



BLUE RAVEN SOLAR, LLC.
Firm License No. D-0369
1403 North Research Way , Bldg. J
Orem, UT 84097

April 2, 2021

To: Blue Raven Solar
1220 S. 630 E. Ste. 430
American Fork, UT. 84003

Subject: Certification Letter
Grest Residence
150 Topsail Ln
Angier, NC. 27501

To Whom It May Concern,

A jobsite observation of the condition of the existing framing system was performed by an audit team of Blue Raven Solar. All attached structural calculations are based on these observations and the design criteria listed below.

On the above referenced project, the roof structural framing has been reviewed for additional loading due to the installation of the solar PV addition to the roof. The structural review, including the plans and calculations only apply to the section of the roof that is directly supporting the solar PV system and its supporting elements. The observed roof framing is described below.

The roof structure of (MP1,2,3,4&5) consists of composition shingle on roof plywood that is supported by 2x8 rafters @ 16" o.c.. The rafters support a vaulted ceiling and have a max projected horizontal span of 17'-6", with a slope of 40 degrees. The rafters are supported at the ridge by a ridge board and at the eave by a load bearing wall.

The existing roof framing system of (MP1,2,3,4&5) is judged to be adequate to withstand the loading imposed by the installation of the solar panels. No reinforcement is necessary.

The spacing of the solar standoffs should be kept at 64" o.c. for landscape and 48" o.c. for portrait orientation, with a staggered pattern to ensure proper distribution of loads.

The scope of this report is strictly limited to an evaluation of the fastener attachment, underlying framing and supporting structure only. The attachment's to the existing structure are required to be in a staggered pattern to ensure proper distribution of loading. All panels, racking and hardware shall be installed per manufacturer specifications and within specified design limitations. All waterproofing shall be provided by the manufacturer.

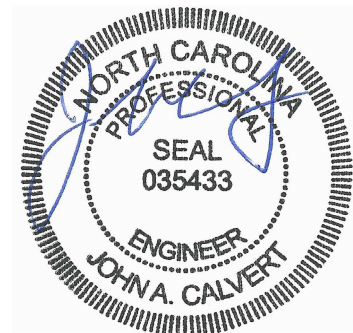
Design Criteria:

- Applicable Codes = 2018 North Carolina State Building Code (NCSBC), ASCE7-10, and NDS-12
- Roof Dead Load = 13 psf (MP1,2,3,4&5)
- Roof Live Load = 20 psf
- Wind Speed = 115 mph, Exposure C
- Ground Snow Load = 15 psf - Roof Snow Load = 10.5 psf
- Attachments: (1) 5/16" dia lag screw with 2.5" min embedment depth, at spacing shown above.

Please contact me with any further questions or concerns regarding this project.

Sincerely,

John Calvert, P.E.
Project Engineer





Wind Calculations

Per ASCE7-10 Components and Cladding

Input Variables	
Wind Speed	115 mph
Exposure Category	C
Roof Shape	Gable/Hip
Roof Slope	40 degrees
Mean Roof Height	20 ft
Effective Wind Area	19.3 ft

Design Wind Pressure Calculations	
Wind Pressure $P = qh * G * C_n$	
$qh = 0.00256 * K_z * K_{zt} * K_d * V^2$	(Eq. 30.3-1)
K_z (Exposure Coefficient) = 0.9	(Table 30.3-1)
K_{zt} (topographic factor) = 1	(Fig. 26.8-1)
K_d (Wind Directionality Factor) = 0.85	(Table 26.6-1)
V (Design Wind Speed) = 115 mph	(Fig. 26.5-1A)
Risk Category = II	(Table 1.5-1)
$qh = 25.90$	
$0.6 * qh = 15.54$	

Standoff Uplift Calculations-Portrait				
	Zone 1	Zone 2	Zone 3	Positive
$G C_p =$	-0.88	-1.08	-1.08	0.84
Uplift Pressure =	-13.61 psf	-16.72 psf	-16.72 psf	21.7 psf
X Standoff Spacing =	4.00	4.00	2.67	
Y Standoff Spacing =	5.50	2.75	2.75	
Tributary Area =	22.00	11.00	7.33	
Footing Uplift =	-299 lb	-184 lb	-123 lb	

Standoff Uplift Calculations-Landscape				
	Zone 1	Zone 2	Zone 3	Positive
$G C_p =$	-0.88	-1.08	-1.08	0.84
Uplift Pressure =	-13.61 psf	-16.72 psf	-16.72 psf	10.0 psf
X Standoff Spacing =	5.33	5.33	3.56	
Y Standoff Spacing =	3.50	1.75	1.75	
Tributary Area =	18.67	9.33	6.22	
Footing Uplift =	-254 lb	-156 lb	-104 lb	

