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STRUCTURAL ANALYSIS
for the
ROOFTOP PV SOLAR INSTALLATION

Project: Curtis Collins, 728 Collins Road, Lillington, NC 27546

Prepared for:

FREEDOM
SOLAR POWER

Freedom Solar, LLC
4801 Freidrich Ln, Ste 100 - Austin, TX 78744

Project Number: 36.114123, Rev. 0   Report Date: 03/27/2024   Report Prepared by:
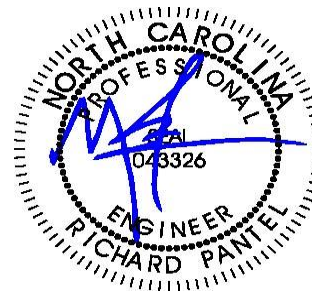
Richard Pantel, P.E.
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Sealed 03/27/2024

Richard Pantel

V240326
iR4QDZ

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	140	*mph*	*Over-ridden per client request. Original data from Municipality provided wind / snow loadings.*
qz	29.85	*psf*	*Velocity qz, calculated at height z [ASD]*

Snow Loading			
pg	15	*psf*	*Ground Snow Load pg (Over-ridden per client request. Original data from Municipality provided wind / snow loadings.)*
Total Snow Load			
ps	15.00	*psf*	*Effective snow load on roof and modules*

Module Data			
REC Solar: REC420AA Pure-R			
Dimensions	*mm*	*ft*	*in*
Length	1,730	5.68	68.11
Width	1,118	3.67	44.02
Area (m^2, ft^2)	1.9	20.82	
Weight	*kg*	*lb*	
Module	21.50	47.40	

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*	-71	-88	-88	205

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			1	
Bolt thread embedment depth		in	3	
Safety Factor			1.10	
Pull-out for 5/16 threaded fasteners		lb/in	220	
Factored max fastener uplift capacity		lb	599	
Fastener details	*Material* Stainless	*Size*	5/16	*Predrill hole 0.16" dia or use self tapping*
Max stanchion uplift capacity		lb	618	
Max support point uplift capacity		lb	599	

Roof Zones			*1*	*2*	*3*
Net lift per module	lb		71	88	88
Min tot bolt thread embedment depth rq'd	in		0.36	0.44	0.44
Net uplift pressure	7. 0.6D - 0.6W	psf	-6.26	-7.77	-7.77
Allowable lift area / support point	sf		95.72	77.03	77.03
Max rail span per framing spacing	ft		4.00	4.00	4.00
Landscape Modules					
Length along rafter	ft		3.67		
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		7.34	7.34	7.34
Factored lift per support point	lb		-46	-57	-57
Portrait Modules					
Length along rafter	ft		5.68		
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		11.35	11.35	11.35
Factored lift per support point	lb		-71	-88	-88

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 Curtis Collins, located at 728 Collins Road, Lillington, NC, by Freedom Solar, LLC, to determine its suitability to support a PV solar system installation.

The referenced building's roof structure was field measured by Freedom Solar, LLC on 03/22/2024. 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 Freedom Solar, LLC. Loads are calculated to combine the existing building and environmental loads with the proposed new PV array loads.

The Pegasus PSR-B Rail racking and Pegasus Solar InstaFlash PIF-RB0 stanchions were selected for this project by Freedom Solar, LLC. The racking and support stanchions shall be placed as shown on their plans, dated 03/26/2024, 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 rafter. Intermediate rows shall move the support points laterally to the next rafter. The support rail can be cantilevered up to 1/3 of the maximum span between modules. 1/3 maximum span = 16.00 inches.

