

STRUCTURAL CERTIFICATION REPORT*Roof-mounted Solar Panels*

August 14, 2025

To: SunnyMac Solar
505 Carr Rd
Wilmington, DE 19809

Re: Sean Domincovitch
24 Battery Hill Dr
Voorhees Township, NJ 08043
AHJ: **Camden (County), NJ**

SunnyMac Solar proposes to install new roof-mounted solar panels at this residence and asked *Right Angle Engineering* to review the existing structure for suitability. This letter summarizes the methods that were used to survey, evaluate, and certify the existing roof framing and the attachment of the new solar panels to it.

STRUCTURAL DESIGN

Building Code: International Residential Code New Jersey Edition 2021
Design Standards: ASCE 7-16
Snow: Ground: $p_g = 25.0$ psf | Flat Roof: $p_f = 17.33$ psf | Sloped Roof: $p_s = 11.84$ psf
Wind: Ultimate Wind Speed = 115.0 mph | Exposure = B
Seismic: Risk Category = 2 | Seismic Design Category = A | Site Class = D

STRUCTURE

Right Angle Engineering performed a virtual site inspection of the roof structure and observed the following:

Array Name	Panel Quantity	Roof Framing	Material	Pitch
Array 1	8	2x4 Rafter 24" o.c.	Asphalt Shingles	29°
Array 2	10	2x4 Rafter 24" o.c.	Asphalt Shingles	29°
Array 3	15	2x6 Rafter 24" o.c.	Asphalt Shingles	29°
Array 4	2	2x4 Rafter 24" o.c.	Asphalt Shingles	29°

ANCHORAGE

The solar panel anchorage shall be installed according to the manufacturer's most current installation manual. The attachment configuration should match the certified building plans. The solar panels should be mounted parallel (max 5 inches) to the roof surface.

Array Name	Connection Type	Fastener	Max Anchorage Spacing
Array 1	Rockit Smart Slide	(2) 3" #12 Wood Screws (2.0" embedment) into roof substructure	48"
Array 2	Rockit Smart Slide	(2) 3" #12 Wood Screws (2.0" embedment) into roof substructure	48"
Array 3	Rockit Smart Slide	(2) 3" #12 Wood Screws (2.0" embedment) into roof substructure	48"
Array 4	Rockit Smart Slide	(2) 3" #12 Wood Screws (2.0" embedment) into roof substructure	48"

Installation Instructions

Solar panels and the equipment shall be installed per the manufacturer's installation specifications. Improper installation will void this certification. If deviations from the approved structural plans occur, Right Angle Engineering must be notified. Prior to installation, the installer should:

- Confirm that the existing structure matches the information provided in the site survey, the approved installation plans and this certification.

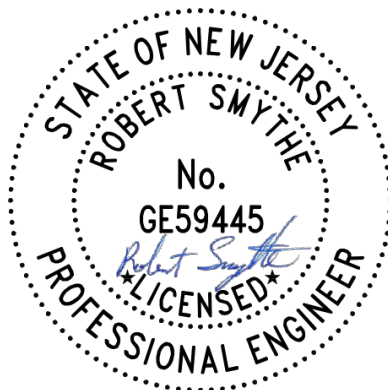
- Identify discrepancies between this certification and the approved installation plans. If found, then this certification shall govern.
- Identify structural elements that are dangerous (cracked, broken, excessive sag, signs of overstress, rot, decay, fire, water). If found, installation shall cease until those elements are adequately abated and made to comply with the referenced building code.
- Verify that both the existing structure and the solar addition has been permitted through the AHJ.

STRUCTURAL CERTIFICATION

I certify the addition of solar panels on the roof of this structure does not cause the structure to become unsafe or make it generally less compliant with the life-safety requirements of the referenced building code. Based on the evaluation methods described below, for the loads that exist at this site, the existing framing will safely support the weight of the new solar panels if they are installed and attached correctly. Electrical design is not included in this certification.

Array Name	Certification Method	Retrofits
Array 1	Stress analysis International Residential Code New Jersey Edition 324.4.1.1	None required
Array 2	Stress analysis International Residential Code New Jersey Edition 324.4.1.1	None required
Array 3	Stress analysis International Residential Code New Jersey Edition 324.4.1.1	None required
Array 4	Stress analysis International Residential Code New Jersey Edition 324.4.1.1	None required

