

iRoofA®

Instant Roof Framing Analysis

www.iroofa.solar

tel: 540.313.5317 - email: info@iRoofA.solar

STRUCTURAL ANALYSIS

for the

ROOFTOP PV SOLAR INSTALLATION

Project: Deleon Kelly, 269 S W Thomas Rd, Lake City, FL 32024

Prepared for:



Lunex Power

4721 N Grady Ave - Tampa, FL 33614

Calculation Report Index

<u>Pages</u>	<u>Description</u>	<u>Pages</u>	<u>Description</u>
1	Cover	2-5	Loading Summary
<i>Roof Structural Calculations for PV Solar Installation</i>		<i>Roof Structural Calculations for PV Solar Installation</i>	
6-8	Location: MP 1	9-11	Location: MP 2
12-14	Location: MP 3	15-17	Location: MP 4
18-20	Location: MP 5		

Project No: 66.432767, Rev. 0

Report Date: 03/25/2026

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, P.E.
FL License No. 73222
Sealed 03/25/2026

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	165	mph	Value overridden from ASCE Hazards default
qz	41.47	psf	Velocity qz, calculated at height z

Snow Loading			
pg	4.01	psf	Ground Snow Load pg (Value overridden from ASCE Hazards default)
<i>Total Snow Load</i>			
ps	4.01	psf	Effective snow load on roof and modules

Module Data			
Q Cells: Q.TRON BLK M-G2.C+ 430W			
Dimensions	mm	ft	in
Length	1,722	5.65	67.80
Width	1,134	3.72	44.65
Area (m ² , ft ²)	2.0	21.02	
Weight	kg	lb	psf load
Module	21.20	46.74	2.22

Roof Panel (Cladding) Loading Summary		Module Loading Summary			
Support Point Loads		Upward	Upward	Upward	Downward
Roof Zones		1	2e,2r	3	All
Net load per module	lb	-62	-71	-89	104

Positive values indicate net downward force

Primary Stanchion: Unirac NXT Horizon Stronghold Attachment

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				1
Bolt thread embedment depth	in			2.50
Safety Factor				1.10
Pull-out for 5/16 threaded fasteners	lb/in			220
Factored max fastener uplift capacity	lb			499
Fastener details	Material	Stainless	Size	5/16
Max stanchion uplift capacity	lb			1089
Max support point uplift capacity	lb			499

lb per inch of embedment

Predrill hole 0.16" dia or use self tapping

Roof Zones			1	2e,2r	3
Net lift per module	lb		62	71	89
Min tot bolt thread embedment depth req'd	in		0.31	0.35	0.44
Net uplift pressure	7. 0.60D - 0.6W	psf	-16.76	-19.00	-23.86
Allowable lift area / support point		sf	29.77	26.27	20.92
Max rail span per support spacing		ft	4.00	4.00	4.00

Landscape Modules				
Length along rafter	ft			3.72
Lift calc'ed max stanchion EW spacing	ft			> 6
Max stanchion EW spacing	ft			4.00
Maximum module area / support point	sf			7.44
Factored lift per support point	lb			-125

Portrait Modules

Length along rafter	<i>ft</i>	5.65		
Lift calc'ed max stanchion EW spacing	<i>ft</i>	> 6	> 6	6.00
Max stanchion EW spacing	<i>ft</i>	4.00	4.00	4.00
Maximum module area / support point	<i>sf</i>	11.30	11.30	11.30
Factored lift per support point	<i>lb</i>	-189	-215	-270

