

iRooFAtm
Instant Roof Framing Analysis
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STRUCTURAL ANALYSIS
for the
ROOFTOP PV SOLAR INSTALLATION

Project: Chong Ting, 66 Pecan Grv Ln, Fuquay Varina, NC 27526

Prepared for:

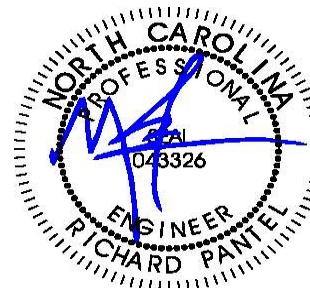
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Project No: 66.414408.86, Rev. 0

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Loading Summary

Exposure and Occupancy Categories		
B		Exposure Category (ASCE 7-10 Table 26.7.3, Page 274)
II		Building Use Occupancy / Risk Category (ASCE 7-10 Table 1.5-1, Page 5)

Wind Loading:			
v	117	mph	ASCE 7-10, Figure 26.5-1 A, B or C, pp 249-251. [(117 mph, 50 year wind MRI)]
qz	20.82	psf	Velocity qz, calculated at height z [ASD]

Snow Loading			
pg	15.00	psf	Ground Snow Load pg (ASCE 7-10 Table 7.2-1, Page 56-60)
<i>Total Snow Load</i>			
ps	15.00	psf	Effective snow load on roof and modules

Module Data			
Jinko Solar: JKM425N-54HL4-B			
Dimensions	<i>mm</i>	<i>ft</i>	<i>in</i>
<i>Length</i>	1,722	5.65	67.80
<i>Width</i>	1,134	3.72	44.65
<i>Area (m², ft²)</i>	2.0	21.02	
Weight	kg	lb	
<i>Module</i>	22.00	48.50	

Roof Panel (Cladding) Loading Summary		Module Loading Summary			
Support Point Loads		<i>Upward</i>	<i>Upward</i>	<i>Upward</i>	<i>Downward</i>
Roof Zones		1	2	3	All
Net load per module	<i>lb</i>	-35	-150	-298	171

Positive values indicate net downward force

Primary Stanchion: IronRidge HALO ULTRAGRIP - (QM-HUG-01-B1)

StanchionFastener 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
Bolt thread embedment depth	<i>in</i>	1.75
Safety Factor		1.10
Pull-out for #14 threaded fasteners	<i>lb/in</i>	134
Factored max fastener uplift capacity	<i>lb</i>	425
Fastener details	<i>Material</i> Stainless	<i>Size</i> #14
Max stanchion uplift capacity	<i>lb</i>	1100
Max support point uplift capacity	<i>lb</i>	425

lb per inch of embedment

Predrill hole 0.12" dia or use self tapping

Roof Zones		1	2	3	
Net lift per module	<i>lb</i>	35	150	298	
Min tot bolt thread embedment depth req'd	<i>in</i>	0.15	0.62	1.23	
Net uplift pressure	7. 0.6D - 0.6W	<i>psf</i>	-1.56	-6.64	-13.21
Allowable lift area / support point		<i>sf</i>	271.70	63.97	32.16
Max rail span per support spacing		<i>ft</i>	4.00	4.00	4.00
Landscape Modules					
Length along rafter	<i>ft</i>	3.72			
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>	7.44	7.44	7.44
Factored lift per support point		<i>lb</i>	-12	-49	-98
Portrait Modules					
Length along rafter	<i>ft</i>	5.65			
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>	11.30	11.30	11.30
Factored lift per support point		<i>lb</i>	-18	-75	-149

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 Chong Ting, located at 66 Pecan Grv Ln, Fuquay Varina, NC, by EMPWR Solar, to determine its suitability to support a PV solar system installation.

The referenced building's roof structure was field measured by EMPWR Solar. 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 EMPWR Solar. Loads are calculated to combine the existing building and environmental loads with the proposed new PV array loads.

