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Instant Roof Framing Analysis

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STRUCTURAL ANALYSIS

for the

ROOFTOP PV SOLAR INSTALLATION

Project: Shawn Hawkins, 1549 N W Moore Rd, Lake City, FL 32055

Prepared for:

sunergy

Sunergy

7625 Little Rd Ste 200a - New Port Richey, FL 34654

Calculation Report Index

Project Number: 66.405072.2, Rev. 0

Report Date: 05/10/2024

Report Prepared by:

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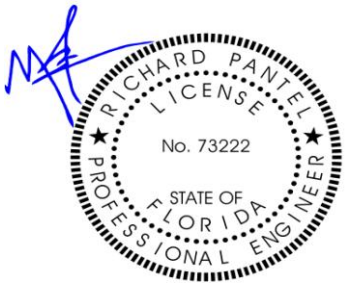

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Loading Summary

Exposure and Occupancy Categories		
B		*Exposure Category (ASCE 7-22 Table 26.7.3, Page 274)*
II		*Building Use Occupancy / Risk Category (ASCE 7-22 Table 1.5-1, Page 5)*

Wind Loading:			
v	119	*mph*	*ASCE 7-22, Figure 26.5-1 A, B or C [(119 mph, 50 year wind MRI)]*
qz	21.43	*psf*	*Velocity qz, calculated at height z [ASD]*

Snow Loading			
pg	4.19659	*psf*	*Ground Snow Load pg (ASCE 7-22 Table 7.2-1, Page 56-60)*
Total Snow Load			
ps	4.20	*psf*	*Effective snow load on roof and modules*

Module Data			
Vietnam Sunergy Joint Stock Co: VSUN370-120M-BB			
Dimensions	*mm*	*ft*	*in*
Length	1,762	5.78	69.37
Width	1,048	3.44	41.25
Area (m^2, ft^2)	1.9	19.87	
Weight	kg	lb	
Module	19.60	43.21	

Roof Panel (Cladding) Loading Summary		Module Loading Summary			
Support Point Loads		*Upward*	*Upward*	*Upward*	*Downward*
Roof Zones		1	2	3	All
Net load per module	*lb*	-204	-315	-453	96

Positive values indicate net downward force

Stanchion Fastener Pull-out and Spacing Calculations				
Framing spacing		*ft*	2.00	
Rails / Module		*ea*	2	
Max proposed stanchion span		*ft*	4.00	
# fasteners per stanchion			4	
Bolt thread embedment depth		*in*	0.5	
Safety Factor			1.10	
Pull-out for 1/4 threaded fasteners		*lb/in*	186	
Factored max fastener uplift capacity		*lb*	338	
Fastener details	*Material* Stainless	*Size*	1/4	*Predrill hole 0.12" dia or use self tapping*
Max stanchion uplift capacity		*lb*	400	
Max support point uplift capacity		*lb*	338	

Roof Zones			*1*	*2*	*3*
Net lift per module		*lb*	204	315	453
Min tot bolt thread embedment depth rq'd		*in*	0.30	0.47	0.67
Net uplift pressure	7. 0.60D - 0.6W	*psf*	-8.82	-13.64	-19.57
Allowable lift area / support point		*sf*	38.29	24.75	17.25
Max rail span per framing spacing		*ft*	4.00	4.00	4.00
Landscape Modules					
Length along rafter		*ft*	3.44		
Lift calc'ed max stanchion EW spacing		*ft*	> 6	> 6	> 6
Max stanchion EW spacing		*ft*	4.00	4.00	4.00
Maximum module area / support point		*sf*	6.88	6.88	6.88
Factored lift per support point		*lb*	-61	-94	-135
Portrait Modules					
Length along rafter		*ft*	5.78		
Lift calc'ed max stanchion EW spacing		*ft*	> 6	> 6	4.00
Max stanchion EW spacing		*ft*	4.00	4.00	4.00
Maximum module area / support point		*sf*	11.56	11.56	11.56
Factored lift per support point		*lb*	-102	-158	-226
Plywood Nailing Calculations					
Nail Size		*Gauge*	*Shank Dia*	*Length*	*W*
8D		10	0.134	2.5	54
10D		9	0.148	3	59
Load Duration Factor - Wind		1.6			
AWC 11.3.1 W'=W*Cd*Cm*Ct*Ceg*LD					
8D withdrawl force @ 2" penetration (lb)		138			
10D withdrawl force @ 2.5" penetration (lb)		189			
			1	*2*	*3*
# 8D's Req'd / stanchion in Landscape		*ea*	0.44	0.68	0.97
# 10D's Req'd / stanchion in Landscape		*ea*	0.32	0.50	0.71
# 8D's Req'd / stanchion in Portrait		*ea*	0.74	1.14	1.64
# 10D's Req'd / stanchion in Portrait		*ea*	0.54	0.84	1.20