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 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) *IBC 2015*
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.*

Geometric Data			
Ө	deg.	33.99	*Angle of roof plane from horizontal, in degrees*
ω	deg.	0.00	*Angle the solar panel makes with the roof surface*
L	ft.	26.50	*Length of roof plane, in feet (meters)*
W	ft.	18.50	*Plan view width of roof plane, in feet (meters)*
h	ft.	24.33	*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=	29.85	*psf*	Vasd q_z=	18.10	*psf*	Basic wind pressure
V=	140			mph	

Framing Data				
Wood type	US Spruce			
Wood source, moisture content	White 0.12%		2	# Rafters / Rack Support Width
# Framing Members / Support		1	4.00	Rack Support Spacing (ft)
Rafter / Truss OC	in	24.00	48	Max. Rack Support Spacing (in)
Member Total Length	ft	21.11	1	Max # of mod's / Rafter

Member Properties		Member	* Mem properties based upon field measurements
Name		(1)1.5x5.5	Rafter
Repetitive Member Factor (Cr)		1.15	
Max Shear perp. to grain	psi	530	
Max Shear parallel to grain	psi	1,100	24.00 Collar tie OC spacing, in.

Module Physical Data			
Weight	kg	lb	psf load
Module	21.50	47.40	2.28
4 Stanchions	1.36	3.0	0.14
Existing Dead Loads	*Units*	*Value*	*Description*
Framing Member	*psf*	0.79	
Roof Deck & Surface	*psf*	4.40	*0.50 in. Plywood w/ Standard Asphalt Shingles*

Rack Support Spacing and Loading			
Across rafters	ft	4.0	
Along rafter slope	ft	5.7	
Area / support point	sf	11.4	
Uphill gap between modules	in	1.0	0.08	ft

Member Total Length	ft	21.11		
Maximum member free span	ft	7.25	Rafter above Collar Tie.	** Collar Tie & Knee wall height @*
Rafter segment to calc	ft	7.25	Free span	*7.75' AFF max height. Adjust to*
Deflection Ratio		180	Use max delta 1/x for deflection	*match lowest adjoining roof's collar*

Eave Overhang Length past Rafter Plate	1.00	*ft*
Uphill Distance from Eave to Lowest Support	15.92	*ft*

Zones	1	2	3
GCp	-0.94	-1.14	-1.14

Downward, Zones 1, 2 & 3
GCp   0.87

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	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of PV Module + Stanchion	2.42	2.42	2.42	2.42
S = snow load	15.00	15.00	15.00	15.00
W = wind load	-16.94	-20.56	-20.56	15.71

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*
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
6. D + 0.75L - 0.75(0 or 0.7)eE + 0.75S	17.42	17.42	17.42	20.74
Module Support point load (lb)	198	198	198	235
Cr Factored Module Support point load (lb)	172	172	172	205

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.6D - 0.6W	-6.26	-7.77	-7.77	4.56
Module Support point load (lb)	-71	-88	-88	52

DOWNWARD

Presume loading directly over member.

		Rafter above Collar Tie.			
PV Module Row	Point load loc's from Left support		Module Support Point Load	Comment	Module Orientation
	ft from left		*lb*		
1	14.92		205		Portrait
1	20.60			Support placed on adjoining rafter	Portrait

Combined Dead and Wind Pressure Downward Loading

Analysis for PV impacted areas

5. Simple Beam - Exposed Roof Snow Load - Above and Below PV				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta @ mid span	*in*	0.02	0.48	**OK**
M at mid span	*lb-ft*	1,427	4,117	**OK**

Sum Downward Loading Conditions: PV; Beam DL; Exposed Roof Environmental Load				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta	*in*	0.07	0.48	**OK**
Percent Max Delta	*%*	14%	100%	**OK**
Moment	*lb-ft*	2,094	4,117	**OK**
fs	*psi*	3,323	6,533	**OK**