Regards,



08/14/2025

Robert D. Smythe, P.E.
Right Angle Engineering

Job Details

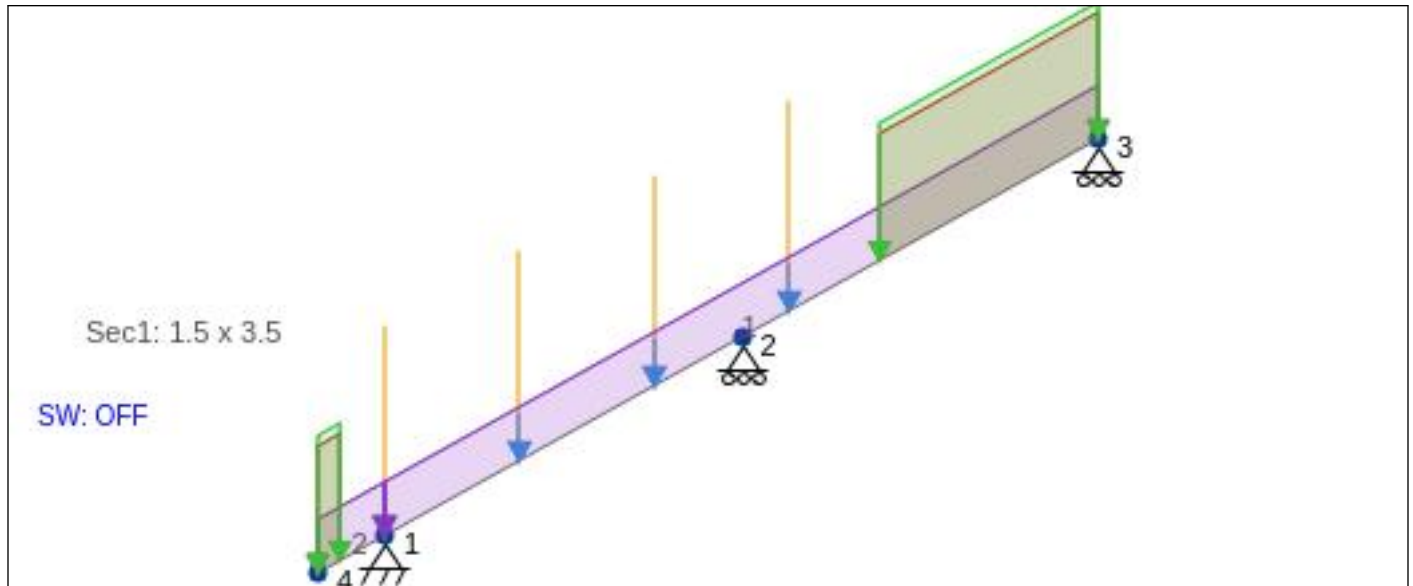
Roof Snow Load - ASCE 7-16	
Ground Snow Load (p_g) <i>Section 7.2</i>	25.0 psf
Exposure Factor (C_e) <i>Table 7.3-1</i>	0.9
Thermal Factor (C_t) <i>Table 7.3-2</i>	1.1
Importance Factor (I_s) <i>Table 1.5-2</i>	1.0
Flat Roof Snow Load (p_f) <i>Equation 7.3-1</i>	17.33 psf
Non-Slippery Surface Slope Factor (C_s) <i>Figure 7.4-1</i>	1
Slippery Surface Slope Factor (C_s) <i>Figure 7.4-1</i>	0.68
Roof Snow Load <i>Equation 7.4-1</i>	17.33 psf
Reduced Snow Load (Slippery Surface) <i>Equation 7.4-1</i>	11.84 psf

Design Criteria	
Wind Speed (V_{ult}) <i>Local Design Criteria</i>	115.0mph
Exposure Category	B
Risk Category	2
Mean Roof Height	20 ft
Roof Type	Gable Roof
Building Type	Enclosed
Roof Live Load	
Existing Roof Live Load <i>ASCE 7-16 Table 4.3-1</i>	20 psf

¹ Roof Dead Load			
Asphalt Shingles	2.0 psf	Solar Panel Array	2.74 psf
5/8 plywood Sheathing	2.0 psf	Dead Load Without Panels	6.77 psf
Roof Framing	1.57 psf		
Insulation	1.2 psf		

¹Roof Dead Load is taken from the worst case scenario dead load from all arrays of the job in order to provide a more conservative evaluation.

Array 1



Array Details		GCP Zones			
			1/2e/ 2r	2n/3r	3e
Roof Framing	2x4 Rafter SPF No. 1/ No. 2	GC _p Figure 30.3-(2A-5B)	-1.46	-1.74	-2.15
Spacing	24.0"	Design Pressure Up [psf] Equation 29.4-7 $\gamma_a=0.53$ $\gamma_E=1.0$,	-16	-16.6	-20.5
Beam Span	8.0', 8.0'	Factored Design Pressure Up [psf] ASD LC (.6D + .6W)	-8.2	-8.5	-10.9
Roof Pitch	29°	Factored Exposed Design Pressure Up [psf] $\gamma_a=0.53$ $\gamma_E=1.5$, (.6D + .6W)	-11.1	-13.5	-17.1
Panel Quantity	8	Design Pressure Down [psf]	16	16	16
Panel Array Area	173.08 ft ²	Tributary Area [ft ²]	20.1	20.1	20.1
Panel Orientation	Landscape	Maximum Connection Spacing [in]	139	139	139
Lag Screw Embedment	2.0"	Maximum Rail Span [in]	48	48	48
Roof Attachment Type	Rockit Smart Slide (2) 3" #12 Wood Screws	Maximum Rail Cantilever [in]	16	16	16
Shear Capacity <i>Ecofasten Testing</i>	142.0 lbs	Design Connection Spacing [in] <i>*Adjusted</i>	48	48	48
Pullout Capacity <i>Ecofasten Testing</i>	530.0 lbs	Design Connection Spacing (exposed) [in]	48	48	48
Velocity Pressure Equation 26.10-1 ($K_z=0.62$, $K_{ht}=1$, $K_d=0.85$, $K_e=1.0$)	17.89 psf				