Stanchion support threaded fastener sizes are indicated in the Module Loading Summary table above. Lift forces were determined from GCp and other coefficients contained in the ASCE nomographs

Conclusions

We were asked to review the roof of Shawn Hawkins, located at 1549 N W Moore Rd, Lake City, FL, by Sunergy, to determine its suitability to support a PV solar system installation.

The referenced building's roof structure was field measured by Sunergy. The attached framing analyses reflect the results of those field measurements combined with the PV solar module locations shown on the PV solar roof layout design prepared by Sunergy. Loads are calculated to combine the existing building and environmental loads with the proposed new PV array loads.

The IronRidge XR100 Rail racking and S5 ProteaBracket stanchions were selected for this project by Sunergy. The racking and support stanchions shall be placed as shown on their plans, dated 03/01/2024, and shall be fastened to the roof framing using fastener sizes indicated in this report. Rack support spacing shall be no more than that shown above. Note that support points for alternating rows shall share the same rafter. Intermediate rows shall move the support points laterally to the next rafter.

Google Location Map

Framing Summary

Based upon the attached calculations and in accordance with the 2023 FBC Section R324.4 and the FBC's reference to 2021 IBC Section 1607.12.5.2, the existing roof's framing system is capable of supporting the additional loading for the proposed PV solar system along with the existing building and environmental loads. No supplemental roof framing structural supports are required. Minimum required anchorage fastening is described above.

Fastener notes: 1) Install fasteners with head and where required, washer, flush to material surface (no gap). Do not over-torque.

References and Codes:

1) *ASCE 7-22 Minimum Design Loads for Buildings and Other Structures*
2) *2021 IBC*
3) *2023 FBC*
4) *American Wood Council, NDS 2018,Table 12.2A, 12.3.3A.*
5) *American Wood Council, Wood Structural Design, 1992, Figure 6.*

Location: MP 1

Member: Rafter - Total Length 17.36 ft, Unsupported 14.75 ft

Geometric Data			
Θ	*deg.*	18.99	*Angle of roof plane from horizontal, in degrees*
ω	*deg.*	0.00	*Angle the solar panel makes with the roof surface*
L	*ft.*	49.00	*Length of roof plane, in feet (meters)*
W	*ft.*	17.42	*Plan view width of roof plane, in feet (meters)*
h	*ft.*	15.00	*Average height of roof above grade, in feet (meters)*

Roof Wind Zone Width			
	use, a =	3.00	*ft*

Wind Velocity Pressure, q_z evaluated at the height z						
q_z=	21.43	*psf*	*Vasd* q_z=	12.89	*psf*	Basic wind pressure
V=	119	mph				

Framing Data		
Wood type	US Spruce	
Wood source, moisture content	White 0.12%	
# Framing Members / Support		1
Rafter / Truss OC	*in*	24.00
Member Total Length	*ft*	17.36

2	# Rafters / Rack Support Width
4.00	Rack Support Spacing (ft)
48	Max. Rack Support Spacing (in)
3	Max # of mod's / Rafter

Member Properties		**Member**
Name		(1)1.5x5.5
Repetitive Member Factor (Cr)		1.15
Max Shear perp. to grain	*psi*	530
Max Shear parallel to grain	*psi*	1,100

** Mem properties based upon field measurements*

Rafter

24.00	Collar tie OC spacing, in.

Module Physical Data			
Weight	kg	lb	psf load
Module	19.60	43.21	2.17
4 Stanchions	1.27	2.8	0.14

