419
External Pressure Down, GCp =	0.87	0.44
Design Pressure Up, p_1 (psf) =	-26.001	-24.067
Design Pressure Up, p_2 (psf) =	-31.535	-42.869
Design Pressure Up, p_3 (psf) =	-31.535	-66.937
Design Pressure Down, p (psf) =	24.067	16.0

Snow Load Calculations:

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

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Lag Screw Checks:

	Roof 1	Roof 2
Ref. Withdrawal Value, W (lb/in) =	266.0	266.0
(C_m = C_t = C_{eg} = 1.0) CD =	1.6	1.6
Adjusted Withdrawal Value, W' (lb/in) =	425.6	425.6
Lag Penetration, p (in.) =	2.5	2.5
Allowable Withdrawal Force, W'p (lbs) =	1064.0	1064.0
Applied Uplift Force (lbs) =	-193.114	-267.511
Uplift DCR =	0.181	0.251
Ref. Lateral Value, Z (lbs) =	266.0	266.0
(C_m = C_t = C_Δ = C_{eg} = 1.0) CD =	1.15	1.15
Adjusted Lateral Value, Z' (lbs) =	310.5	310.5
Applied Lateral Force (lbs) =	70.307	48.358
Angle of Resultant Force, α (deg) =	1.222	1.392
Adjusted Interaction Lateral Value, Z'α (lbs) =	828.652	988.121
Lateral DCR =	0.085	0.049

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Roof Framing Checks:

Force Checks:

LC1: D+S

	Roof 1	Roof 2
Applied Moment (lb-ft) =	215.0	206.0
Applied Shear (lbs) =	158.0	158.0
Allowable Moment (lb-ft) =	456.0	456.0
Allowable Shear (lbs) =	724.0	724.0
Moment DCR =	0.472	0.451
Shear DCR =	0.218	0.218

LC2: D+0.6W

Applied Moment (lb-ft) =	313.0	239.0
Applied Shear (lbs) =	229.0	183.0
Allowable Moment (lb-ft) =	634.0	634.0
Allowable Shear (lbs) =	1008.0	1008.0
Moment DCR =	0.493	0.377
Shear DCR =	0.228	0.182

LC3: D+0.75(S+0.6W)

Applied Moment (lb-ft) =	333.0	274.0
Applied Shear (lbs) =	245.0	210.0
Allowable Moment (lb-ft) =	634.0	634.0
Allowable Shear (lbs) =	1008.0	1008.0
Moment DCR =	0.526	0.432
Shear DCR =	0.243	0.208

LC4: 0.6D+0.6W

Applied Moment (lb-ft) =	263.0	191.0
Applied Shear (lbs) =	193.0	147.0
Allowable Moment (lb-ft) =	634.0	634.0
Allowable Shear (lbs) =	1008.0	1008.0
Moment DCR =	0.414	0.301
Shear DCR =	0.191	0.145

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Deflection Checks (Service Level):

LC1: D+L

Deflection (in.) =	0.384	0.477
Deflection Limit (in.) =	2.8	2.6
Deflection DCR =	0.137	0.183

LC2: S

Deflection (in.) =	0.078	0.085
Deflection Limit (in.) =	1.867	1.733
Deflection DCR =	0.042	0.049

LC3: W (Down)

Deflection (in.) =	0.113	0.083
Deflection Limit (in.) =	1.867	1.733
Deflection DCR =	0.061	0.048

LC4: W (Up)

Deflection (in.) =	0.122	0.125
Deflection Limit (in.) =	1.867	1.733
Deflection DCR =	0.066	0.072

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Seismic Check:

Existing Weight:

Wall Weight (psf) =	17.0
Tributary Wall Area (ft^2) =	2550.0
Total Wall Weight (lbs) =	43350.0
Roof Weight (psf) =	6.602
Roof Area (ft^2) =	1764.0
Total Roof Weight (lbs) =	11645.156
Total Existing Weight (lbs) =	54995.156

Total Additional PV Weight (lbs) = 1608.75

Weight Increase:

(Existing W + Additional W)/(Existing W) = 1.029

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.