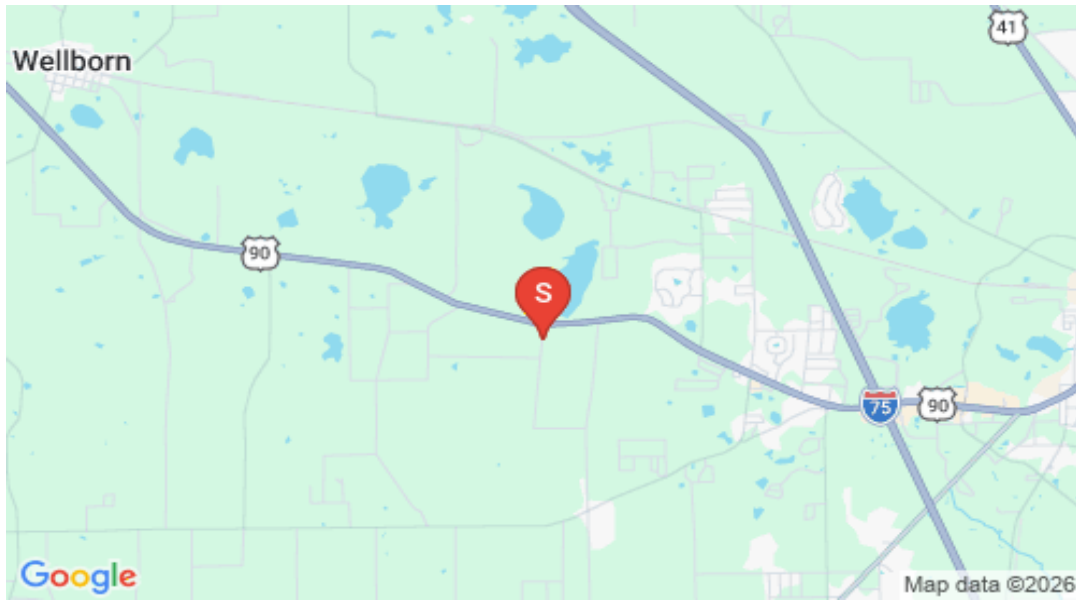
Stanchion support threaded fastener sizes are indicated in the Module Loading Summary table above. Lift forces were determined from GCp and other coefficients contained in the ASCE nomographs

Conclusions

We were asked to review the roof of Deleon Kelly, located at 269 S W Thomas Rd, Lake City, FL, by Lunex Power, to determine its suitability to support a PV solar system installation.

Building design plans were used in the preparation of the roof structural calculations combined with the PV solar module locations shown on the PV solar roof layout design prepared by Lunex Power. Loads are calculated to combine the existing building and environmental loads with the proposed new PV array loads.

The Unirac NXT Umount Rail racking and Unirac NXT Horizon Stronghold Attachment stanchions were selected for this project by Lunex Power. The racking and support stanchions shall be placed as shown on their plans, dated 03/13/2026, 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

	<u>Ex. Framing</u>	<u>Total Ex DL</u>
MP 1: 1.50" x 3.50" member @ 24" OC	0.50 psf	5.65 psf
MP 2: 1.50" x 3.50" member @ 24" OC	0.50 psf	5.65 psf
MP 3: 1.50" x 3.50" member @ 24" OC	0.50 psf	5.65 psf
MP 4: 1.50" x 3.50" member @ 24" OC	0.50 psf	5.65 psf
MP 5: 1.50" x 3.50" member @ 24" OC	0.50 psf	5.65 psf

* Wood species used in these calculations assumes spruce, pine or fir, #2 grade.

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 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. No further structural alterations or modifications are needed to support the system..

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) 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.

Geometric Data			
Θ	deg.	23.0	Angle of roof plane from horizontal, in degrees
ω	deg.	0.0	Angle the solar panel makes with the roof surface
L	ft.	66.17	Length of roof plane, in feet (meters)
W	ft.	21.00	Plan view width of roof plane, in feet (meters)
h	ft.	14.67	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					
$q_z =$	41.47	psf	$V_{asd} q_z =$	24.96 psf	Basic wind pressure
V=	165				mph

Framing Data		
# Framing Members / Support		1
Rafter / Truss OC	in	24.00
Member Total Length	ft	21.73