The IronRidge XR10 Rail racking and IronRidge HALO ULTRAGRIP - (QM-HUG-01-B1) stanchions were selected for this project by EMPWR Solar. The racking and support stanchions shall be placed as shown on their plans, dated 02/25/2025, 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 truss. Intermediate rows shall move the support points laterally to the next truss.



Google Location Map

Framing Summary

	<u>Ex. Framing</u>	<u>Total Ex DL</u>
MP 1: Truss @ 24" OC	0.79 psf	5.94 psf
* Wood species used in these calculations assumes spruce, pine or fir, #2 grade.		

Based upon the attached calculations, 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. No further structural alterations or modifications are needed to support the system. 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 7-10 Minimum Design Loads for Buildings and Other Structures
- 2) 2015 IBC
- 3) 2018 NC Building Code
- 4) American Wood Council, NDS 2018, Table 12.2A, 12.3.3A.
- 5) American Wood Council, Wood Structural Design, 1992, Figure 6.

Roof Structural Calculations for PV Solar Installation

Array AR-1

Location: MP 1

Member: Truss - Total Length 24 ft, Unsupported 24 ft

Geometric Data			
Θ	deg.	25.0	Angle of roof plane from horizontal, in degrees
ω	deg.	0.0	Angle the solar panel makes with the roof surface
L	ft.	42.00	Length of roof plane, in feet (meters)
W	ft.	22.58	Plan view width of roof plane, in feet (meters)
h	ft.	24.46	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 =	20.82	psf	Vasd q_z = 12.61 psf Basic wind pressure
V=	117		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 24.00

2	# Rafters / Rack Support Width
4.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
3	Max # of mod's / Truss top chord

Member Properties	Member
Name	(1) 2x4
Repetitive Member Factor (Cr)	1.15

* Mem properties based upon field measurements

Truss top chord

Module Data			
Weight	kg	lb	psf load
Module	22.00	48.50	2.31
4 Stanchions	0.91	2.0	0.10

Existing Dead Loads	Units	Value	Description
Roof Deck & Surface Material*	psf	5.15	Truss members' self weight added to FEA analysis

* Roof surface: Shingles, Asphalt, Architectural (Typical)

Rack Support Spacing and Loading			
Across rafters	ft	4.0	
Along rafter slope	ft	5.6	
Area / support point	sf	11.3	
Uphill gap between modules	in	1.0	0.08 ft

Member Total Length	ft	24.00	
Maximum member free span	ft	24.00	Truss top chord span
Zones	1	2	3
GCp	-0.87	-1.54	-2.41

Downward, Zones 1, 2 & 3
GCp 0.44

ASCE 7-10 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf)

Zones	1	2	3	1, 2 & 3
2.2 SYMBOLS AND NOTATION	<i>Module Upward</i>	<i>Module Upward</i>	<i>Module Upward</i>	<i>Downward</i>
D = dead load of PV Module + Stanchion	2.40	2.40	2.40	2.40
S = snow load	15.00	15.00	15.00	15.00
W = wind load = (Vu Windload) = (Vasd Windload / 0.6)	-10.95	-19.41	-30.35	5.49

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.

<i>Combination Formulae</i>	<i>Upward</i>	<i>Upward</i>	<i>Upward</i>	<i>Downward</i>
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
3. D + S	17.40	17.40	17.40	17.40
Module Support point load (lb)	197	197	197	197
Cr Factored Module Support point load (lb)	171	171	171	171

Use this loading combination for UPWARD for Proposed PV Dead Load

7. 0.6D - 0.6W	-1.56	-6.64	-13.21	5.00
Module Support point load (lb)	-18	-75	-149	57

DOWNWARD

Presume loading directly over member.

