Purelight Power

March 22, 2025

Subject: Proposed Solar Panel Installation
Chaiya Lappin Residence, 2415 SE Woodward St, Portland, OR

To Whom it May Concern,

Our engineering department has reviewed information, gathered by our field crews, related to the proposed solar panel installation at the above-referenced address. The purpose of our review was to determine the structural adequacy of the existing roof for the proposed installation. Based on our review and analysis of the available information, it is our professional opinion that the existing structure requires a retrofit to ensure structural adequacy to support the proposed installation.

The retrofit shall consist of 2x6 sister for the existing 2x4 rafters on roof 3 where panels are to be installed, with 12d nails at 12" O.C., staggered. New sister to extend within 12" of existing 2x, only required at existing member with new solar attachment. Retrofit should happen before install.

Design Parameter Summary

Governing Building Code: 2022 Oregon Structural Specialty Code (2022 OSSC)
Risk Category: II
Design Wind Speed: 98 mph (per ASCE 7-16)
Ground Snow Load: 20 psf
Roof Snow Load: 20 psf (city/county requirement)

Roof Information

Roof Structure: 2x4 Rafters @ 24" O.C.
Roofing Material: Asphalt Shingles (1 layer)
Roof Slope: 20°

Roof Connection Details

Lag Screws: (1) 5/16" diameter min., with min. 2.5" embedment into framing members, at 48" O.C. max, Locations per design drawings
Note: Required embedment length excludes the tapered tip of the screw, and embedment into sheathing.

Analysis

The proposed installation - including weight of panels, racking, and mounts - will be approximately 2.7 psf. The existing roof is composed of one layer of asphalt shingles. Therefore, according to the Oregon Structural Specialty Code, Section 3408.5.2 (IEBC Section 805.2), Exception 2, the structure need not be altered for gravity loading. The relevant provision states "buildings in which the increased dead load is attributable to the addition of a second layer of roof covering weighing 3 pounds per square foot (0.1437 kN/m2) or less over an existing single layer of roof covering" are excepted from alterations for gravity loading.

The proposed installation will be 6" max. above the roof surface (flush mounted) and parallel to the roof surface. Therefore, any increase in wind loading on the building structure from the solar panel installation is expected to be negligible. Wind is the governing lateral load case. Because the increase in lateral loading is not increased by more than 10%, per provisions in the adopted building codes, the structure need not be altered for lateral loading.

Wind uplift on the panels has been calculated in accordance with the relevant provisions of ASCE 7-16. This loading has been used to verify the adequacy of the connection specified above. Connection locations should be in accordance with design drawings.

Conclusion

When the retrofits detailed in this letter's opening paragraph are performed, the structure will have adequate strength to support the proposed installation. Connections to the roof must be made per the "Roof Connection Details" section above. Copies of all relevant calculations are enclosed.

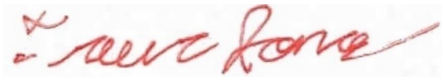
Limitations and Disclaimers

The opinion expressed in this letter is made in reliance on the following assumptions: the existing structure is in good condition (apart from the damage which shall be repaired or retrofit per the above); the existing structure is free from defects in design or workmanship; and the existing structure was code-compliant at the time of its design and construction. These assumptions have not been independently verified, and we have relied on representations made by the property owner and his or her agents with respect to the foregoing. The undersigned has not inspected the structure for patent or latent defects.

Electrical engineering and waterproofing are beyond the scope of this analysis. Solar panels must be installed per manufacturer specifications. Structural design and analysis of the adequacy of solar panels, racks, mounts, rails, and other components is performed by each component's respective manufacturer and the undersigned makes no statement of opinion regarding such components. This letter and the opinions expressed herein are rendered solely for the benefit of the permitting authority (city or county building department), and may not be utilized or relied on by any other party.

If you have any questions or concerns, please contact our office at (855)-709-1181, or email Austen.Morfin@purelightpower.com.