2.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
8	# Modules / Roof Plane

Member Properties	Member
Name	(1)1.5x3.5

* Mem properties based upon field measurements

Roof Support Member

Module Data			
Weight	kg	lb	psf load
Module	21.20	46.74	2.22
4 Stanchions	1.36	3.0	0.14

Existing Dead Loads	Units	Value	Description
Framing Members	psf	0.50	1.00 plf / 2.00 ft spacing
Roof Deck & Surface Material*	psf	5.15	0.50 in. Plywood w/ Shingles, Asphalt, Architectural (Typical)
Proposed PV Dead Load			
PV Module + Stanchion	psf	2.37	

ASCE 7-22 Method for Calculating Uplift on PV Modules

Notation

Lp = Panel chord length.

p = uplift wind pressure

ya = Solar panel pressure equalization factor, defined in Fig. 29.4-8.

yE = 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) =	8.47
yE =	1.5
ya =	0.67

p = qh(GCp) (yE) (ya) (lb/ft2) (29.4-7)

Zones	1	2e,2r	3
GCp	-1.21	-1.35	-1.68
p, Windload (psf)	-30.30	-34.03	-42.13

Downward, Zones All Zones
GCp 0.57

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2e,2r	3	All Zones
GCp	-1.21	-1.35	-1.68	0.57
Vasd Windload (psf)	-30.30	-34.03	-42.13	14.25

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	5.65	5.65	5.65	5.65
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 = Vasd Windload	-30.30	-34.03	-42.13	14.25

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	2e,2r	3	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	8.02	8.02	8.02	8.02
Lr = roof live load	20.00	20.00	20.00	20.00
W = Vasd Windload	-30.30	-34.03	-42.13	14.25
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)	25.65	25.65	25.65	32.06

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(L_r \text{ or } S \text{ or } R)$	28.02	28.02	28.02	34.43
Module Support point load (lb)	104	104	104	128

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-16.76	-19.00	-23.86	4.63
Module Support point load (lb)	-62	-71	-89	17

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	958
Existing Downward Roof Load	<i>psf</i>	32.06
Existing Downward Roof Load	<i>lb</i>	30,715
Number of PV Modules	<i>ea</i>	8
Area of PV Modules	<i>sf</i>	168
Total weight of Existing Roof + PV	<i>lb</i>	31,113
% increase in total loading		1.3%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	8	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	30	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.	23.0	Angle of roof plane from horizontal, in degrees
ω	deg.	0.0	Angle the solar panel makes with the roof surface
L	ft.	40.75	Length of roof plane, in feet (meters)
W	ft.	21.00	Plan view width of roof plane, in feet (meters)
h	ft.	14.67	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					
$q_z =$	41.47	psf	$V_{asd} q_z =$	24.96 psf	Basic wind pressure
V =	165				mph

Framing Data		
# Framing Members / Support		1
Rafter / Truss OC	in	24.00
Member Total Length	ft	21.73

2.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
8	# Modules / Roof Plane

Member Properties	Member
Name	(1)1.5x3.5

* Mem properties based upon field measurements

Roof Support Member

Module Data			
Weight	kg	lb	psf load
Module	21.20	46.74	2.22
4 Stanchions	1.36	3.0	0.14

Existing Dead Loads	Units	Value	Description
Framing Members	psf	0.50	1.00 plf / 2.00 ft spacing
Roof Deck & Surface Material*	psf	5.15	0.50 in. Plywood w/ Shingles, Asphalt, Architectural (Typical)
Proposed PV Dead Load			
PV Module + Stanchion	psf	2.37	

ASCE 7-22 Method for Calculating Uplift on PV Modules

Notation

Lp = Panel chord length.

p = uplift wind pressure

ya = Solar panel pressure equalization factor, defined in Fig. 29.4-8.

yE = 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) =	8.47
yE =	1.5
ya =	0.67

p = qh(GCp) (yE) (ya) (lb/ft2) (29.4-7)

