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Instant Roof Framing Analysis

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STRUCTURAL ANALYSIS

for the

ROOFTOP PV SOLAR INSTALLATION

Project: William Kunzler, 340 Sw Callaway Dr, Lake City, FL 32024

Prepared for:

Sunergy

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

Calculation Report Index

Project Number: 66.400444.2, Rev. 0

Report Date: 11/09/2023

Report Prepared by:

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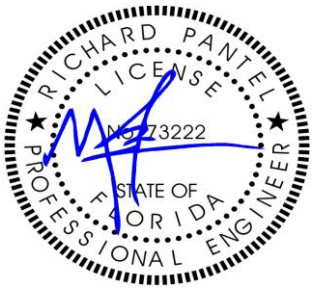

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Loading Summary

Exposure and Occupancy Categories		
B		*Exposure Category (ASCE 7-16 Table 26.7.3, Page 266)*
II		*Building Use Occupancy / Risk Category (ASCE 7-16 Table 1.5-1, Page 4)*

Wind Loading:			
v	118	*mph*	*ASCE 7-16, Figure 26.5-1 A, B or C, pp 249-251. [(118 mph, 50 year wind MRI)]*
qz	21.18	*psf*	*Velocity qz, calculated at height z [ASD]*

Snow Loading			
pg	0	*psf*	*Ground Snow Load pg (ASCE 7-16 Table 7.2-1, Page 52-53)*

Module Data			
Mission Solar Energy LLC: MSE385SX5R			
Dimensions	*mm*	*ft*	*in*
Length	1,905	6.25	75.00
Width	1,041	3.42	41.00
Area (m^2, ft^2)	2.0	21.35	
Weight	kg	lb	
Module	22.23	49.00	

Roof Panel (Cladding) Loading Summary		Module Loading Summary			
Support Point Loads		*Upward*	*Upward*	*Upward*	*Downward*
Roof Zones		1,2e,2r	2n,3r	3e	All
Net load per module	*lb*	-116	-145	-189	174

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		2	
Screw thread embedment depth	*in*	2	
Safety Factor		1.10	
Pull-out for M5 threaded fasteners	*lb/in*	103	
Factored max fastener uplift capacity	*lb*	376	
Fastener details *Material* Stainless	*Size*	M5	
Max stanchion uplift capacity	*lb*	400	
Max support point uplift capacity	*lb*	376	

Roof Zones		*1,2e,2r*	*2n,3r*	*3e*
Net lift per module	*lb*	116	145	189
Min tot screw thread embedment depth rq'd	*in*	0.62	0.77	1.00
Net uplift pressure 7. 0.60D - 0.6W	*psf*	-4.69	-6.12	-8.24
Allowable lift area / support point	*sf*	80.21	61.52	45.66
Max rail span per framing spacing	*ft*	4.00	4.00	4.00
Landscape Modules				
Length along rafter	*ft*	3.42		
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*	6.83	6.83	6.83
Factored lift per support point	*lb*	-32	-42	-56
Portrait Modules				
Length along rafter	*ft*	6.25		
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*	12.50	12.50	12.50
Factored lift per support point	*lb*	-59	-76	-103

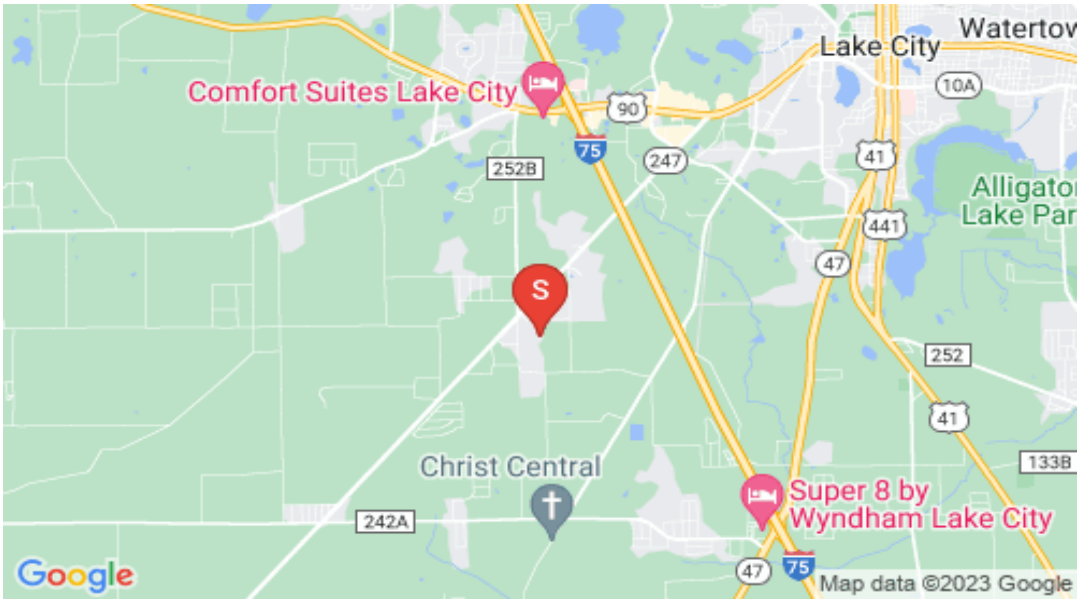
Stanchion support threaded fastener sizes are indicated in the Module Loading Summary table above. Lift forces were determined from GCp and other coefficients contained in the ASCE nomographs