Combined Dead and Wind Pressure Downward Loading

Truss top chord span					
PV Module Row	Point load loc's from Left support	Point Load #'s	Module Support Point Load	Comment	Module Orientation
	<i>ft from left</i>		<i>lb</i>		
1	0.84		171		Portrait
1	6.49			Support placed on adjoining truss	Portrait
2	6.57			Support placed on adjoining truss	Portrait
2	12.22		171		Portrait
3	12.31		171		Portrait
3	17.96			Support placed on adjoining truss	Portrait

Truss Data and Loading for MP 1

Roof slope (degrees)	25.00
Top ridge height above floor plane	10.14

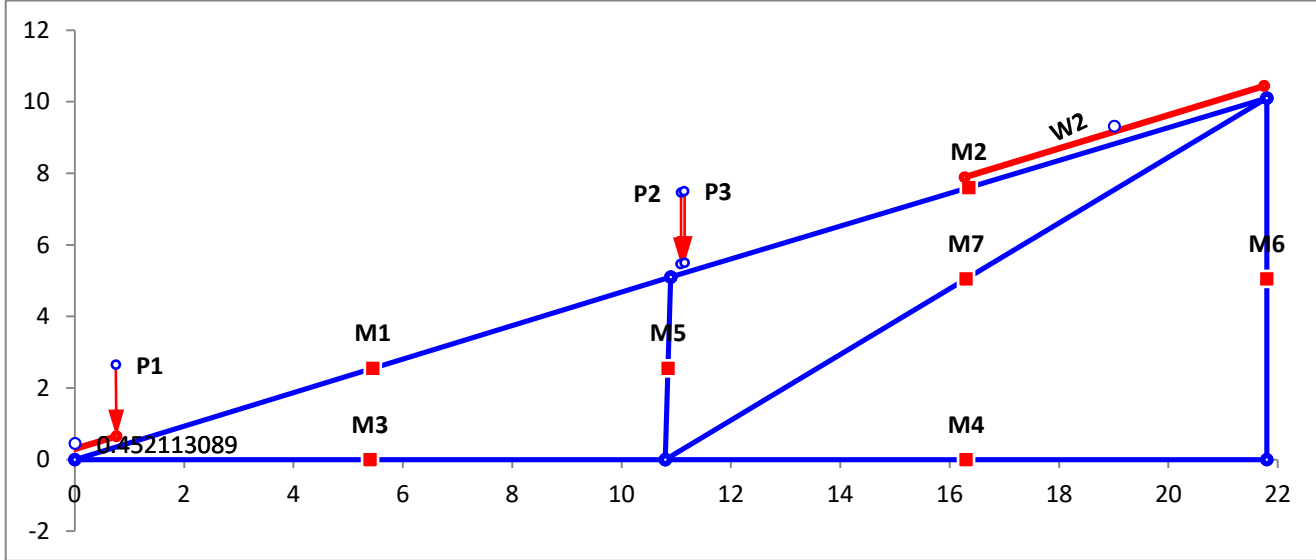
Length of roof plane	24.00
Length of floor plane	21.75

Truss Segments

Roof Plane		Floor Plane	
Mem #	Mem Type	Mem #	Mem Type
1	2x4	3	2x4
2	2x4	4	2x4

Diagonals		Diagonals	
Mem #	Mem Type	Mem #	Mem Type
5	2x4	7	2x4
6	2x4		

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



Snow Loading Analysis

where:

- | | Fully Exposed | Exposure category |
|------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| C_e = | 0.9 | Exposure Factor, C _e (ASCE 7-10 Table 7.3-1, Page 61) |
| C_t = | 1.0 | Thermal Factor, C _t (ASCE 7-10 Table 7.3-2, Page 61) |
| I_s = | 1.0 | Snow Importance Factor, I _s (ASCE 7-10 Table 1.5-2, Page 5) |
| p_g = | 15.00 | Ground Snow Load p _g (ASCE 7-10 Table 7.2-1, Page 56-60) |
| p_f = | 0.7C_eC_tI_sP_g | Flat Roof Snow Load, p _f (ASCE 7-10 Table 7.3-1, Page 61) |
| p_f = | 9.45 | psf |
| | | but where P _f is not less than the following: |
| | | Minimum Snow Load p _m (ASCE 7-10 Table 7.3.4, Page 62) |
| p_m = | 15.00 | When P _g <=20 psf, then use P _f = P _g x I _s |
| p_f = | 15.00 | psf. Resultant Snow pressure to be used with Roof slope factor below |
| p_s = | C_sp_f | Sloped Roof Snow Load p _s (ASCE 7-10 Table 7.4, Page 61) |
| | | Roof Type Warm Roofs |