Zones	1	2e,2r	3
GCp	-1.21	-1.35	-1.68
p, Windload (psf)	-30.30	-34.03	-42.13

Downward, Zones All Zones
GCp 0.57

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2e,2r	3	All Zones
GCp	-1.21	-1.35	-1.68	0.57
Vasd Windload (psf)	-30.30	-34.03	-42.13	14.25

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	5.65	5.65	5.65	5.65
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 = Vasd Windload	-30.30	-34.03	-42.13	14.25

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	2e,2r	3	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	8.02	8.02	8.02	8.02
Lr = roof live load	20.00	20.00	20.00	20.00
W = Vasd Windload	-30.30	-34.03	-42.13	14.25
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)	25.65	25.65	25.65	32.06

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(L_r \text{ or } S \text{ or } R)$	28.02	28.02	28.02	34.43
Module Support point load (lb)	104	104	104	128

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-16.76	-19.00	-23.86	4.63
Module Support point load (lb)	-62	-71	-89	17

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	445
Existing Downward Roof Load	<i>psf</i>	32.06
Existing Downward Roof Load	<i>lb</i>	14,283
Number of PV Modules	<i>ea</i>	8
Area of PV Modules	<i>sf</i>	168
Total weight of Existing Roof + PV	<i>lb</i>	14,681
% increase in total loading		2.8%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	8	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	14	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.	23.0	Angle of roof plane from horizontal, in degrees
ω	deg.	0.0	Angle the solar panel makes with the roof surface
L	ft.	40.25	Length of roof plane, in feet (meters)
W	ft.	21.00	Plan view width of roof plane, in feet (meters)
h	ft.	14.67	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				
$q_z =$	41.47	psf	$V_{asd} q_z =$	24.96 psf
V =	165		mph	
Basic wind pressure				

Framing Data		
# Framing Members / Support		1
Rafter / Truss OC	in	24.00
Member Total Length	ft	21.73

2.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
11	# Modules / Roof Plane

Member Properties	Member
Name	(1)1.5x3.5

* Mem properties based upon field measurements

Roof Support Member

Module Data			
Weight	kg	lb	psf load
Module	21.20	46.74	2.22
4 Stanchions	1.36	3.0	0.14

Existing Dead Loads	Units	Value	Description
Framing Members	psf	0.50	1.00 plf / 2.00 ft spacing
Roof Deck & Surface Material*	psf	5.15	0.50 in. Plywood w/ Shingles, Asphalt, Architectural (Typical)
Proposed PV Dead Load			
PV Module + Stanchion	psf	2.37	

ASCE 7-22 Method for Calculating Uplift on PV Modules

Notation

Lp = Panel chord length.

p = uplift wind pressure

ya = Solar panel pressure equalization factor, defined in Fig. 29.4-8.

yE = 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) =	8.47
yE =	1.5
ya =	0.67

p = qh(GCp) (yE) (ya) (lb/ft2) (29.4-7)

Zones	1	2e,2r	3
GCp	-1.21	-1.35	-1.68
p, Windload (psf)	-30.30	-34.03	-42.13

Downward, Zones All Zones
GCp 0.57

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2e,2r	3	All Zones
GCp	-1.21	-1.35	-1.68	0.57
Vasd Windload (psf)	-30.30	-34.03	-42.13	14.25

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	5.65	5.65	5.65	5.65
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 = Vasd Windload	-30.30	-34.03	-42.13	14.25

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	2e,2r	3	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	8.02	8.02	8.02	8.02
Lr = roof live load	20.00	20.00	20.00	20.00
W = Vasd Windload	-30.30	-34.03	-42.13	14.25
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)	25.65	25.65	25.65	32.06

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(Lr \text{ or } S \text{ or } R)$	28.02	28.02	28.02	34.43
Module Support point load (lb)	104	104	104	128

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-16.76	-19.00	-23.86	4.63
Module Support point load (lb)	-62	-71	-89	17