Conclusions

Princeton Engineering was asked to review the roof of William Kunzler, located at 340 Sw Callaway Dr, 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.

Sunergy selected the Everest CrossRail 44-X racking with K2-Systems Splice Foot XL w/2 bolts stanchions for this project. The racking and support stanchions shall be placed as shown on their plans, dated 11/10/2023, 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 roof support member. Intermediate rows shall move the support points laterally to the next roof support member.



Google Location Map

Framing Summary

Based upon the attached calculations and in accordance with the FBC 2020 Section R324.4 and the FBC's reference to IRC 2018 Section 1607.12.5.2, the existing roofs' framing systems are 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.

Wood fastener notes: 1) Fastener threads must be embedded in the side grain of a roof support structural member or other structural member integrated into the building's structure. 2) Fastener must be located in the middle third of the structural member. 3) Install fasteners with head and where required, washer, flush to material surface (no gap). Do not over-torque.

References and Codes:

1) *ASCE 7-16 Minimum Design Loads for Buildings and Other Structures*
2) *IBC 2018*
3) *FBC 2020*
4) *2022 Florida Statues and 2023 Florida Administrative Codes*
5) *American Wood Council, NDS 2018,Table 12.2A, 12.3.3A.*
6) *American Wood Council, Wood Structural Design, 1992, Figure 6.*

Geometric Data			
Θ	*deg.*	34.00	*Angle of roof plane from horizontal, in degrees*
ω	*deg.*	0.00	*Angle the solar panel makes with the roof surface*
L	*ft.*	35.17	*Length of roof plane, in feet (meters)*
W	*ft.*	12.83	*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=	21.18	*psf*	*Vasd* q_z=	12.89	*psf*	Basic wind pressure
V=	118	mph				

Framing Data		
Rafter / Truss OC	*in*	24.00
Member Total Length	*ft*	15.48

48	Max. Rack Support Spacing (in)
8	# Modules / Roof Plane

Member Properties		**Member**
Name		(1)1.5x3.5

** Mem properties based upon field measurements*

Rafter

Module Physical Data			
Weight	kg	lb	psf load
Module	22.23	49.00	2.29
4 Stanchions	1.27	2.8	0.13

Existing Dead Loads	*Units*	*Value*	*Description*
Framing Members	*psf*	0.50	
Roof Deck & Surface	*psf*	4.40	*0.50 in. Plywood w/ Standard Asphalt Shingles*
Sum Existing DL Roof Loads	*psf*	4.90	
Proposed PV Dead Load			
PV Module + Stanchion	*psf*	2.43	

ASCE 7-16 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 **FALSE** ***Use NOT EXPOSED for uplift calculations***

1.5(Lp) =	9.38
γE =	1
γa =	0.67

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

Zones	1,2e,2r	2n,3r	3e
p, Windload (psf)	-12.67	-15.04	-18.58

Wind Loading	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
Zones	1,2e,2r	2n,3r	3e	All Zones
GCp	-1.47	-1.75	-2.16	0.77
Windload (psf)	-12.67	-15.04	-18.58	9.90

Roof Live Load (Lr)					
Ex. Roof Design Live Load per ASCE 7-16 Table 4-1	*psf*	20	20	20	20

ASCE 7-16 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf)				
2.2 SYMBOLS AND NOTATION	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of Sum Existing DL Roof Loads	4.90	4.90	4.90	4.90
Lr = roof live load	20.00	20.00	20.00	20.00
S = snow load Zeroed out to test for IBC 5% Dead Load Only	0.00	0.00	0.00	0.00
W = wind load	-12.67	-15.04	-18.58	9.90