Design Ratio

Member ID	Axial	Moment _z	Shear _y	Combined	Slenderness	Deflection	Status
1	0.013	0.688	0.335	0.785	0.035	0.427	Pass
2	0.005	0.091	0.064	0.096	0.035	0.316	Pass

Member Design Capacity (LRFD)

Member ID	F _b ^t (ksi)	F _t ^t (ksi)	F _v ^t (ksi)	F _c ^t (ksi)	F _{cp} ^t (ksi)	E' (ksi)	E _{min} ^t (ksi)
1	2.607	1.166	0.233	2.285	0.639	1400.0	915.552
2	2.607	1.166	0.233	2.285	0.639	1400.0	915.552

Node Coordinates

ID	X Coordinate	Y Coordinate
1	0.000	0.000
2	8.000	4.434
3	16.000	8.869
4	-1.500	-0.831

Members

ID	Node A	Node B	Section	Node A Fixity	Node B Fixity	Length
1	1	3	1	FFFFFF	FFFFFF	18.294
2	4	1	1	FFFFFF	FFFFFF	1.715

Supports

ID	Node ID	Restraint Code
1	2	RFFRRR
2	3	RFFRRR
3	1	FFFFFR

Materials

ID	Name	Young's Modulus	Density	Poisson's Ratio
1	NDS - Table 4A - SPRUCE-PINE-FIR - No. 1/ No. 2- 2in & wider	1600.000	33.308	0.400

Sections

ID	Name	Depth	Width	Shear Area Z	Shear Area Y	Torsion Radius
1	1.5 x 3.5	3.500	1.500	4.375	4.375	1.437

ID	Centroid Y	Centroid Z	Area	Y-Axis Mol	Z-Axis Mol	Torsion Constant
1	0.750	1.750	5.250	0.984	5.359	2.875

Point Loads

ID	Load Group	Member	Position %	Y Magnitude
1	Solar-Snow	1	0.000%	-0.053
2	Solar	1	0.000%	-0.011
3	Solar-Snow	1	18.903%	-0.053
4	Solar	1	18.903%	-0.011
5	Solar-Snow	1	37.805%	-0.053
6	Solar	1	37.805%	-0.011
7	Solar-Snow	1	56.708%	-0.053
8	Solar	1	56.708%	-0.011

Member Distributed Loads

ID	Load Group	Start Position	End Position	Member	Y Magnitude
1	Dead Load	0.000%	100.000%	2	-0.014
2	Dead Load	0.000%	100.000%	1	-0.014
3	Roof Live Load	0.000%	33.333%	2	-0.032
4	Roof Live Load	69.361%	100.000%	1	-0.032
5	Snow Load	0.000%	33.333%	2	-0.035
6	Snow Load	69.361%	100.000%	1	-0.035

Load Combinations

ID	Name	Dead Load Factor	Snow Load Factor	Solar Factor	Solar-Snow Factor	Roof Live Load Factor
1	1. 1.4D	1.4	0	1.4	0	0
2	3. 1.2D + 1.6Lr	1.2	0	1.2	0	1.6
3	3. 1.2D + 1.6S	1.2	1.6	1.2	1.6	0
4	4. service loads A	0	1	0	1	0
5	5. service loads B	0	0	0	0	1

Internal Member Forces and Moments

Member	Axial Force (Min/Max)	Shear Force Y (Min/Max)	Shear Force Z (Min/Max)	Torsion (Min/Max)	Bending Moment Y (Min/Max)	Bending Moment Z (Min/Max)
1	-0.119 / 0.151	-0.215 / 0.273	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.458 / 0.328
2	-0.029 / 0.000	-0.052 / 0.000	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.061 / 0.000