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	538
Existing Downward Roof Load	<i>psf</i>	32.06
Existing Downward Roof Load	<i>lb</i>	17,244
Number of PV Modules	<i>ea</i>	11
Area of PV Modules	<i>sf</i>	231
Total weight of Existing Roof + PV	<i>lb</i>	17,791
% increase in total loading		3.2%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	11	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	17	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.	23.0	Angle of roof plane from horizontal, in degrees
ω	deg.	0.0	Angle the solar panel makes with the roof surface
L	ft.	18.25	Length of roof plane, in feet (meters)
W	ft.	15.00	Plan view width of roof plane, in feet (meters)
h	ft.	13.40	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 =	41.47	psf	$V_{asd} q_z$ =	24.96 psf
V=	165		mph	
Basic wind pressure				

Framing Data		
# Framing Members / Support		1
Rafter / Truss OC	in	24.00
Member Total Length	ft	15.21

2.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
3	# Modules / Roof Plane

Member Properties	Member
Name	(1)1.5x3.5

* Mem properties based upon field measurements

Roof Support Member

Module Data			
Weight	kg	lb	psf load
Module	21.20	46.74	2.22
4 Stanchions	1.36	3.0	0.14

Existing Dead Loads	Units	Value	Description
Framing Members	psf	0.50	1.00 plf / 2.00 ft spacing
Roof Deck & Surface Material*	psf	5.15	0.50 in. Plywood w/ Shingles, Asphalt, Architectural (Typical)
Proposed PV Dead Load			
PV Module + Stanchion	psf	2.37	

ASCE 7-22 Method for Calculating Uplift on PV Modules

Notation

Lp = Panel chord length.

p = uplift wind pressure

ya = Solar panel pressure equalization factor, defined in Fig. 29.4-8.

yE = 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) =	8.47
yE =	1
ya =	0.67

p = qh(GCp) (yE) (ya) (lb/ft2) (29.4-7)

Zones	1	2e,2r	3
GCp	-1.21	-1.35	-1.68
p, Windload (psf)	-20.20	-22.68	-28.09

Downward, Zones All Zones
GCp 0.57

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2e,2r	3	All Zones
GCp	-1.21	-1.35	-1.68	0.57
Vasd Windload (psf)	-20.20	-22.68	-28.09	14.25

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	5.65	5.65	5.65	5.65
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 = Vasd Windload	-20.20	-22.68	-28.09	14.25

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	2e,2r	3	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	8.02	8.02	8.02	8.02
Lr = roof live load	20.00	20.00	20.00	20.00
W = Vasd Windload	-20.20	-22.68	-28.09	14.25
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)	25.65	25.65	25.65	32.06

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(Lr \text{ or } S \text{ or } R)$	28.02	28.02	28.02	34.43
Module Support point load (lb)	104	104	104	128

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-10.70	-12.19	-15.43	4.63
Module Support point load (lb)	-40	-45	-57	17

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	194
Existing Downward Roof Load	<i>psf</i>	32.06
Existing Downward Roof Load	<i>lb</i>	6,218
Number of PV Modules	<i>ea</i>	3
Area of PV Modules	<i>sf</i>	63
Total weight of Existing Roof + PV	<i>lb</i>	6,367
% increase in total loading		2.4%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	3	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	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.

Geometric Data			
Θ	deg.	23.0	Angle of roof plane from horizontal, in degrees
ω	deg.	0.0	Angle the solar panel makes with the roof surface
L	ft.	27.58	Length of roof plane, in feet (meters)
W	ft.	15.00	Plan view width of roof plane, in feet (meters)
h	ft.	13.40	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					
$q_z =$	41.47	psf	$V_{asd} q_z =$	24.96 psf	Basic wind pressure
V =	165				mph

Framing Data		
# Framing Members / Support		1
Rafter / Truss OC	in	24.00
Member Total Length	ft	15.21

2.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
3	# Modules / Roof Plane

Member Properties	Member
Name	(1)1.5x3.5

* Mem properties based upon field measurements

Roof Support Member

Module Data			
Weight	kg	lb	psf load
Module	21.20	46.74	2.22
4 Stanchions	1.36	3.0	0.14

