



November 16, 2021

Power Home Solar and Roofing
919 North Main Street
Mooreville, NC 28115

Design Criteria:

Design Wind Speed (ASD)- 120 mph
Ground Snow Load- 10 psf
Risk Category- II
Exposure category- C

RE: Structural Roof Evaluation for the *Burkhart Residence: 2128 Rawls Church Road, Angier, North Carolina*

As per your request, we have evaluated the roof structure under the proposed solar panel array. The information used to evaluate this structure was gathered by Power Home Solar and Roofing on behalf of Right Angle Engineering. The roof structure consists of 2x6 rafters spaced at 16" on center. The roof material consists of asphalt shingles. The design criteria used to analyze this structure are listed above and included with this letter. The adopted building codes in this jurisdiction are: *the 2018 North Carolina Building Code, the 2018 North Carolina Existing Building Code, and ASCE 7-16.*

North Carolina Existing Building Code (NCEBC) 2018 section 807.4 indicates that alterations to an existing building that results in less than a 10% increase in the total stress may be performed without a structural evaluation of the existing building. As demonstrated in the attached calculations, the additional weight of the solar panels will be less than 10% increase in the gravity loading and the stress on the existing roof framing.

Based on our assessment we have determined that the existing roof framing will safely and adequately support the additional loads imposed by the solar panels without reinforcement. In order for the loads to be evenly distributed, the roof attachments should be staggered and spread evenly throughout the panel array. Attachment points should be spaced at a maximum of 48" on center. The racking system should be installed per the manufacture's specifications. There should be a minimum of 20 L-foot attachment points to the roof. Each attachment should have a 5/16" or 18/8 SS lag screw with 2.5" minimum penetration centered on each truss top chord or rafter. Waterproofing around the roof penetrations is the responsibility of others. Right Angle Engineering assumes no responsibility for improper installation of the solar panels.

Regards,



11/16/21

Robert D Smythe, P.E.
Right Angle Engineering

Design Criteria:

Design Wind Speed (3 second gust)	120	mph
Exposure Category	C	
Risk Category	2	
Mean Roof Height	30	ft
Roof Type	Gable Roof	
Building Type	enclosed	

Roof Dead Load- ASCE Table C3-1

Asphalt Shingles	2	psf
5/8" Plywood Sheathing	2	psf
Roof Framing	4	psf
Insulation	0	psf
Gypsum sheathing	0	psf
Solar Panel Array	3	psf
Dead Load Without Panels	8	psf
Dead Load With Solar panels	11	psf

Roof Live Load

Existing Roof Live Load	20	psf	ASCE 7-16 Table 4.3-1
Roof Live Load with Solar Panels	0	psf	2018 NCBC 1607.12.5

Roof Snow Load-ASCE 7-16

Ground Snow Load (pg)	10	psf	Section 7.2
Exposure Factor (Ce)	0.9		Table 7.3-1
Thermal Factor (Ct)	1.1		Table 7.3-2
Importance Factor (Is)	1		Table 1.5-2
Flat Roof Snow Load (Pf)	7		Equation 7.3-1
Slippery surface Slope Factor (Cs)	0.87		Figure 7-2
Nonslippery Surface Slope Factor (Cs)	1		Figure 7-2
Roof Snow Load	7	psf	Equation 7.4-1
Reduced Roof Snow Load (Slippery Surface)	6	psf	Equation 7.4-1

Load Combinations - ASCE 7-16 Section 2.4.1

	Without Solar Panels	With Solar panels
D + Lr	28 psf	11 psf
D + S	14.9 psf	17 psf

Solar Array 1-

Roof Slope	18	degrees
Number of panels	12	
Panel Area	210	ft ²

Wind Calculations- ASCE 7-16

GC _p Zone 1	-1		Figure 30.3-(2A-5B)
GC _p Zone 2	-1.8		Figure 30.3-(2A-5B)
GC _p Zone 3	-2.8		Figure 30.3-(2A-5B)
G _{cpi}	0.18		Table 26.13-1
Velocity Pressure (q _h)	30.7	psf	
$q_h = .00256K_hK_{ht}K_dV^2$			Equation 26.10-1
K _h	0.98		Table 26.10-1
K _{ht}	1		Equation 26.8-1
K _d	0.85		Table 26.6-1
Designed wind pressure (P)		psf	Equation 30.8-1
$P = q_h(GC_h) - (GC_{hi})$			
Zone 1 Pressure (P)	-36.2	psf	
Zone 2 Pressure (P)	-60.8	psf	
Zone 3 Pressure (P)	-91.5	psf	