Existing Dead Loads	*Units*	*Value*	*Description*
Framing Member	*psf*	0.79	
Roof Deck & Surface	*psf*	4.60	*0.50 in. Plywood w/ Metal*

Rack Support Spacing and Loading				
Across rafters	*ft*	4.0		
Along rafter slope	*ft*	5.8		
Area / support point	*sf*	11.6		
Uphill gap between modules	*in*	1.0	0.08	*ft*

Member Total Length	*ft*	17.36	
Maximum member free span	*ft*	14.75	Rafter below Collar tie
Rafter segment to calc	*ft*	14.75	Free span
Deflection Ratio		180	Use max delta 1/x for deflection

** Collar tie height @ 4.80' AFF max height. Adjust to match lowest adjoining roof's collar tie as needed*

Eave Overhang Length past Rafter Plate	1.00	*ft*
Uphill Distance from Eave to Lowest Support	1.92	*ft*

ASCE 7-22 Method for Calculating Uplift on PV Modules

Notation
Lp = Panel chord length.
p = uplift wind pressure
γa = Solar panel pressure equalization factor, defined in Fig. 29.4-8.
γE = Array edge factor as defined in Section 29.4.4.
θ = Angle of plane of roof from horizontal, in degrees.

29.4.4 Rooftop Solar Panels Parallel to the Roof Surface on Buildings of All Heights and Roof Slopes.
Θ >= 7 deg TRUE

Min.d1: Exposed **FALSE**
Max.d1: Exposed **TRUE** ***Use EXPOSED for uplift calculations***

1.5(Lp) =	5.16
γE =	1.5
γa =	0.68

$p = qh(GCp)\ (\gamma_E)\ (\gamma_a)$ (lb⁄ft2) (29.4-7)

Zones	1	2	3
GCp	-1.70	-2.31	-3.06
p, Windload (psf)	-22.40	-30.44	-40.32

Downward, Zones 1, 2 & 3
GCp 0.53

ASCE 7-22 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf)				
Zones	1	2	3	1, 2 & 3
2.2 SYMBOLS AND NOTATION	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of PV Module + Stanchion	2.32	2.32	2.32	2.32
S = snow load	4.20	4.20	4.20	4.20
W = wind load	-22.40	-30.44	-40.32	6.77

2.4 Combining Nominal Loads Using Allowable Stress Design (in psf)				
2.4.1 Basic Combinations. Loads listed herein shall be considered to act in the following combinations; whichever produces the most unfavorable effect in the building, foundation, or structural member being considered. Effects of one or more loads not acting shall be considered.				
Combination Formulae	*Upward*	*Upward*	*Upward*	*Downward*
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
6. D + 0.75L - 0.75(0.60W) + 0.75(Lr or S or R)	6.51	6.51	6.51	9.56
Module Support point load (lb)	75	75	75	111
Cr Factored Module Support point load (lb)	65	65	65	96

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.60D - 0.6W	-8.82	-13.64	-19.57	7.70
Module Support point load (lb)	-102	-158	-226	89

DOWNWARD

Presume loading directly over member.