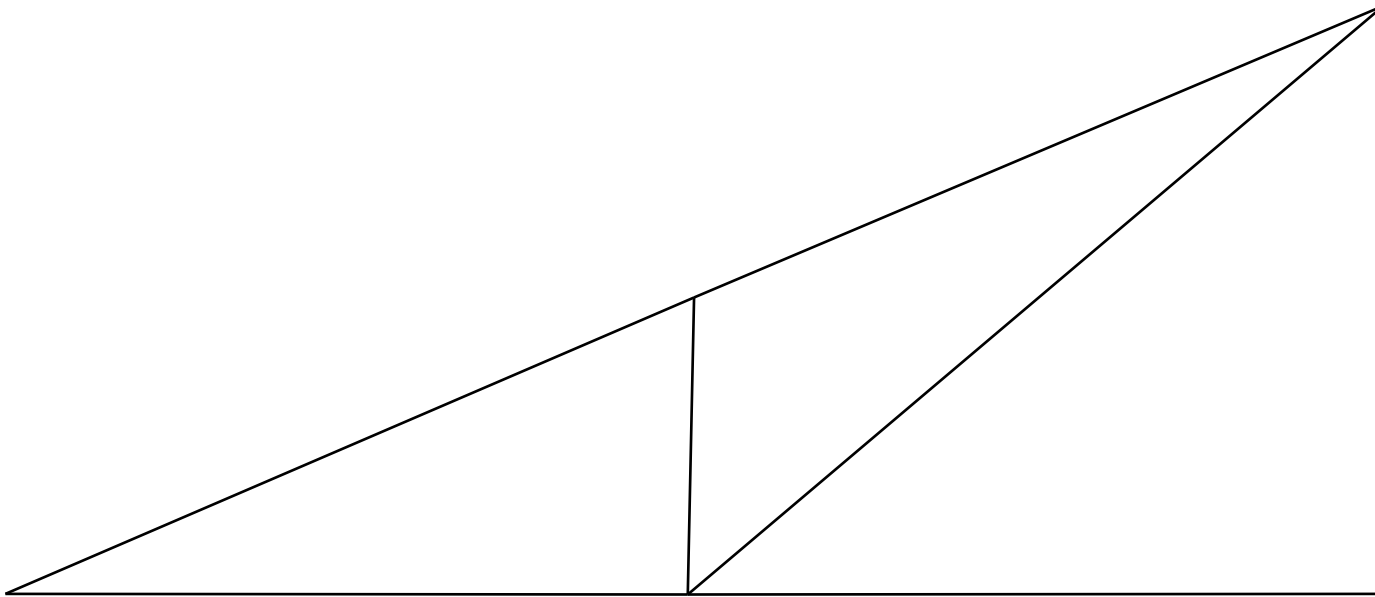
Roof slope factor C_s for Warm Roofs, where C_t = 1.0
Roof surface condition = Slippery Roof

- C_s** = 1.00 Roof Slope Factor, C_s (ASCE 7-10 Table 7.4-1a, Page 62)

Total Snow Load

p_s =	15.00 psf	Roof snow load
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* vertical deflections do not take into account any supporting intermediate walls



Scaled 2X Deflected Truss Plot
Roof Plane MP 1 for EMPWR Solar Client CHONG TING