* Loading includes member self weight & roofing materials. w loading = wind & snow on exposed areas
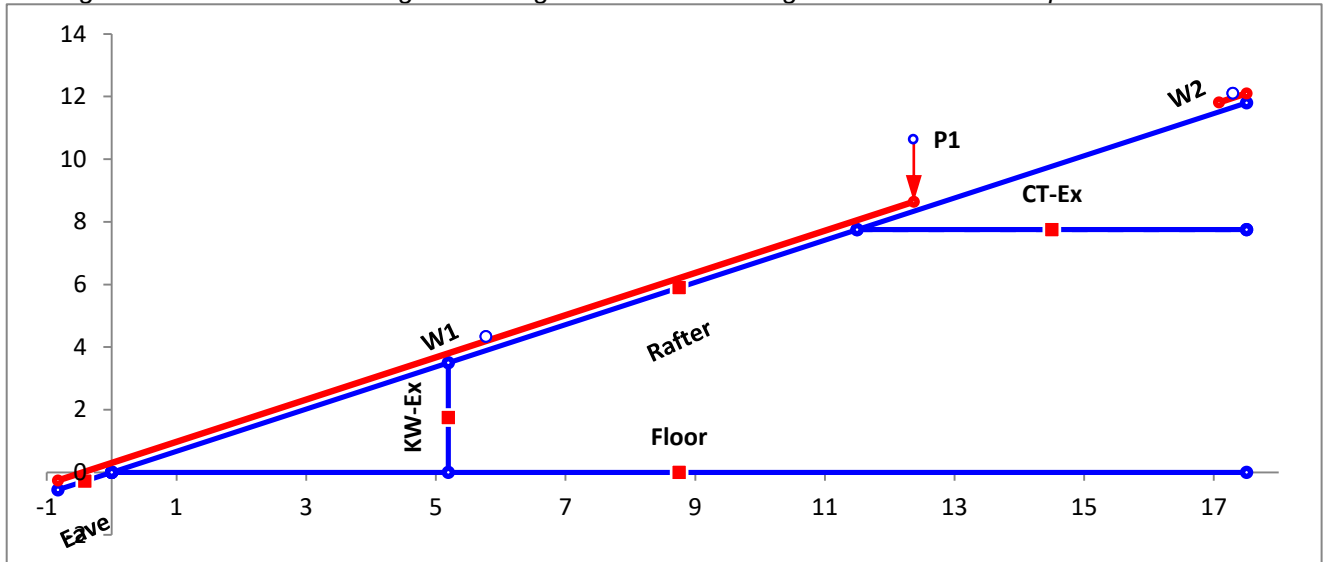
Framing section with max stress: Rafter above Collar Tie.

Roof Structural Calculations for PV Solar Installation
Location: MP 2
Member: Rafter - Total Length 22.32 ft, Unsupported 8.46 ft

Array AR-2

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.	12.00	*Length of roof plane, in feet (meters)*
W	ft.	19.50	*Plan view width of roof plane, in feet (meters)*
h	ft.	24.33	*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=	29.85	*psf*	Vasd q_z=	18.10	*psf*	Basic wind pressure
V=	140			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*	22.32

2	# Rafters / Rack Support Width
4.00	Rack Support Spacing (ft)
48	Max. Rack Support Spacing (in)
3	Max # of mod's / Rafter

Member Properties		Member
Name		(1)1.5x5.5
Repetitive Member Factor (Cr)		1.15
Max Shear perp. to grain	*psi*	530
Max Shear parallel to grain	*psi*	1,100

* *Mem properties based upon field measurements*

Rafter

24.00	Collar tie OC spacing, in.

Module Physical Data			
Weight	kg	lb	psf load
Module	21.50	47.40	2.28
4 Stanchions	1.36	3.0	0.14
Existing Dead Loads	Units	Value	Description
Framing Member	*psf*	0.79	
Roof Deck & Surface	*psf*	4.40	*0.50 in. Plywood w/ Standard Asphalt Shingles*

Rack Support Spacing and Loading				
Across rafters	*ft*	4.0		
Along rafter slope	*ft*	5.7		
Area / support point	*sf*	11.4		
Uphill gap between modules	*in*	1.0	0.08	*ft*