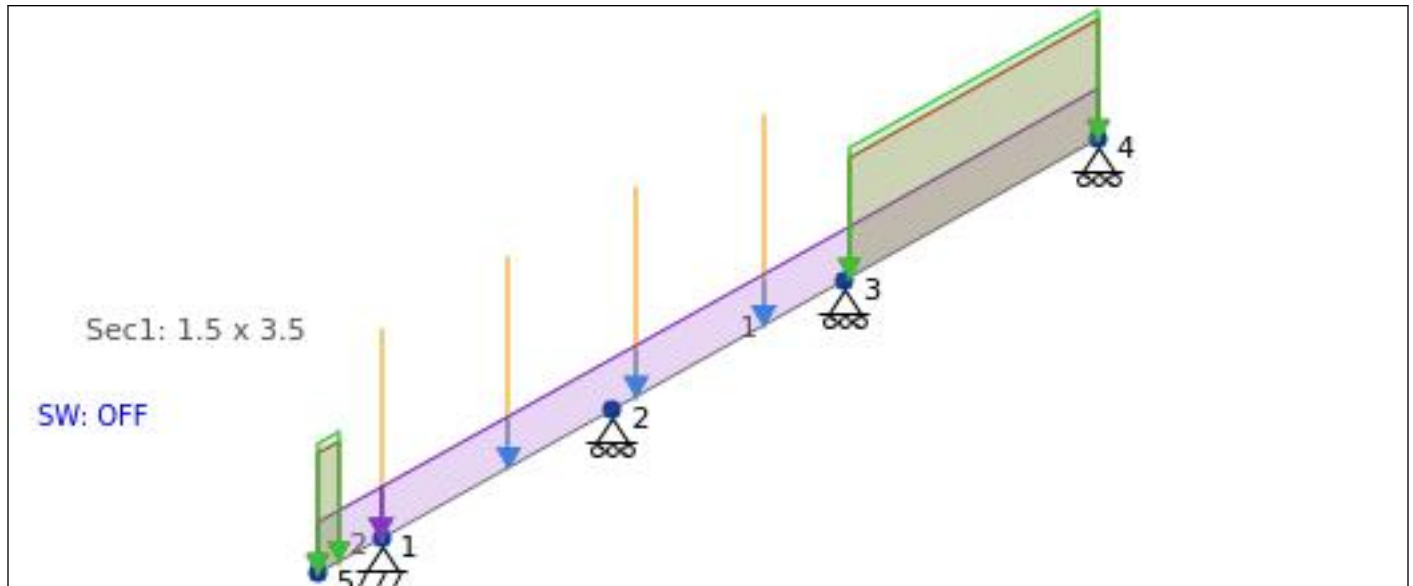
Member Displacement Span Check

Member	Length	Max Relative Displacement	Span Method 1
1	18.294	0.260	L/422
2	1.715	0.072	L/285

Member Stresses

Member	Axial Stress (Min/Max)	Torsion Stress (Min/Max)	Shear Stress Y (Min/Max)	Shear Stress Z (Min/Max)	Top Bending Moment Z (Min/Max)	Bottom Bending Moment Z (Min/Max)
1	-0.023 / 0.029	0.000 / 0.000	-0.062 / 0.078	-0.000 / -0.000	-1.793 / 1.284	-1.284 / 1.793
2	-0.005 / 0.000	0.000 / 0.000	-0.015 / 0.000	-0.000 / -0.000	-0.237 / 0.000	0.000 / 0.237

Array 2



Array Details		GCP Zones			
			1/2e/ 2r	2n/3r	3e
Roof Framing	2x4 Rafter SPF No. 1/ No. 2	GC_p <i>Figure 30.3-(2A-5B)</i>	-1.46	-1.74	-2.15
Spacing	24.0"	Design Pressure Up [psf] <i>Equation 29.4-7 $\gamma_a=0.53$ $\gamma_E=1.0$,</i>	-16	-16.6	-20.5
Beam Span	5.5', 5.5', 6.0'	Factored Design Pressure Up [psf] <i>ASD LC (.6D + .6W)</i>	-8.2	-8.5	-10.9
Roof Pitch	29°	Factored Exposed Design Pressure Up [psf] <i>$\gamma_a=0.53$ $\gamma_E=1.5$, (.6D + .6W)</i>	-11.1	-13.5	-17.1
Panel Quantity	10	Design Pressure Down [psf]	16	16	16
Panel Array Area	216.35 ft ²	Tributary Area [ft²]	20.1	20.1	20.1
Panel Orientation	Landscape	Maximum Connection Spacing [in]	139	139	139
Lag Screw Embedment	2.0"	Maximum Rail Span [in]	48	48	48
Roof Attachment Type	Rockit Smart Slide (2) 3" #12 Wood Screws	Maximum Rail Cantilever [in]	16	16	16
Shear Capacity <i>Ecofasten Testing</i>	142.0 lbs	Design Connection Spacing [in] <i>*Adjusted</i>	48	48	48
Pullout Capacity <i>Ecofasten Testing</i>	530.0 lbs	Design Connection Spacing (exposed) [in]	48	48	48
Velocity Pressure <i>Equation 26.10-1 ($K_z=0.62$, $K_{ht}=1$, $K_d=0.85$, $K_e=1.0$)</i>	17.89 psf				

Design Ratio

Member ID	Axial	Moment _z	Shear _y	Combined	Slenderness	Deflection	Status
1	0.011	0.397	0.305	0.453	0.035	0.214	Pass
2	0.005	0.091	0.064	0.096	0.035	0.045	Pass

Member Design Capacity (LRFD)

Member ID	F _b ^T (ksi)	F _t ^T (ksi)	F _v ^T (ksi)	F _c ^T (ksi)	F _{cp} ^T (ksi)	E ^T (ksi)	E _{min} ^T (ksi)
1	2.607	1.166	0.233	2.285	0.639	1400.0	915.552
2	2.607	1.166	0.233	2.285	0.639	1400.0	915.552

Node Coordinates

ID	X Coordinate	Y Coordinate
1	0.000	0.000
2	5.500	3.049
3	11.000	6.097
4	17.000	9.423
5	-1.500	-0.831

Members

ID	Node A	Node B	Section	Node A Fixity	Node B Fixity	Length
1	1	4	1	FFFFFF	FFFFFF	19.437
2	5	1	1	FFFFFF	FFFFFF	1.715

Supports

ID	Node ID	Restraint Code
1	2	RFFRRR
2	3	RFFRRR
3	4	RFFRRR
4	1	FFFFFF

Materials

ID	Name	Young's Modulus	Density	Poisson's Ratio
1	NDS - Table 4A - SPRUCE-PINE-FIR - No. 1/ No. 2- 2in & wider	1600.000	33.308	0.400