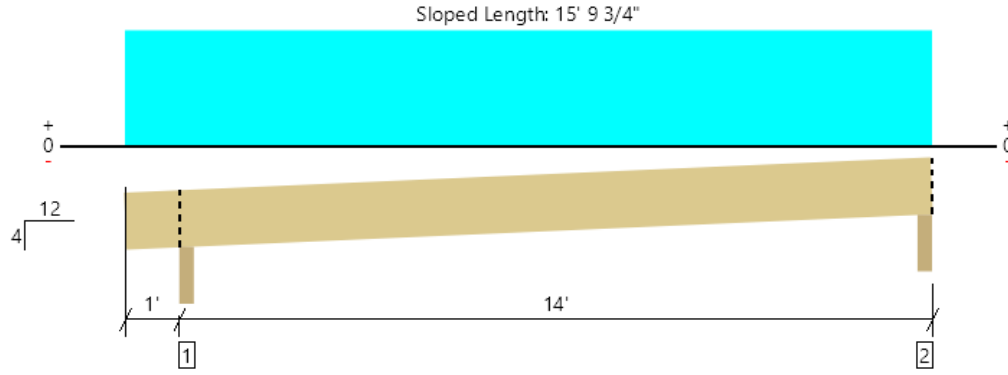
Roof Connection

Shear Capacity	190	lbs	NDS 2015 Table 12K
Shear tributary area	68.3	ft ²	
Pullout Capacity	266	lbs/in	
Lag screw embedment	2.5	in	
Total pullout capacity	665	lbs	NDS 2015 Table 12.2A
Pullout max tributary area	10.9	ft ²	
Factor of Safety	1.21		
Minimum number of connections	20		

Beam Stress NCEBC 2018 Section 806.2

Beam Span	14	ft		
Spacing	1.33	ft		
Roof Framing type	2x6 rafters			
Panel Orientation	portrait			
Number of Panels per rafter	2			
Panel distance from eave	1			
	Without Solar Panels	With Solar Panels	Percent Increase	
Bending Moment	912.4 ft-lbs	691.2 ft-lbs	75.8%	Less than 105%
Vertical Reaction (V1)	260.7 lbs	208.8 lbs	80.1%	Less than 105%
Vertical Reaction (V2)	260.7 lbs	155.99 lbs	59.8%	Less than 105%

Level, Roof: Joist
1 piece(s) 2 x 6 DF No.2 @ 16" OC



All locations are measured from the outside face of left support (or left cantilever end). All dimensions are horizontal.

Member Length : 15' 11 9/16"

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	304 @ 1' 1 3/4"	2352 (3.50")	Passed (13%)	--	1.0 D + 1.0 Lr (All Spans)
Shear (lbs)	238 @ 1' 8 11/16"	1238	Passed (19%)	1.25	1.0 D + 1.0 Lr (All Spans)
Moment (Ft-lbs)	874 @ 8"	1060	Passed (82%)	1.25	1.0 D + 1.0 Lr (All Spans)
Live Load Defl. (in)	0.689 @ 7' 11 3/4"	0.719	Passed (L/251)	--	1.0 D + 1.0 Lr (All Spans)
Total Load Defl. (in)	0.977 @ 7' 11 3/4"	0.959	Passed (L/177)	--	1.0 D + 1.0 Lr (All Spans)

System : Roof
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD
Member Pitch : 4/12

- Deflection criteria: LL (L/240) and TL (L/180).
- Overhang deflection criteria: LL (2L/240) and TL (2L/180). Upward deflection on left cantilever exceeds overhang deflection criteria.
- Allowed moment does not reflect the adjustment for the beam stability factor.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)				Accessories
	Total	Available	Required	Dead	Roof Live	Snow	Total	
1 - Beveled Plate - SPF	3.50"	3.50"	1.50"	90	214	107	411	Blocking
2 - Beveled Plate - SPF	3.50"	3.50"	1.50"	79	187	93	359	Blocking

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	7' 6" o/c	
Bottom Edge (Lu)	15' 10" o/c	

- Maximum allowable bracing intervals based on applied load.

Vertical Load	Location (Side)	Spacing	Dead (0.90)	Roof Live (non-snow: 1.25)	Snow (1.15)	Comments
1 - Uniform (PSF)	0 to 15'	16"	8.0	20.0	10.0	Default Load

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The product application, input design loads, dimensions and support information have been provided by ForteWEB Software Operator

ForteWEB Software Operator	Job Notes
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