Member Total Length	*ft*	22.32		
Maximum member free span	*ft*	8.46	Rafter above Collar Tie.	
Rafter segment to calc	*ft*	8.46	Free span	
Deflection Ratio		180	Use max delta 1/x for deflection	

* Collar Tie & Knee wall height @ 7.75' AFF max height. Adjust to match lowest adjoining roof's collar

Eave Overhang Length past Rafter Plate	1.00	*ft*
Uphill Distance from Eave to Lowest Support	1.50	*ft*

Zones	1	2	3		Downward, Zones 1, 2 & 3
GCp	-0.94	-1.14	-1.14		GCp 0.87

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	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of PV Module + Stanchion	2.42	2.42	2.42	2.42
S = snow load	15.00	15.00	15.00	15.00
W = wind load	-16.94	-20.56	-20.56	15.71

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*
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
6. D + 0.75L - 0.75(0 or 0.7)eE + 0.75S	17.42	17.42	17.42	20.74
Module Support point load (lb)	198	198	198	235
Cr Factored Module Support point load (lb)	172	172	172	205

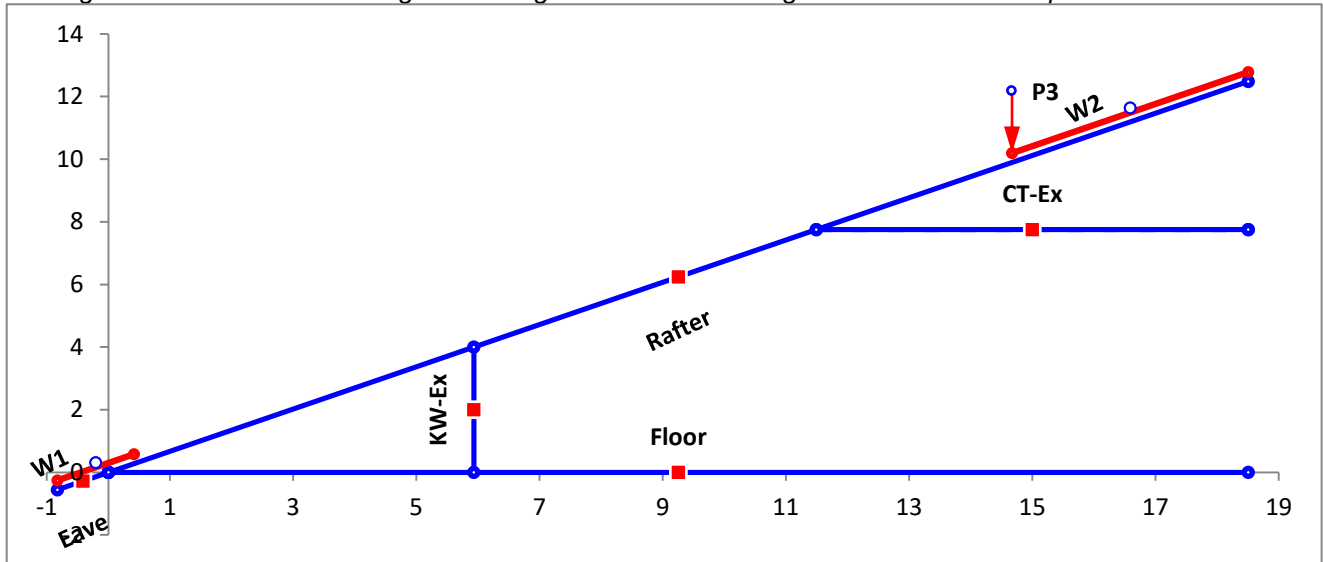| **Use this loading combination for UPWARD for Proposed PV Dead Load**				
7. 0.6D - 0.6W	-6.26	-7.77	-7.77	4.56
Module Support point load (lb)	-71	-88	-88	52

DOWNWARD

Presume loading directly over member.