Sections

ID	Name	Depth	Width	Shear Area Z	Shear Area Y	Torsion Radius
1	1.5 x 3.5	3.500	1.500	4.375	4.375	1.437

ID	Centroid Y	Centroid Z	Area	Y-Axis Mol	Z-Axis Mol	Torsion Constant
1	0.750	1.750	5.250	0.984	5.359	2.875

Point Loads

ID	Load Group	Member	Position %	Y Magnitude
1	Solar-Snow	1	0.000%	-0.056
2	Solar	1	0.000%	-0.012
3	Solar-Snow	1	17.791%	-0.056
4	Solar	1	17.791%	-0.012
5	Solar-Snow	1	35.582%	-0.056
6	Solar	1	35.582%	-0.012
7	Solar-Snow	1	53.372%	-0.056
8	Solar	1	53.372%	-0.012

Member Distributed Loads

ID	Load Group	Start Position	End Position	Member	Y Magnitude
1	Dead Load	0.000%	100.000%	2	-0.014
2	Dead Load	0.000%	100.000%	1	-0.014
3	Roof Live Load	0.000%	33.333%	2	-0.032
4	Roof Live Load	65.281%	100.000%	1	-0.032

5	Snow Load	0.000%	33.333%	2	-0.035
6	Snow Load	65.281%	100.000%	1	-0.035

Load Combinations

ID	Name	Dead Load Factor	Snow Load Factor	Solar Factor	Solar-Snow Factor	Roof Live Load Factor
1	1. 1.4D	1.4	0	1.4	0	0
2	3. 1.2D + 1.6Lr	1.2	0	1.2	0	1.6
3	3. 1.2D + 1.6S	1.2	1.6	1.2	1.6	0
4	4. service loads A	0	1	0	1	0
5	5. service loads B	0	0	0	0	1

Internal Member Forces and Moments

Member	Axial Force (Min/Max)	Shear Force Y (Min/Max)	Shear Force Z (Min/Max)	Torsion (Min/Max)	Bending Moment Y (Min/Max)	Bending Moment Z (Min/Max)
1	-0.098 / 0.138	-0.177 / 0.248	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.264 / 0.240
2	-0.029 / 0.000	-0.052 / 0.000	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.061 / 0.000

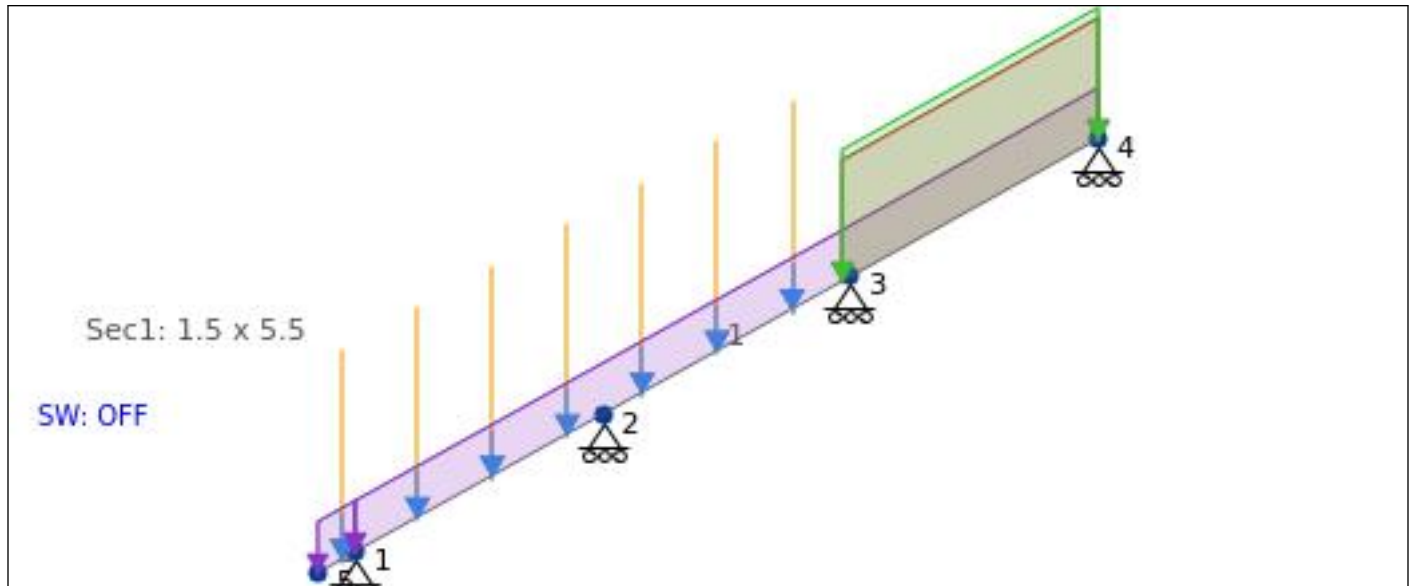
Member Displacement Span Check

Member	Length	Max Relative Displacement	Span Method 1
1	19.437	0.098	L/841
2	1.715	0.010	L/2017

