



9/29/2021

Von Loor & Sloof Energy LLC

Attn.: To Whom It May Concern

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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.

After review, 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 NC Building Code		
	ASCE 7-10		
Live Load:	20	psf	
Ult Wind Speed:	118	mph	
Exposure Cat:	B		
Ground Snow:	15	psf	Min Roof Snow: NA

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Roof Properties:

	Roof 1
Roof Type =	Shingle
Roof Pitch (deg) =	20
Mean Roof Height (ft) =	13
Attachment Trib Width (ft) =	2.75
Attachment Spacing (ft) =	4
Framing Type =	Rafter
Framing Size =	2x6
Framing OC Spacing (in.) =	24
Section Thickness, b (in.) =	1.5
Section Depth, d (in.) =	5.5
Section Modulus, Sx (in.^3) =	7.6
Moment of Inertia, Ix (in.^4) =	20.8
Framing Span (ft) =	10.19868761
Deflection Limit D+L (in.) =	2.039737523
Deflection Limit S or W (in.) =	1.36
Attachments Pattern =	Stacked
Framing Upgrade =	Adequate
Sister Size =	NA
Wood Species =	DF #2
Wood Fb (psi) =	900
Wood Fv (psi) =	180
Wood E (psi) =	1600000
C _D (Wind) =	1.6
C _D (Snow) =	1.15
C _{LS} =	1.00
C _M = C _t = C _L = C _i =	1.0
C _F =	1.3
C _{fu} =	1.00
C _r =	1.15
F'b_wind (psi) =	2153
F'b_snow (psi) =	1547
F'v_wind (psi) =	288
F'v_snow (psi) =	207
M_allowable_wind (lb-ft) =	1357
M_allowable_snow (lb-ft) =	975
V_allowable_wind (lbs) =	1584
V_allowable_snow (lbs) =	1139

E' (psi) = | 1600000

Load Calculation:

Dead Load Calculations:

Panels Dead Load (psf) =	3.0
Roof 1	
Roofing Weight (psf) =	3.0
Decking Weight (psf) =	2.0
Framing Weight (psf) =	0.9
Misc. Additional Weight (psf) =	1.0
Existing Dead Load (psf) =	6.9
Total Dead Load (psf) =	9.9

Snow Load Calculations:

Ground Snow Load, p_g (psf) =	15
Min Flat Snow, p_{f_min} (psf) =	NA
Min Sloped Snow, p_{s_min} (psf) =	NA
Snow Importance Factor, I_c =	1.0
Exposure Factor, C_e =	0.9
Roof 1	
Thermal Factor, C_t =	1.2
Flat Roof Snow, p_f (psf) =	11.34
Slope Factor, C_s =	1.00
Sloped Roof Snow, p_s (psf) =	11

Wind Load Calculations:

Ultimate Wind Speed (mph) =	118
Directionality Factor, k_d =	0.85
Topographic Factor, k_{zt} =	1.0
Roof 1	
Velocity Press Exp Factor, k_z =	0.70
Velocity Pressure, q_z (psf) =	21.2
External Pressure Up, G_{Cp_1} =	-0.85
External Pressure Up, G_{Cp_2} =	-1.55
External Pressure Up, G_{Cp_3} =	-2.45
External Pressure Down, G_{Cp} =	0.45
Design Pressure Up, $p_{_1}$ (psf) =	-18.0
Design Pressure Up, $p_{_2}$ (psf) =	-32.9
Design Pressure Up, $p_{_3}$ (psf) =	-52.0
Design Pressure Down, p (psf) =	16.0

Roof Framing Checks:

Force Checks:

Roof 1

LC1: D+S

Applied Moment (lb-ft) =	926
Applied Shear (lbs) =	363
Allowable Moment (lb-ft) =	975
Allowable Shear (lbs) =	1139
Moment DCR =	0.95
Shear DCR =	0.32

LC2: D+0.6W

Applied Moment (lb-ft) =	836
Applied Shear (lbs) =	328
Allowable Moment (lb-ft) =	1357
Allowable Shear (lbs) =	1584
Moment DCR =	0.62
Shear DCR =	0.21

LC3: D+0.75(S+0.6W)

Applied Moment (lb-ft) =	1153
Applied Shear (lbs) =	452
Allowable Moment (lb-ft) =	1357
Allowable Shear (lbs) =	1584
Moment DCR =	0.85
Shear DCR =	0.29

LC4: 0.6D+0.6W

Applied Moment (lb-ft) =	361
Applied Shear (lbs) =	142
Allowable Moment (lb-ft) =	1357
Allowable Shear (lbs) =	1584
Moment DCR =	0.27
Shear DCR =	0.09

Deflection Checks (Service Level):

Roof 1

LC1: D+L

Deflection (in.) =	0.28
Deflection Limit (in.) =	2.039737523
Deflection DCR =	0.14

LC2: S

Deflection (in.) =	0.33
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	Deflection Limit (in.) =	1.36
	Deflection DCR =	0.24
LC3: W (Down)		
	Deflection (in.) =	0.20
	Deflection Limit (in.) =	1.36
	Deflection DCR =	0.14
LC4: W (Up)		
	Deflection (in.) =	-0.22
	Deflection Limit (in.) =	1.36
	Deflection DCR =	0.16

Seismic Check:

Existing Weight:

Wall Weight (psf) =	17
Tributary Wall Area (ft ²) =	1250
Total Wall Weight (lbs) =	21250
Roof Weight (psf) =	7
Roof Area (ft ²) =	3876
Total Roof Weight (lbs) =	26920
Total Existing Weight (lbs) =	48170

Additional PV Weight:

PV Panel Weight (lbs) =	54
Number of Panels =	32
Total Additional PV Weight (lbs) =	1742

Weight Increase:

$$(\text{Existing W} + \text{Additional W}) / (\text{Existing W}) = 104\%$$

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 plan set and were completed according to generally recognized structural analysis standards and procedures, professional engineering and design experience, opinions and judgments. 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.