Combined Dead and Wind Pressure Downward Loading					
		Rafter above Collar Tie.			
PV Module Row	Point load loc's from Left support		Module Support Point Load	Comment	Module Orientation
	ft from left		*lb*		
1	0.50			Support outside of max stressed section	Portrait
1	6.18			Support outside of max stressed section	Portrait
2	6.26			Support outside of max stressed section	Portrait
2	11.94			Support outside of max stressed section	Portrait
3	12.02			Support outside of max stressed section	Portrait
3	17.69		205		Portrait

Analysis for PV impacted areas

5. Simple Beam - Exposed Roof Snow Load - Above and Below PV				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta @ mid span	*in*	0.15	0.56	**OK**
M at mid span	*lb-ft*	464	4,117	**OK**

Sum Downward Loading Conditions: PV; Beam DL; Exposed Roof Environmental Load				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta	*in*	0.31	0.56	**OK**
Percent Max Delta	*%*	55%	100%	**OK**
Moment	*lb-ft*	984	4,117	**OK**
fs	*psi*	1,561	6,533	**OK**

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

Framing section with max stress: Rafter above Collar Tie.

Member: Rafter - Total Length 22.32 ft, Unsupported 8.91 ft

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.	11.50	Length of roof plane, in feet (meters)	
W	ft.	19.50	Plan view width of roof plane, in feet (meters)	
h	ft.	24.33	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=	29.85	psf	Vasd q_z=	18.10	psf	Basic wind pressure
V=	140			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	22.32

2	# Rafters / Rack Support Width
4.00	Rack Support Spacing (ft)
48	Max. Rack Support Spacing (in)
3	Max # of mod's / Rafter

Member Properties		Member
Name		(1)1.5x5.5
Repetitive Member Factor (Cr)		1.15
Max Shear perp. to grain	psi	530
Max Shear parallel to grain	psi	1,100

Mem properties based upon field measurements

Rafter

24.00	Collar tie OC spacing, in.

Module Physical Data			
Weight	kg	lb	psf load
Module	21.50	47.40	2.28
4 Stanchions	1.36	3.0	0.14
Existing Dead Loads	Units	Value	Description
Framing Member	psf	0.79	
Roof Deck & Surface	psf	4.40	0.50 in. Plywood w/ Standard Asphalt Shingles

Rack Support Spacing and Loading				
Across rafters	ft	4.0		
Along rafter slope	ft	5.7		
Area / support point	sf	11.4		
Uphill gap between modules	in	1.0	0.08	ft

Member Total Length	ft	22.32		*Collar Tie & Knee wall height @*
Maximum member free span	ft	8.91	Rafter above Collar Tie.	*7.50' AFF max height. Adjust to*
Rafter segment to calc	ft	8.91	Free span	*match lowest adjoining roof's collar*
Deflection Ratio		180	Use max delta 1/x for deflection	

Eave Overhang Length past Rafter Plate	1.00	*ft*
Uphill Distance from Eave to Lowest Support	1.17	*ft*

	Zones	1	2	3		Downward, Zones 1, 2 & 3
	GCp	-0.94	-1.14	-1.14		GCp 0.87

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	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of PV Module + Stanchion	2.42	2.42	2.42	2.42
S = snow load	15.00	15.00	15.00	15.00
W = wind load	-16.94	-20.56	-20.56	15.71

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*
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
6. D + 0.75L - 0.75(0 or 0.7)eE + 0.75S	17.42	17.42	17.42	20.74
Module Support point load (lb)	198	198	198	235
Cr Factored Module Support point load (lb)	172	172	172	205