Member Stresses

Member	Axial Stress (Min/Max)	Torsion Stress (Min/Max)	Shear Stress Y (Min/Max)	Shear Stress Z (Min/Max)	Top Bending Moment Z (Min/Max)	Bottom Bending Moment Z (Min/Max)
1	-0.019 / 0.026	0.000 / 0.000	-0.051 / 0.071	-0.000 / -0.000	-1.034 / 0.940	-0.940 / 1.034
2	-0.005 / 0.000	0.000 / 0.000	-0.015 / 0.000	-0.000 / -0.000	-0.237 / 0.000	0.000 / 0.237

Array 3



Array Details		GCP Zones			
			1/2e/ 2r	2n/3r	3e
Roof Framing	2x6 Rafter SPF No. 1/ No. 2	GC_p Figure 30.3-(2A-5B)	-1.46	-1.74	-2.15
Spacing	24.0"	Design Pressure Up [psf] Equation 29.4-7 $\gamma_a=0.53$ $\gamma_E=1.0$,	-16	-16.6	-20.5
Beam Span	10.0', 10.0', 10.0'	Factored Design Pressure Up [psf] ASD LC (.6D + .6W)	-8.2	-8.5	-10.9
Roof Pitch	29°	Factored Exposed Design Pressure Up [psf] $\gamma_a=0.53$ $\gamma_E=1.5$, (.6D + .6W)	-11.1	-13.5	-17.1
Panel Quantity	15	Design Pressure Down [psf]	16	16	16
Panel Array Area	324.53 ft ²	Tributary Area [ft²]	20.1	20.1	20.1
Panel Orientation	Landscape	Maximum Connection Spacing [in]	139	139	139
Lag Screw Embedment	2.0"	Maximum Rail Span [in]	48	48	48
Roof Attachment Type	Rockit Smart Slide (2) 3" #12 Wood Screws	Maximum Rail Cantilever [in]	16	16	16
Shear Capacity <i>Ecofasten Testing</i>	142.0 lbs	Design Connection Spacing [in] <i>*Adjusted</i>	48	48	48
Pullout Capacity <i>Ecofasten Testing</i>	530.0 lbs	Design Connection Spacing (exposed) [in]	48	48	48
Velocity Pressure Equation 26.10-1 ($K_z=0.62$, $K_{ht}=1$, $K_d=0.85$, $K_e=1.0$)	17.89 psf				

Design Ratio

Member ID	Axial	Moment _z	Shear _y	Combined	Slenderness	Deflection	Status
1	0.013	0.511	0.33	0.528	0.044	0.261	Pass
2	0.008	0.051	0.089	0.058	0.044	0.186	Pass

Member Design Capacity (LRFD)

Member ID	F _b ^I (ksi)	F _t ^I (ksi)	F _v ^I (ksi)	F _c ^I (ksi)	F _{cp} ^I (ksi)	E ^I (ksi)	E _{min} ^I (ksi)
1	2.259	1.011	0.233	2.186	0.639	1400.0	915.552
2	2.259	1.011	0.233	2.186	0.639	1400.0	915.552

Node Coordinates

ID	X Coordinate	Y Coordinate
1	0.000	0.000
2	10.000	5.543
3	20.000	11.086
4	30.000	16.629
5	-1.500	-0.831

Members

ID	Node A	Node B	Section	Node A Fixity	Node B Fixity	Length
1	1	4	1	FFFFFF	FFFFFF	34.301
2	5	1	1	FFFFFF	FFFFFF	1.715

Supports

ID	Node ID	Restraint Code
1	2	RFFRRR
2	3	RFFRRR
3	4	RFFRRR
4	1	FFFFFF

Materials

ID	Name	Young's Modulus	Density	Poisson's Ratio
1	NDS - Table 4A - SPRUCE-PINE-FIR - No. 1/ No. 2- 2in & wider	1600.000	33.308	0.400

Sections

ID	Name	Depth	Width	Shear Area Z	Shear Area Y	Torsion Radius
1	1.5 x 5.5	5.500	1.500	6.876	6.875	1.492

ID	Centroid Y	Centroid Z	Area	Y-Axis Mol	Z-Axis Mol	Torsion Constant
1	0.750	2.750	8.250	1.547	20.797	5.124

Point Loads

ID	Load Group	Member	Position %	Y Magnitude
1	Solar-Snow	2	66.667%	-0.055
2	Solar	2	66.667%	-0.012
3	Solar-Snow	1	8.415%	-0.055
4	Solar	1	8.415%	-0.012
5	Solar-Snow	1	18.496%	-0.055
6	Solar	1	18.496%	-0.012
7	Solar-Snow	1	28.578%	-0.055
8	Solar	1	28.578%	-0.012
9	Solar-Snow	1	38.659%	-0.055
10	Solar	1	38.659%	-0.012
11	Solar-Snow	1	48.741%	-0.055
12	Solar	1	48.741%	-0.012
13	Solar-Snow	1	58.822%	-0.055
14	Solar	1	58.822%	-0.012

Member Distributed Loads

ID	Load Group	Start Position	End Position	Member	Y Magnitude
1	Dead Load	0.000%	100.000%	2	-0.014
2	Dead Load	0.000%	100.000%	1	-0.014
3	Roof Live Load	65.570%	100.000%	1	-0.032
4	Snow Load	65.570%	100.000%	1	-0.035