Standoff Uplift Check	
Maximum Design Uplift =	-299 lb
Standoff Uplift Capacity =	450 lb
450 lb capacity > 299 lb demand	Therefore, OK

Fastener Capacity Check	
Fastener =	1 - 5/16" dia Lag
Number of Fasteners =	1
Embedment Depth =	2.5
Pullout Capacity Per Inch =	250 lb
Fastener Capacity =	625 lb
w/ F.S. of 1.5 & DOL of 1.6 =	667 lb
667.2 lb capacity > 299 lb demand	Therefore, OK



Gravity Loading

Roof Snow Load Calculations		
p_g = Ground Snow Load =	15 psf	
$p_f = 0.7 C_e C_t I p_g$		(ASCE7 - Eq 7-1)
C_e = Exposure Factor =	1	(ASCE7 - Table 7-2)
C_t = Thermal Factor =	1	(ASCE7 - Table 7-3)
I = Importance Factor =	1	
p_f = Flat Roof Snow Load =	10.5 psf	
$p_s = C_s p_f$		(ASCE7 - Eq 7-2)
C_s = Slope Factor =	1	
p_s = Sloped Roof Snow Load =	10.5 psf	

PV Dead Load = 3 psf (Per Blue Raven Solar)	
PV System Weight	
Weight of PV System (Per Blue Raven Solar)	3.0 psf
X Standoff Spacing =	4.00 ft
Y Standoff Spacing =	5.50 ft
Standoff Tributary Area =	22.00 sft
Point Loads of Standoffs	66 lb

Note: PV standoffs are staggered to ensure proper distribution of loading

Roof Live Load = 20 psf	
Note: Roof live load is removed in area's covered by PV array.	

Roof Dead Load (MP1,2,3,4&5)	
Composition Shingle	4.00
Roof Plywood	2.00
2x8 Rafters @ 16"o.c.	2.27
Vaulted Ceiling	4.00
Miscellaneous	0.73
Total Roof DL (MP1,2,3,4&5)	13.0 psf
DL Adjusted to 40 Degree Slope	17.0 psf

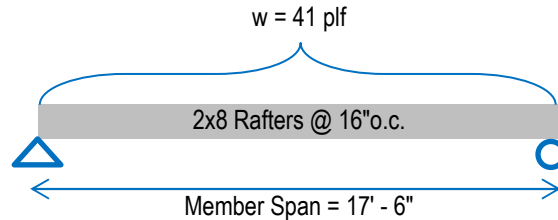


Framing Check

(MP1,2,3,4&5)

PASS

Dead Load 17.0 psf
 PV Load 3.0 psf
 Snow Load 10.5 psf



Governing Load Combo = DL + SL
Total Load 30.5 psf

Member Properties

Member Size	S (in ³)	I (in ⁴)	Lumber Sp/Gr	Member Spacing
2x8	13.14	47.63	DF#2	@ 16"o.c.

Check Bending Stress

$$F_b \text{ (psi)} = f_b \times C_d \times C_f \times C_r \quad \text{(NDS Table 4.3.1)}$$

$$900 \times 1.15 \times 1.2 \times 1.15$$

Allowed Bending Stress = 1428.3 psi

$$\text{Maximum Moment} = (wL^2) / 8$$

$$= 1555.255 \text{ ft}\#$$

$$= 18663.06 \text{ in}\#$$

$$\text{Actual Bending Stress} = (\text{Maximum Moment}) / S$$

$$= 1420.3 \text{ psi}$$

Allowed > Actual -- 99.5% Stressed -- Therefore, OK

Check Deflection

$$\text{Allowed Deflection (Total Load)} = L/180 \quad (E = 1600000 \text{ psi Per NDS})$$

$$= 1.166 \text{ in}$$

$$\text{Deflection Criteria Based on} = \text{Simple Span}$$

$$\text{Actual Deflection (Total Load)} = (5 \cdot w \cdot L^4) / (384 \cdot E \cdot I)$$

$$= 1.125 \text{ in}$$

$$= L/187 > L/180 \quad \text{Therefore OK}$$

$$\text{Allowed Deflection (Live Load)} = L/240$$

$$0.875 \text{ in}$$

$$\text{Actual Deflection (Live Load)} = (5 \cdot w \cdot L^4) / (384 \cdot E \cdot I)$$

$$0.388 \text{ in}$$

$$L/542 > L/240 \quad \text{Therefore OK}$$

Check Shear

$$\text{Member Area} = 10.9 \text{ in}^2 \quad F_v \text{ (psi)} = 180 \text{ psi} \quad \text{(NDS Table 4A)}$$

$$\text{Allowed Shear} = F_v \cdot A = 1958 \text{ lb} \quad \text{Max Shear (V)} = w \cdot L / 2 = 355 \text{ lb}$$

Allowed > Actual -- 18.2% Stressed -- Therefore, OK