

iRooFAtm
Instant Roof Framing Analysis
www.iroofa.solar
tel: 540.313.5317 - email: info@iRooFA.solar

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

Pages **Description**

1 Cover

Roof Structural Calculations for PV Solar Installation

5-7 Location: MP 1

Pages **Description**

2-4 Loading Summary

Roof Structural Calculations for PV Solar Installation

8-10 Location: MP 2

Project Number: 66.400444.2, Rev. 0

Report Date: 01/04/2024

Report Prepared by:

*This item has been digitally signed and sealed by
Richard Pantel, P.E. on the date adjacent to the seal.
Printed copies of this document are not considered
signed and sealed and the signature must be verified on
any electronic copies.*



**Richard
Pantel**

Digitally signed by Richard Pantel DN: c=US,
st=Virginia, l=Round Hill, o=TectoniCorp, P.C.,
cn=Richard Pantel email=rpantel@princeton-
engineering.com Date: 2024.01.04 16:49:43
+00:00

Richard Pantel, P.E.
FL License No. 73222
Sealed 01/04/2024

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	118	mph	ASCE 7-22, Figure 26.5-1 A, B or C [(118 mph, 50 year wind MRI)]
qz	21.30	psf	Velocity qz, calculated at height z [ASD]

Snow Loading			
pg	0	psf	Ground Snow Load pg (ASCE 7-22 Table 7.2-1, Page 56-60)

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	2	3	All
Net load per module	lb	-91	-116	-166	168

Positive values indicate net downward force

Stanchion Fastener Pull-out and Spacing Calculations				
Framing spacing	<i>ft</i>	2.00		
Rails / Module	<i>ea</i>	2		
Max proposed stanchion span	<i>ft</i>	4.00		
# fasteners per stanchion		2		
Screw thread embedment depth	<i>in</i>	2		
Safety Factor		1.10		
Pull-out for M5 threaded fasteners	<i>lb/in</i>	103		
Factored max fastener uplift capacity	<i>lb</i>	376		
Fastener details	<i>Material</i>	Stainless	<i>Size</i>	M5
Max stanchion uplift capacity	<i>lb</i>	400		
Max support point uplift capacity	<i>lb</i>	376		

Roof Zones			1	2	3
Net lift per module	<i>lb</i>		91	116	166
Min tot screw thread embedment depth rq'd	<i>in</i>		0.49	0.62	0.88
Net uplift pressure	7. 0.60D - 0.6W	<i>psf</i>	-3.48	-4.69	-7.11
Allowable lift area / support point		<i>sf</i>	108.11	80.21	52.91
Max rail span per framing spacing		<i>ft</i>	4.00	4.00	4.00
Landscape Modules					
Length along rafter	<i>ft</i>	3.42			
Lift calc'ed max stanchion EW spacing	<i>ft</i>	> 6	> 6	> 6	
Max stanchion EW spacing	<i>ft</i>	4.00	4.00	4.00	
Maximum module area / support point		<i>sf</i>	6.83	6.83	6.83
Factored lift per support point		<i>lb</i>	-24	-32	-49
Portrait Modules					
Length along rafter	<i>ft</i>	6.25			
Lift calc'ed max stanchion EW spacing	<i>ft</i>	> 6	> 6	> 6	
Max stanchion EW spacing	<i>ft</i>	4.00	4.00	4.00	
Maximum module area / support point		<i>sf</i>	12.50	12.50	12.50
Factored lift per support point		<i>lb</i>	-43	-59	-89

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 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.

