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Instant Roof Framing Analysis

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STRUCTURAL ANALYSIS

for the

ROOFTOP PV SOLAR INSTALLATION

Project: Jerome Love; Location: 833 Northwest Wilson Street, Lake City, FL 32055

Prepared for:

Sunergy

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

Calculation Report Index

Project Number: 66.1010.1, Rev. 0

Report Date: 07/13/2023

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

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Ver. 20230713

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	21.10	*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			
HYUNDAI ENERGY SOLUTIONS CO.: HiS-S400YH(BK)			
Dimensions	*mm*	*ft*	*in*
Length	1,924	6.31	75.75
Width	1,038	3.41	40.87
Area (m^2, ft^2)	2.0	21.50	
Weight	kg	lb	
Module	21.10	46.52	

Roof Panel (Cladding) Loading Summary		Module Loading Summary			
Support Point Loads		*Upward*	*Upward*	*Upward*	*Downward*
Roof Zone		1,2e,2r	2n,3r	3e	All
Net total load / support point	*lb*	-98	-140	-174	167

Positive values indicate net downward force

Lag Bolt Data	Size	5/16x2.20	Pre-drill	0.16" dia	Material	Stainless

Rack Support Lag Bolt Pull-out Calculations in US Spruce Roof Framing				
Roof Zone		1,2e,2r	2n,3r	3e
Bolt Pullout Per Module Connection	*lb*	98	140	174
Number of Pullout Loads / Support		2	2	2
Safety Factor		1.50	1.50	1.50
Pull-out for 5/16 dia bolts	*lb/in*	206	206	206
Min threaded inches embedment required	*in*	0.36	0.51	0.63
Min threaded Inches embedment provided	*in*	1.20	1.20	1.20
Min Lag Bolt length to use	*in*	2.20	2.20	2.20

Stanchion support Lag Bolts 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 Jerome Love, located at 833 Northwest Wilson Street, 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 K2-Systems CrossRail 44-X racking system with K2-Systems Splice Foot XL stanchions for this project. The racking and support stanchions shall be placed as shown on their plans, dated 07/13/2023, and shall be fastened to the roof framing using lag bolt sizes indicated in this report. Rack support spacing shall be no more than that shown on each framing condition calculation. 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, 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 bolting is described below.

Bracket to Roof Framing Lag Bolts

US Spruce framing material has a bolt pullout strength of 207 lb / inch of thread using the 5/16" dia. fasteners. In order to maintain at least a 1.5X Safety Factor for pullout, 1.2 inches of THREAD embedment are required. Use a 2.20" x 5/16" stainless lag bolt, or longer, in order to achieve the above specified embedment into each joist at each rail support point. Predrill with a 0.16" dia pilot hole.

Notes: (1) Bolt 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) Lag bolts must be located in the middle third of the structural member. (3) Install lag bolts with head and washer flush to 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) *American Wood Council, NDS 2005,Table 11.2A, 11.3.2A.*
5) *American Wood Council, Wood Structural Design, 1992, Figure 6.*

Roof Data			
Θ	*deg.*	16.00	*Angle of plane of roof from horizontal, in degrees*
L	*ft.*	48.96	*Length of Building, in feet (meters).*
W	*ft.*	14.40	*Width of Building, in feet (meters).*
h	*ft.*	15.00	*Height of Building, in feet (meters).*

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

Wind Velocity Pressure, q_z evaluated at the height z						
q_z=	21.10	*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*	14.98

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

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

** Mem properties based upon field measurements*

Rafter

Module Data			
HYUNDAI ENERGY SOLUTIONS CO.: HiS-S400YH(BK)			
Weight	kg	lb	psf load
Module	21.10	46.52	2.16
4 Stanchions	1.27	2.8	0.13
Total Module and Support load	22.37	49.3	2.29

Existing Dead Loads	*Units*	*Value*	*Description*
Framing Members	*psf*	0.44	
Roof Deck & Surface	*psf*	4.40	*0.50 in. Plywood w/ Standard Asphalt Shingles*
Sum Existing DL Roof Loads	*psf*	4.84	
Proposed PV Dead Load			
PV Module + Stanchion	*psf*	2.29	

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

	Exposed	**FALSE**
	1.5(Lp) =	9.47
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)	-16.62	-21.72	-25.83

Wind Loading	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
Zones	1,2e,2r	2n,3r	3e	All Zones
GCp	-1.93	-2.53	-3.00	0.57
Windload (psf)	-16.62	-21.72	-25.83	7.32

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	4.84	4.84	4.84	4.84
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	-16.62	-21.72	-25.83	7.32

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	7.14	7.14	7.14	7.14
Lr = roof live load	20.00	20.00	20.00	20.00
W = wind load	-16.62	-21.72	-25.83	7.32
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)	24.84	24.84	24.84	28.14

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)	27.14	27.14	27.14	30.43
Module Support point load (lb)	185	185	185	207

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.6D + 0.6W	-7.22	-10.28	-12.74	5.61
Module Support point load (lb)	-49	-70	-87	38

Check % Roof Load Increase		
Total Roof Area	*sf*	520
Existing Downward Roof Load	*psf*	12.64
Existing Downward Roof Load	*lb*	14,634
Number of PV Modules	*ea*	12
Area of PV Modules	*sf*	258
Total weight of Existing Roof + PV	*lb*	15,225
% increase in total loading		4.0%
Check if % increase < 5%		**OK**

Maximum allowable number of PV modules	*ea*	14	# PV modules proposed is allowed.
Number of modules that can be added	*ea*	*2*	

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.

Roof Data			
Θ	*deg.*	16.00	*Angle of plane of roof from horizontal, in degrees*
L	*ft.*	21.28	*Length of Building, in feet (meters).*
W	*ft.*	14.24	*Width of Building, in feet (meters).*
h	*ft.*	15.00	*Height of Building, in feet (meters).*

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

Wind Velocity Pressure, q_z evaluated at the height z						
q_z=	21.10	*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*	14.98

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

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

** Mem properties based upon field measurements*

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Proposed PV Dead Load			
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Wind Loading	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
Zones	1,2e,2r	2n,3r	3e	All Zones
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7. 0.6D + 0.6W	-7.22	-10.28	-12.74	5.61
Module Support point load (lb)	-49	-70	-87	38

Check % Roof Load Increase		
Total Roof Area	*sf*	284
Existing Downward Roof Load	*psf*	12.64
Existing Downward Roof Load	*lb*	8,000
Number of PV Modules	*ea*	3
Area of PV Modules	*sf*	64
Total weight of Existing Roof + PV	*lb*	8,148
% increase in total loading		1.8%
Check if % increase < 5%		**OK**

Maximum allowable number of PV modules	*ea*	8	# PV modules proposed is allowed.
Number of modules that can be added	*ea*	*5*	

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.