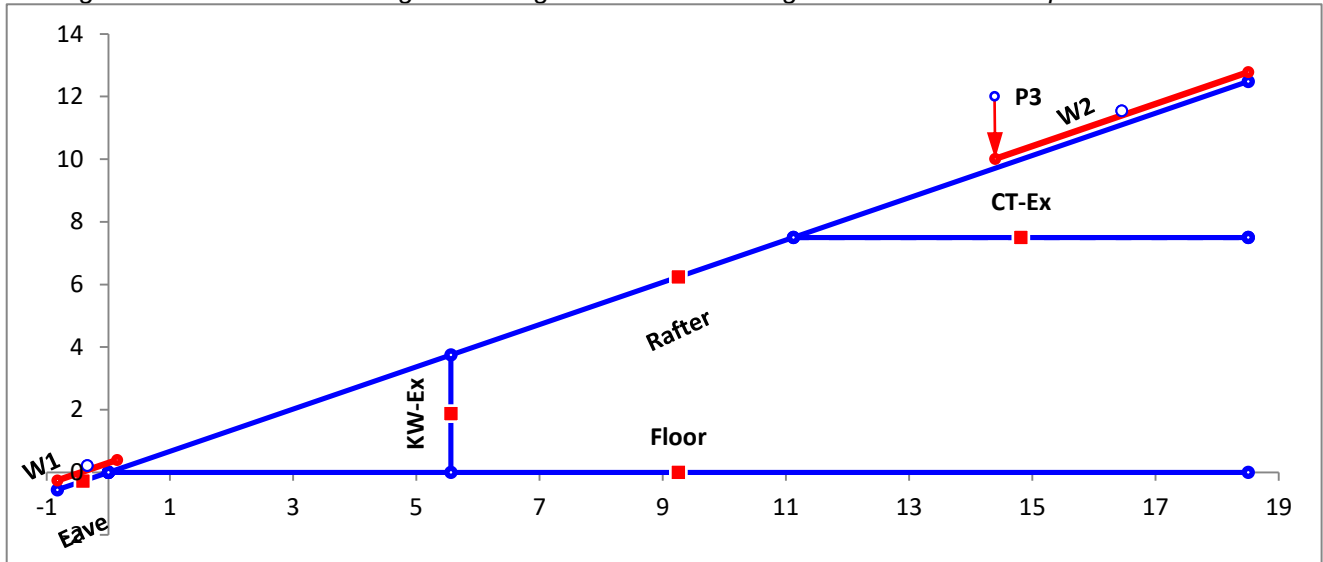| **Use this loading combination for UPWARD for Proposed PV Dead Load**				
7. 0.6D - 0.6W	-6.26	-7.77	-7.77	4.56
Module Support point load (lb)	-71	-88	-88	52

DOWNWARD

Presume loading directly over member.

		Combined Dead and Wind Pressure Downward Loading			
		Rafter above Collar Tie.			
PV Module Row	Point load loc's from Left support		Module Support Point Load	Comment	Module Orientation
	ft from left		*lb*		
1	0.17			Support outside of max stressed section	Portrait
1	5.85			Support outside of max stressed section	Portrait
2	5.93			Support outside of max stressed section	Portrait
2	11.61			Support outside of max stressed section	Portrait
3	11.69			Support outside of max stressed section	Portrait
3	17.36		205		Portrait

Analysis for PV impacted areas

5. Simple Beam - Exposed Roof Snow Load - Above and Below PV				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta @ mid span	*in*	0.20	0.59	**OK**
M at mid span	*lb-ft*	543	4,117	**OK**

Sum Downward Loading Conditions: PV; Beam DL; Exposed Roof Environmental Load				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Delta	*in*	0.39	0.59	**OK**
Percent Max Delta	*%*	66%	100%	**OK**
Moment	*lb-ft*	1,101	4,117	**OK**
fs	*psi*	1,748	6,533	**OK**

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

Framing section with max stress: Rafter above Collar Tie.