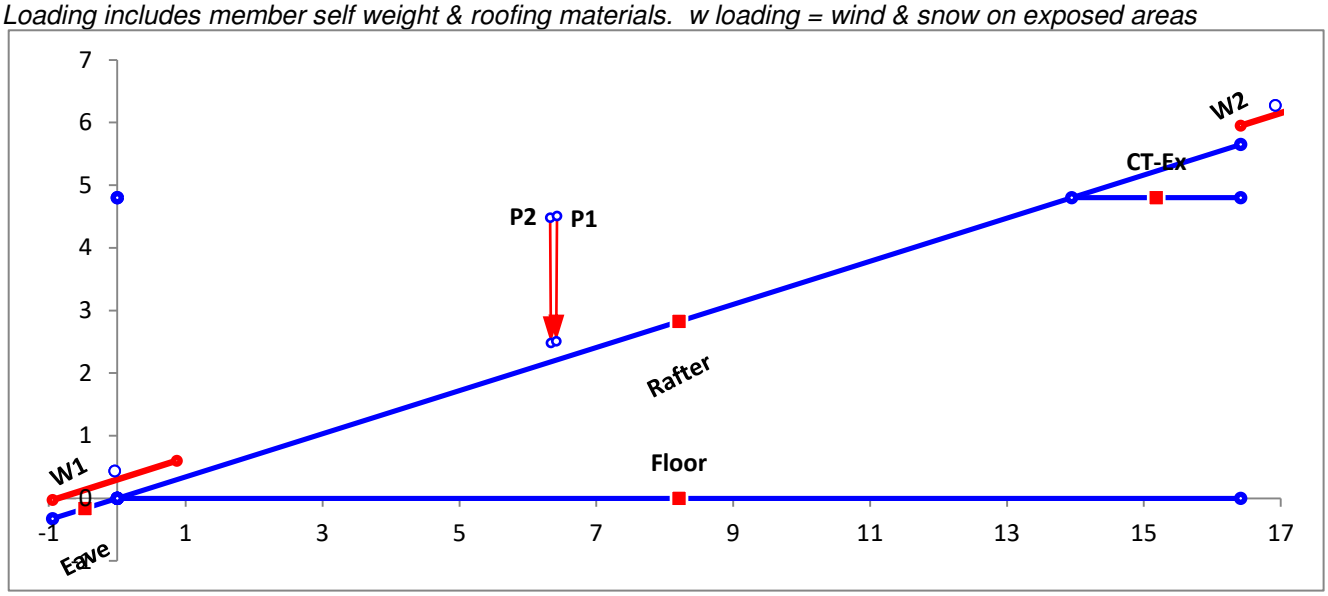
Combined Dead and Wind Pressure Downward Loading					
	Rafter below Collar tie				
PV Module Row	Point load loc's from Left support		Module Support Point Load	Comment	Module Orientation
	ft from left		*lb*		
1	0.92			Support placed on adjoining rafter	Portrait
1	6.70		96		Portrait
2	6.78		96		Portrait
2	12.56			Support placed on adjoining rafter	Portrait
3	12.65			Support placed on adjoining rafter	Portrait
3	18.43			Support outside of max stressed section	Portrait

Analysis for PV impacted areas

5. Simple Beam - Exposed Roof Snow Load - Above and Below PV				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta @ mid span	*in*	0.01	0.98	***OK***
M at mid span	*lb-ft*	4	4,117	***OK***

Sum Downward Loading Conditions: PV; Beam DL; Exposed Roof Environmental Load				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta	*in*	0.89	0.98	***OK***
Percent Max Delta	*%*	91%	100%	***OK***
Moment	*lb-ft*	799	4,117	***OK***
fs	*psi*	1,267	6,533	***OK***

** Loading includes member self weight & roofing materials. w loading = wind & snow on exposed areas*



Framing section with max stress: Rafter below Collar tie

Snow Loading Analysis

where:

		Fully Exposed	Exposure category	
Ce	=	0.9	Exposure Factor, Ce (ASCE 7-22 Table 7.3-1, Page 61)	
Ct	=	1.0	Thermal Factor, Ct (ASCE 7-22 Table 7.3-2, Page 61)	
Is	=	1.0	Snow Importance Factor, Is (ASCE 7-22 Table 1.5-2, Page 5)	
p_g	=	4.1966	Ground Snow Load pg (ASCE 7-22 Table 7.2-1, Page 56-60)	
p_f	=	**0.7CeCtIsPg**	Flat Roof Snow Load, pf (ASCE 7-22 Table 7.3-1, Page 61)	
p_f	=	**2.6439**	psf	
			but where Pf is not less than the following:	
			Minimum Snow Load pm (ASCE 7-22 Table 7.3.4, Page 62)	
p_m	=	**4.1966**	When Pg <=20 psf, then use Pf = Pg x Is	
p_f	=	**4.1966**	psf. Resultant Snow pressure to be used with Roof slope factor below	
p_s	=	$C_s p_f$	Sloped Roof Snow Load ps (ASCE 7-22 Table 7.4, Page 61)	
			Roof Type Warm Roofs	

Roof slope factor Cs for Warm Roofs, where Ct = 1.0

Roof surface condition = Slippery Roof

C_s	=	1.00	Roof Slope Factor, Cs (ASCE 7-22 Table 7.4-1a, Page 62)

Total Snow Load

p_s	=	**4.20**	**psf**	Roof snow load