Sincerely,

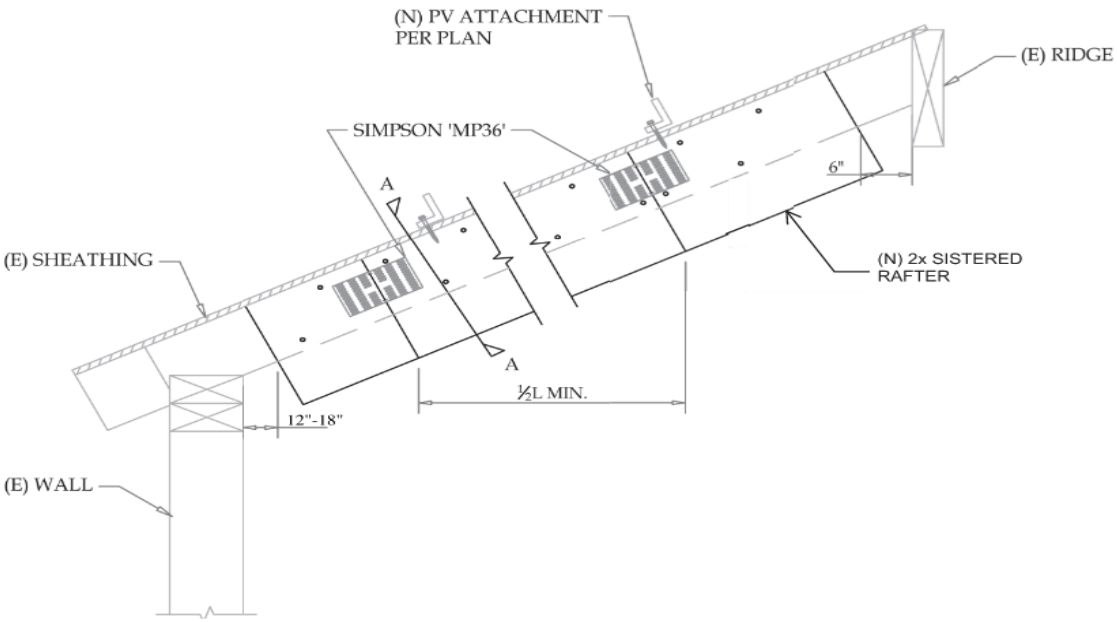


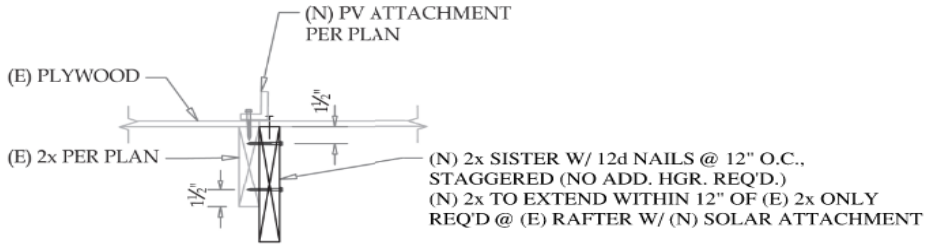
Trevor A. Jones, P.E.
03/22/2025

Retrofit Description

The retrofit shall consist of 2x6 sister for the existing 2x4 rafters on 3 where panels are to be installed, with 12d nails at 12" O.C., staggered. New sister to extend within 12" of existing 2x, only required at existing member with new solar attachment. Retrofit should happen before install.

Additional Retrofit Details and Notes





SECTION "A-A"

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Note: Design per NDS and ASCE 7
Note: This tab is not applicable for trusses
Note: Member is assumed fully restrained by attachment to sheathing

Beam Calculation (Roof 1, 2 & 4)

The purpose of this calculation is to justify the additional solar load by demonstating beam capacity is adequate for the increased demand.

Roof Information

Beam Span	6.8	ft
Beam Member Size	2x4	
Wood Species	DFL #2 (Assumed)	
Beam Spacing	2	ft
Retrofit member (where applies)	--	

Deflection Criteria

LL :	L /	240
DL + LL:	L /	120
DL + SL:	L /	120

Sawn Lumber Properties

F_b	900	psi
F_v	180	psi
Load Duration Factor, C_D	1.15	
Size Factor, C_F	1.5	
Repetitive Member Factor, C_r	1.15	
F'_b	1785	psi
F'_v	207	psi
E	1600000	psi

(Note: $C_M = C_t = C_L = C_{fu} = C_i = 1.0$)

Member Properties

Main member:

Width, b	1.5	in
Depth, d	3.5	in
Area, A	5.25	in^2
Moment of Inertia, I	5.36	in^4
Section Modulus, S	3.06	in^3

Retrofit member (where applies):

Width, b	--	in
Depth, d	--	in
Area, A	--	in^2
Moment of Inertia, I	--	in^4
Section Modulus, S	--	in^3