Geometric Data			
Θ	deg.	33.02	*Angle of roof plane from horizontal, in degrees*
ω	deg.	0.00	*Angle the solar panel makes with the roof surface*
L	ft.	45.33	*Length of roof plane, in feet (meters)*
W	ft.	14.08	*Plan view width of roof plane, in feet (meters)*
h	ft.	24.33	*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=	29.85	psf	Vasd q_z=	18.10	psf	Basic wind pressure
V=	140				mph

Framing Data					
Wood type	US Spruce			2	# Rafters / Rack Support Width
Wood source, moisture content	White 0.12%			4.00	Rack Support Spacing (ft)
# Framing Members / Support		1		48	Max. Rack Support Spacing (in)
Rafter / Truss OC	in	24.00		1	Max # of mod's / Rafter
Member Total Length	ft	15.60			

Member Properties			Member	*Mem properties based upon field measurements*
Name			(1)1.5x5.5	Rafter
Repetitive Member Factor (Cr)			1.15	
Max Shear perp. to grain	psi		530	
Max Shear parallel to grain	psi		1,100	24.00 Collar tie OC spacing, in.

Module Physical Data			
Weight	kg	lb	psf load
Module	21.50	47.40	2.28
4 Stanchions	1.36	3.0	0.14
Existing Dead Loads	*Units*	*Value*	*Description*
Framing Member	psf	0.79	
Roof Deck & Surface	psf	4.40	*0.50 in. Plywood w/ Standard Asphalt Shingles*

Rack Support Spacing and Loading				
Across rafters	ft	4.0		
Along rafter slope	ft	5.7		
Area / support point	sf	11.4		
Uphill gap between modules	in	1.0	0.08	ft

Member Total Length	ft	15.60		*Collar Tie & Knee wall height @*
Maximum member free span	ft	6.42	Rafter btwn CT & KW	*6.50' AFF max height. Adjust to*
Rafter segment to calc	ft	6.42	Free span	*match lowest adjoining roof's collar*
Deflection Ratio		180	Use max delta 1/x for deflection	

Eave Overhang Length past Rafter Plate	1.00	ft
Uphill Distance from Eave to Lowest Support	9.08	ft

Zones	1	2	3
GCp	-0.94	-1.14	-1.14

Downward, Zones 1, 2 & 3
GCp   0.87

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	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
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S = snow load	15.00	15.00	15.00	15.00
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2.4 Combining Nominal Loads Using Allowable Stress Design (in psf)				
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Combination Formulae	*Upward*	*Upward*	*Upward*	*Downward*
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
6. D + 0.75L - 0.75(0 or 0.7)eE + 0.75S	17.42	17.42	17.42	20.74
Module Support point load (lb)	198	198	198	235
Cr Factored Module Support point load (lb)	172	172	172	205

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.6D - 0.6W	-6.26	-7.77	-7.77	4.56
Module Support point load (lb)	-71	-88	-88	52

DOWNWARD

Presume loading directly over member.

Combined Dead and Wind Pressure Downward Loading					
		Rafter btwn CT & KW			
PV Module Row	Point load loc's from Left support		Module Support Point Load	Comment	Module Orientation
	ft from left		*lb*		
1	8.08		205		Portrait
1	13.76			Support outside of max stressed section	Portrait

Analysis for PV impacted areas

5. Simple Beam - Exposed Roof Snow Load - Above and Below PV				
Parameter	Units	Total	Allowed	Check
Delta @ mid span	in	0.04	0.43	**OK**
M at mid span	lb-ft	649	4,117	**OK**

Sum Downward Loading Conditions: PV; Beam DL; Exposed Roof Environmental Load				
Parameter	Units	Total	Allowed	Check
Delta	in	0.10	0.43	**OK**
Percent Max Delta	%	24%	100%	**OK**
Moment	lb-ft	1,070	4,117	**OK**
fs	psi	1,698	6,533	**OK**