The Everest CrossRail 44-X racking and K2-Systems Splice Foot XL w/2 bolts stanchions were selected for this project by Sunergy. 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 2023 Section R324.4 and the FBC's reference to IBC 2021 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 7-22 Minimum Design Loads for Buildings and Other Structures
- 2) IBC 2021
- 3) FBC 2023
- 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					
$q_z =$	21.30	psf	$V_{as} q_z =$	12.89	psf
V =	118				mph
					Basic wind pressure

Framing Data		
Rafter / Truss OC	in	24.00
Member Total Length	ft	14.27

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	

Notation

Lp = Panel chord length.

p = uplift wind pressure

 γ_a = Solar panel pressure equalization factor, defined in Fig. 29.4-8. γ_E = 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.** $\theta \geq 7$ deg

TRUE

Min.d1: Exposed **FALSE**Max.d1: Exposed **FALSE****Use NOT EXPOSED for uplift calculations** $1.5(L_p) = 9.38$ $\gamma_E = 1$ $\gamma_a = 0.67$ $p = qh(GC_p)(\gamma_E)(\gamma_a) \text{ (lb/ft}^2\text{)} \quad (29.4-7)$

Zones	1	2	3
p, Windload (psf)	-10.65	-12.67	-16.70

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2	3	1, 2 & 3
GCp	-1.24	-1.47	-1.94	0.57
Windload (psf)	-10.65	-12.67	-16.70	7.33

Roof Live Load (Lr)				
Ex. Roof Design Live Load per ASCE 7-22 Table 4-1	psf	20	20	20

ASCE 7-22 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	-10.65	-12.67	-16.70	7.33

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 7-22 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 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	-10.65	-12.67	-16.70	7.33
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	28.20

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(L_r \text{ or } S \text{ or } R)$	27.33	27.33	27.33	30.62
Module Support point load (lb)	187	187	187	209

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-3.48	-4.69	-7.11	5.84
Module Support point load (lb)	-24	-32	-49	40

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	367
Existing Downward Roof Load	<i>psf</i>	28.20
Existing Downward Roof Load	<i>lb</i>	10,361
Number of PV Modules	<i>ea</i>	8
Area of PV Modules	<i>sf</i>	171
Total weight of Existing Roof + PV	<i>lb</i>	10,775
% increase in total loading		4.0%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	8	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	10	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					
$q_z =$	21.30	psf	$V_{asd} q_z =$	12.89	psf
V =	118				mph
					Basic wind pressure

Framing Data		
Rafter / Truss OC	in	24.00
Member Total Length	ft	25.13

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			
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	

Notation

Lp = Panel chord length.

p = uplift wind pressure

 γ_a = Solar panel pressure equalization factor, defined in Fig. 29.4-8. γ_E = 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.** $\theta \geq 7$ deg

TRUE

Min.d1: Exposed **FALSE**Max.d1: Exposed **TRUE***Use EXPOSED for uplift calculations* $1.5(L_p) = 9.38$ $\gamma_E = 1.5$ $\gamma_a = 0.67$ $p = qh(GC_p)(\gamma_E)(\gamma_a) \text{ (lb/ft}^2\text{)} \quad (29.4-7)$

Zones	1	2	3
p, Windload (psf)	-15.98	-19.00	-25.05

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2	3	1, 2 & 3
GCp	-1.24	-1.47	-1.94	0.57
Windload (psf)	-15.98	-19.00	-25.05	7.33

Roof Live Load (Lr)				
Ex. Roof Design Live Load per ASCE 7-22 Table 4-1	psf	20	20	20

ASCE 7-22 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	-15.98	-19.00	-25.05	7.33

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 7-22 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 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	-15.98	-19.00	-25.05	7.33
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	28.20

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(L_r \text{ or } S \text{ or } R)$	27.33	27.33	27.33	30.62
Module Support point load (lb)	187	187	187	209

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-6.68	-8.49	-12.12	5.84
Module Support point load (lb)	-46	-58	-83	40

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	215
Existing Downward Roof Load	<i>psf</i>	28.20
Existing Downward Roof Load	<i>lb</i>	6,055
Number of PV Modules	<i>ea</i>	4
Area of PV Modules	<i>sf</i>	85
Total weight of Existing Roof + PV	<i>lb</i>	6,262
% increase in total loading		3.4%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	4	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	5	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.	
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--