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*

ASCE 7-16 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf)				
Zones	1,2e,2r	2n,3r	3e	All Zones
2.2 SYMBOLS AND NOTATION	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of Existing Dead Loads and Proposed PV Dead Load	7.33	7.33	7.33	7.33
Lr = roof live load	20.00	20.00	20.00	20.00
W = wind load	-12.67	-15.04	-18.58	9.90
Use this loading combination for DOWNWARD for Existing Dead Loads				
6. D + 0.75L - 0.75(0.60W) + 0.75(Lr or S or R)	24.90	24.90	24.90	29.36

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. D + 0.75L - 0.75(0.60W) + 0.75(Lr or S or R)	27.33	27.33	27.33	31.78
Module Support point load (lb)	187	187	187	217

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.60D - 0.6W	-4.69	-6.12	-8.24	5.84
Module Support point load (lb)	-32	-42	-56	40

Check % Roof Load Increase		
Total Roof Area	*sf*	399
Existing Downward Roof Load	*psf*	29.36
Existing Downward Roof Load	*lb*	11,702
Number of PV Modules	*ea*	8
Area of PV Modules	*sf*	171
Total weight of Existing Roof + PV	*lb*	12,117
% increase in total loading		3.5%
Check if % increase < 5%		**OK**

# Modules Proposed	*ea*	8	*Within Limits*
# Modules Allowed	*ea*	11	***OK***

In accordance with 'IBC 3404.3 Existing Structures Carrying Gravity Loads', the net increase in roof load after adding the PV modules, is less than 5%. Hence, no structural modifications for this structure are required.

Geometric Data			
Θ	*deg.*	34.00	*Angle of roof plane from horizontal, in degrees*
ω	*deg.*	0.00	*Angle the solar panel makes with the roof surface*
L	*ft.*	28.92	*Length of roof plane, in feet (meters)*
W	*ft.*	21.83	*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=	21.18	*psf*	*Vasd* q_z=	12.89	*psf*	Basic wind pressure
V=	118	mph				

Framing Data		
Rafter / Truss OC	*in*	24.00
Member Total Length	*ft*	26.34

48	Max. Rack Support Spacing (in)
4	# Modules / Roof Plane

Member Properties		**Member**
Name		(1)1.5x3.5

** Mem properties based upon field measurements*

Rafter

Module Physical Data			
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Existing Dead Loads	*Units*	*Value*	*Description*
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Sum Existing DL Roof Loads	*psf*	4.90	
Proposed PV Dead Load			
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γE =	1.5
γa =	0.67

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

Zones	1,2e,2r	2n,3r	3e
p, Windload (psf)	-19.00	-22.57	-27.88

Wind Loading	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
Zones	1,2e,2r	2n,3r	3e	All Zones
GCp	-1.47	-1.75	-2.16	0.77
Windload (psf)	-19.00	-22.57	-27.88	9.90

Roof Live Load (Lr)					
Ex. Roof Design Live Load per ASCE 7-16 Table 4-1	*psf*	20	20	20	20

ASCE 7-16 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf)				
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Lr = roof live load	20.00	20.00	20.00	20.00
S = snow load Zeroed out to test for IBC 5% Dead Load Only	0.00	0.00	0.00	0.00
W = wind load	-19.00	-22.57	-27.88	9.90

2.4 Combining Nominal Loads Using Allowable Stress Design (in psf)				
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Lr = roof live load	20.00	20.00	20.00	20.00
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Use this loading combination for DOWNWARD for Existing Dead Loads				
6. D + 0.75L - 0.75(0.60W) + 0.75(Lr or S or R)	24.90	24.90	24.90	29.36

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. D + 0.75L - 0.75(0.60W) + 0.75(Lr or S or R)	27.33	27.33	27.33	31.78
Module Support point load (lb)	187	187	187	217

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.60D - 0.6W	-8.49	-10.63	-13.81	5.84
Module Support point load (lb)	-58	-73	-94	40

Check % Roof Load Increase		
Total Roof Area	*sf*	225
Existing Downward Roof Load	*psf*	29.36
Existing Downward Roof Load	*lb*	6,608
Number of PV Modules	*ea*	4
Area of PV Modules	*sf*	85
Total weight of Existing Roof + PV	*lb*	6,815
% increase in total loading		3.1%
Check if % increase < 5%		**OK**

# Modules Proposed	*ea*	4	*Within Limits*
# Modules Allowed	*ea*	6	***OK***

In accordance with 'IBC 3404.3 Existing Structures Carrying Gravity Loads', the net increase in roof load after adding the PV modules, is less than 5%. Hence, no structural modifications for this structure are required.