* Loading includes member self weight & roofing materials. w loading = wind & snow on exposed areas
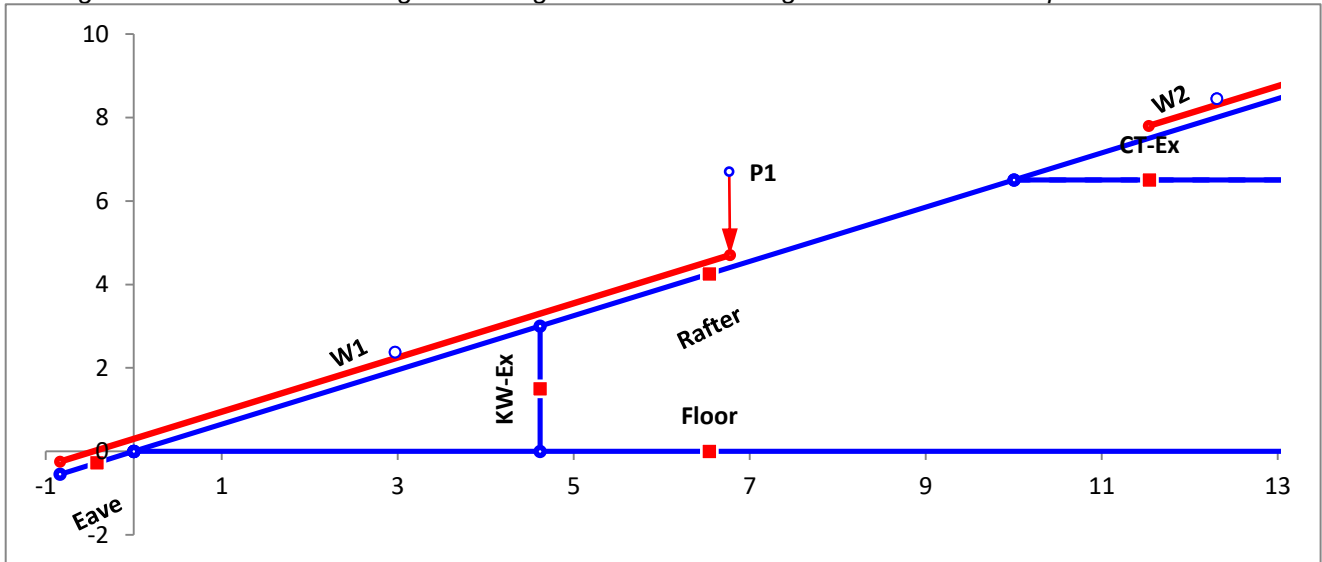
Framing section with max stress: Rafter btwn CT & KW

Snow Loading Analysis

where:

		Fully Exposed	Exposure category
Ce	=	0.9	Exposure Factor, Ce (ASCE 7-10 Table 7.3-1, Page 61)
Ct	=	1.0	Thermal Factor, Ct (ASCE 7-10 Table 7.3-2, Page 61)
Is	=	1.0	Snow Importance Factor, Is (ASCE 7-10 Table 1.5-2, Page 5)
p$_g$	=	15	Ground Snow Load pg (Over-ridden per client request. Original data from Municipality

p$_f$	=	**0.7CeCtIsPg**	Flat Roof Snow Load, pf (ASCE 7-10 Table 7.3-1, Page 61)
p$_f$	=	**9.45**	psf

but where Pf is not less than the following:

Minimum Snow Load pm (ASCE 7-10 Table 7.3.4, Page 62)

p$_m$	=	**15**	When Pg <=20 psf, then use Pf = Pg x Is

p$_f$	=	**15**	psf. Resultant Snow pressure to be used with Roof slope factor below
p$_s$	=	**C$_s$p$_f$**	Sloped Roof Snow Load ps (ASCE 7-10 Table 7.4, Page 61)

Roof Type Warm Roofs

Roof slope factor Cs for Warm Roofs, where Ct = 1.0

Roof surface condition = Slippery Roof

C$_s$	=	1.00	Roof Slope Factor, Cs (ASCE 7-10 Table 7.4-1a, Page 62)

Total Snow Load

p$_s$	=	**15.00 psf**	Roof snow load