Load Combinations

ID	Name	Dead Load Factor	Snow Load Factor	Solar Factor	Solar-Snow Factor	Roof Live Load Factor
1	1. 1.4D	1.4	0	1.4	0	0
2	3. 1.2D + 1.6Lr	1.2	0	1.2	0	1.6
3	3. 1.2D + 1.6S	1.2	1.6	1.2	1.6	0
4	4. service loads A	0	1	0	1	0
5	5. service loads B	0	0	0	0	1

Internal Member Forces and Moments

Member	Axial Force (Min/Max)	Shear Force Y (Min/Max)	Shear Force Z (Min/Max)	Torsion (Min/Max)	Bending Moment Y (Min/Max)	Bending Moment Z (Min/Max)
1	-0.163 / 0.234	-0.295 / 0.422	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.727 / 0.668
2	-0.063 / 0.000	-0.114 / 0.000	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.072 / 0.000

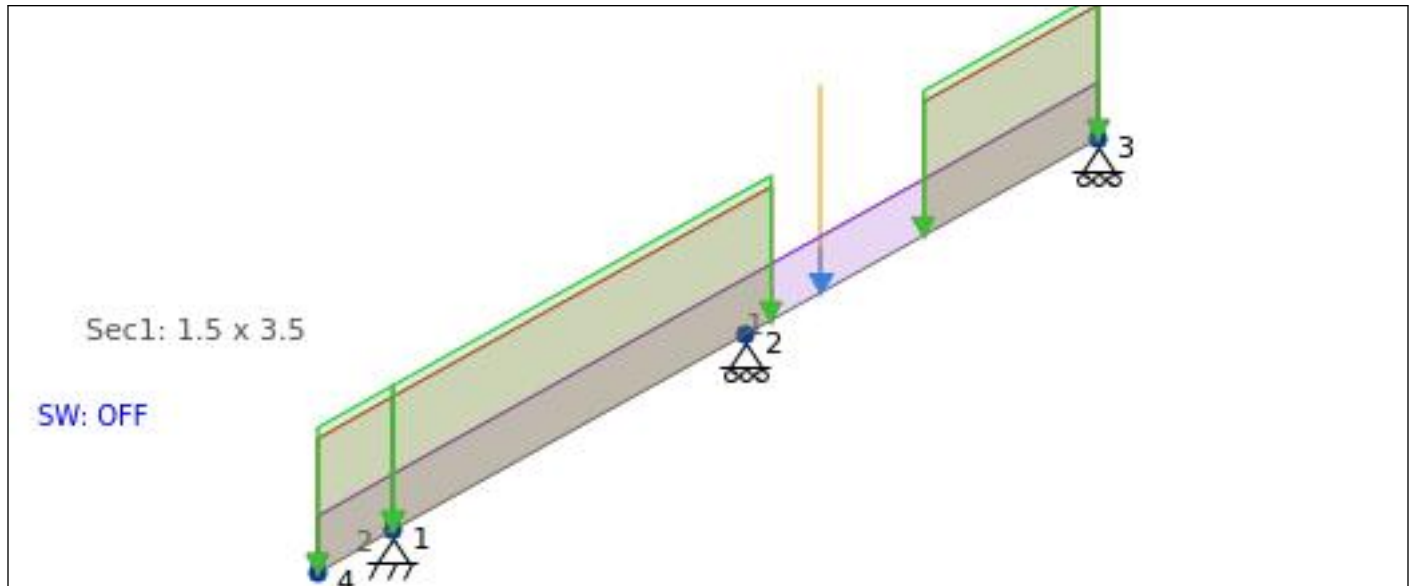
Member Displacement Span Check

Member	Length	Max Relative Displacement	Span Method 1
1	34.301	0.199	L/689
2	1.715	0.043	L/483

Member Stresses

Member	Axial Stress (Min/Max)	Torsion Stress (Min/Max)	Shear Stress Y (Min/Max)	Shear Stress Z (Min/Max)	Top Bending Moment Z (Min/Max)	Bottom Bending Moment Z (Min/Max)
1	-0.020 / 0.028	0.000 / 0.000	-0.054 / 0.077	-0.000 / -0.000	-1.154 / 1.060	-1.060 / 1.154
2	-0.008 / 0.000	0.000 / 0.000	-0.021 / 0.000	-0.000 / -0.000	-0.114 / 0.000	0.000 / 0.114