Existing Dead Loads	Units	Value	Description
Framing Members	psf	0.50	1.00 plf / 2.00 ft spacing
Roof Deck & Surface Material*	psf	5.15	0.50 in. Plywood w/ Shingles, Asphalt, Architectural (Typical)
Proposed PV Dead Load			
PV Module + Stanchion	psf	2.37	

ASCE 7-22 Method for Calculating Uplift on PV Modules

Notation

Lp = Panel chord length.

p = uplift wind pressure

ya = Solar panel pressure equalization factor, defined in Fig. 29.4-8.

yE = 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) =	8.47
yE =	1.5
ya =	0.67

p = qh(GCp) (yE) (ya) (lb/ft2) (29.4-7)

Zones	1	2e,2r	3
GCp	-1.21	-1.35	-1.68
p, Windload (psf)	-30.30	-34.03	-42.13

Downward, Zones All Zones
GCp 0.57

Wind Loading	Module Upward	Module Upward	Module Upward	Downward
Zones	1	2e,2r	3	All Zones
GCp	-1.21	-1.35	-1.68	0.57
Vasd Windload (psf)	-30.30	-34.03	-42.13	14.25

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	5.65	5.65	5.65	5.65
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 = Vasd Windload	-30.30	-34.03	-42.13	14.25

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	2e,2r	3	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	8.02	8.02	8.02	8.02
Lr = roof live load	20.00	20.00	20.00	20.00
W = Vasd Windload	-30.30	-34.03	-42.13	14.25
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)	25.65	25.65	25.65	32.06

Use this loading combination for DOWNWARD for Existing Dead Loads and Proposed PV Dead Load				
6. $D + 0.75L - 0.75(0.60W) + 0.75(Lr \text{ or } S \text{ or } R)$	28.02	28.02	28.02	34.43
Module Support point load (lb)	104	104	104	128

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. $0.60D - 0.6W$	-16.76	-19.00	-23.86	4.63
Module Support point load (lb)	-62	-71	-89	17

Check % Roof Load Increase		
Total Roof Area	<i>sf</i>	212
Existing Downward Roof Load	<i>psf</i>	32.06
Existing Downward Roof Load	<i>lb</i>	6,786
Number of PV Modules	<i>ea</i>	3
Area of PV Modules	<i>sf</i>	63
Total weight of Existing Roof + PV	<i>lb</i>	6,935
% increase in total loading		2.2%
Check if % increase < 5%		OK

# Modules Proposed	<i>ea</i>	3	<i>Within Limits</i>
# Modules Allowed	<i>ea</i>	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.

Snow Loading Analysis

where:

	Fully Exposed	Exposure category
C_e =	0.9	Exposure Factor, C _e (ASCE 7-22 Table 7.3-1, Page 61)
C_t =	1.0	Thermal Factor, C _t (ASCE 7-22 Table 7.3-2, Page 61)
I_s =	1.0	Snow Importance Factor, I _s (ASCE 7-22 Table 1.5-2, Page 5)
p_g =	4.01	Ground Snow Load p _g (Value overridden from ASCE Hazards default)

p_f = **0.7C_eC_tI_sP_g** Flat Roof Snow Load, p_f (ASCE 7-22 Table 7.3-1, Page 61)

p_f = **2.52** psf

but where P_f is not less than the following:

Minimum Snow Load p_m (ASCE 7-22 Table 7.3.4, Page 62)

p_m = **4.01** When P_g <=20 psf, then use P_f = P_g x I_s

p_f = **4.01** psf. Resultant Snow pressure to be used with Roof slope factor below

p_s = **C_sp_f** Sloped Roof Snow Load p_s (ASCE 7-22 Table 7.4, Page 61)

Roof Type Warm Roofs

Roof slope factor C_s for Warm Roofs, where C_t = 1.0

Roof surface condition = Slippery Roof

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

Total Snow Load

p_s = 4.01 psf	Roof snow load
--	----------------