Array 4



Array Details		GCP Zones			
			1/2e/ 2r	2n/3r	3e
Roof Framing	2x4 Rafter SPF No. 1/ No. 2	GC_p Figure 30.3-(2A-5B)	-1.46	-1.74	-2.15
Spacing	24.0"	Design Pressure Up [psf] Equation 29.4-7 $\gamma_a=0.53$ $\gamma_E=1.0$,	-16	-16.6	-20.5
Beam Span	7.0', 7.0'	Factored Design Pressure Up [psf] ASD LC (.6D + .6W)	-8.2	-8.5	-10.9
Roof Pitch	29°	Factored Exposed Design Pressure Up [psf] $\gamma_a=0.53$ $\gamma_E=1.5$, (.6D + .6W)	-11.1	-13.5	-17.1
Panel Quantity	2	Design Pressure Down [psf]	16	16	16
Panel Array Area	43.27 ft ²	Tributary Area [ft²]	20.1	20.1	20.1
Panel Orientation	Landscape	Maximum Connection Spacing [in]	139	139	139
Lag Screw Embedment	2.0"	Maximum Rail Span [in]	48	48	48
Roof Attachment Type	Rockit Smart Slide (2) 3" #12 Wood Screws	Maximum Rail Cantilever [in]	16	16	16
Shear Capacity Ecofasten Testing	142.0 lbs	Design Connection Spacing [in] *Adjusted	48	48	48
Pullout Capacity Ecofasten Testing	530.0 lbs	Design Connection Spacing (exposed) [in]	48	48	48
Velocity Pressure Equation 26.10-1 ($K_z=0.62$, $K_{ht}=1$, $K_d=0.85$, $K_e=1.0$)	17.89 psf				

Design Ratio

Member ID	Axial	Moment _z	Shear _y	Combined	Slenderness	Deflection	Status
1	0.026	0.633	0.359	0.659	0.035	0.272	Pass
2	0.01	0.139	0.132	0.148	0.035	0.405	Pass

Member Design Capacity (LRFD)

Member ID	F _b ^t (ksi)	F _t ^t (ksi)	F _v ^t (ksi)	F _c ^t (ksi)	F _{cp} ^t (ksi)	E ^t (ksi)	E _{min} ^t (ksi)
1	2.607	1.166	0.233	2.285	0.639	1400.0	915.552
2	2.607	1.166	0.233	2.285	0.639	1400.0	915.552

Node Coordinates

ID	X Coordinate	Y Coordinate
1	0.000	0.000
2	7.000	3.880
3	14.000	7.760
4	-1.500	-0.831

Members

ID	Node A	Node B	Section	Node A Fixity	Node B Fixity	Length
1	1	3	1	FFFFFF	FFFFFF	16.007
2	4	1	1	FFFFFF	FFFFFF	1.715

Supports

ID	Node ID	Restraint Code
1	2	RFFRRR
2	3	RFFRRR
3	1	FFFFFR

Materials

ID	Name	Young's Modulus	Density	Poisson's Ratio
1	NDS - Table 4A - SPRUCE-PINE-FIR - No. 1/ No. 2- 2in & wider	1600.000	33.308	0.400

Sections

ID	Name	Depth	Width	Shear Area Z	Shear Area Y	Torsion Radius
1	1.5 x 3.5	3.500	1.500	4.375	4.375	1.437

ID	Centroid Y	Centroid Z	Area	Y-Axis Mol	Z-Axis Mol	Torsion Constant
1	0.750	1.750	5.250	0.984	5.359	2.875

Point Loads

ID	Load Group	Member	Position %	Y Magnitude
1	Solar-Snow	1	60.714%	-0.050
2	Solar	1	60.714%	-0.011

Member Distributed Loads

ID	Load Group	Start Position	End Position	Member	Y Magnitude
1	Dead Load	0.000%	100.000%	2	-0.014
2	Dead Load	0.000%	100.000%	1	-0.014
3	Roof Live Load	0.000%	100.000%	2	-0.032
4	Roof Live Load	0.000%	53.571%	1	-0.032
5	Roof Live Load	75.175%	100.000%	1	-0.032
6	Snow Load	0.000%	100.000%	2	-0.035
7	Snow Load	0.000%	53.571%	1	-0.035
8	Snow Load	75.175%	100.000%	1	-0.035

Load Combinations

ID	Name	Dead Load Factor	Snow Load Factor	Solar Factor	Solar-Snow Factor	Roof Live Load Factor
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1	1. 1.4D	1.4	0	1.4	0	0
2	3. 1.2D + 1.6Lr	1.2	0	1.2	0	1.6
3	3. 1.2D + 1.6S	1.2	1.6	1.2	1.6	0
4	4. service loads A	0	1	0	1	0
5	5. service loads B	0	0	0	0	1

Internal Member Forces and Moments

Member	Axial Force (Min/Max)	Shear Force Y (Min/Max)	Shear Force Z (Min/Max)	Torsion (Min/Max)	Bending Moment Y (Min/Max)	Bending Moment Z (Min/Max)
1	-0.162 / 0.137	-0.292 / 0.248	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.421 / 0.245
2	-0.060 / 0.000	-0.108 / 0.000	0.000 / 0.000	0.000 / 0.000	0.000 / 0.000	-0.092 / 0.000

Member Displacement Span Check

Member	Length	Max Relative Displacement	Span Method 1
1	16.007	0.145	L/661
2	1.715	0.092	L/222

Member Stresses

Member	Axial Stress (Min/Max)	Torsion Stress (Min/Max)	Shear Stress Y (Min/Max)	Shear Stress Z (Min/Max)	Top Bending Moment Z (Min/Max)	Bottom Bending Moment Z (Min/Max)
1	-0.031 / 0.026	0.000 / 0.000	-0.084 / 0.071	-0.000 / -0.000	-1.650 / 0.961	-0.961 / 1.650
2	-0.011 / 0.000	0.000 / 0.000	-0.031 / 0.000	-0.000 / -0.000	-0.361 / 0.000	0.000 / 0.361