Loading

Dead Load

Asphalt Shingles	3	psf
1/2" Plywood	1	psf
Framing	1	psf
Insulation	--	psf
1/2" Gypsum Ceiling	--	psf
M,E, & Misc	1	psf
Solar Panel	2.7	psf
Total Dead Load	**8.7**	**psf**
Roof Live Load	**20.0**	**psf**

Snow Load

Ground Snow Load, P_g	20.0	psf
Exposure Factor, C_e	0.9	
Thermal Factor, C_t	1.1	
Importance Factor, I_s	1.0	
Flat Roof Snow Load	20	psf
Slope	20	degrees
Unobstructed Slippery Surface?	No	
Slope Factor, C_s	1.00	
Sloped Roof Snow Load	**20.0**	**psf**

Load Combination

DL + LL	**28.7**	**psf**
DL + SL	**28.7**	**psf**

Member Checks

Moment Capacity	**455.6**	lb*ft	Moment Demand (max.)	**331.8**	lb*ft
Shear Capacity	**1086.8**	lbs	Shear Demand (max.)	**292.7**	lbs
Allowable Deflection, LL	**0.3**	in	Deflection Calculated, LL	**0.22**	in
Allowable Deflection, DL + LL	**0.7**	in	Deflection Calculated, DL + LL	**0.29**	in
Allowable Deflection, DL + SL	**0.7**	in	Deflection Calculated, DL + SL	**0.32**	in

Result: **Since moment, shear, and deflection capacities are equal to or greater than calculated moment, shear, and deflection demands, the beam capacity is adequate for the increased demand, and the existing roof structure is permitted to remain unaltered.**

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Note: Beam is assumed fully restrained by attachment to sheathing
Note: This calculation is not applicable for trusses
Note: Design per NDS and ASCE 7

Detailed Beam Calculation (Roof 3)

The purpose of this calculation is to show that the sistered rafter has adequate capacity for the increased demand.

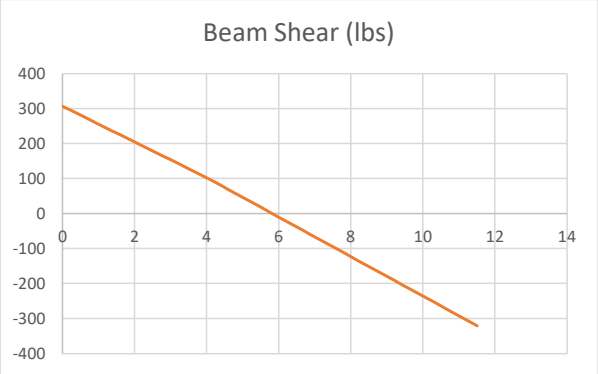
Existing Dead Load			Beam Span, L	11.5	ft
Asphalt Shingles	3	psf	Beam Member Size	2x4	
1/2" Plywood	1	psf	Wood Species	DFL #2 (Assumed)	
Framing	1	psf	Beam Spacing	2	ft
M,E, & Misc	0.5	psf	Retrofit member (where applies)	2x6	
Total Existing Dead Load	5.5	psf	**Sawn Lumber Properties**		
Snow Load			F_b	900	psi
Ground Snow Load, P_g	20	psf	F_v	180	psi
Exposure Factor, C_e	0.9		Load Duration Factor, C_D	1.15	
Thermal Factor, C_t	1.1		Size Factor, C_F	1.5	
Importance Factor, I_s	1.0		Repetitive Member Factor, C_r	1.15	
Flat Roof Snow Load	20	psf	F'_b	1785	psi
Slope	20	degrees	F'_v	207	psi
Unobstructed Slippery Surfac	No		E	1600000	psi
Slope Factor, Cs	1.00		(Note: $C_M = C_t = C_L = C_{fu} = C_i = 1.0$)		
Sloped Roof Snow Load	**20.0**	psf			
Live Load	**20.0**	psf	**Member Properties**		
Governing Load Combination			***Main member:***		
DL + SL	25.5	psf	Width, b	1.5	in
Calculation Values			Depth, d	3.5	in
Linear load, w	51	plf	Area, A	5.3	in^2
Reaction, R_1	293.25	lbs	Moment of Inertia, I	5.4	in^4
Reaction, R_2	293.25	lbs	Section Modulus, S	3.1	in^3
			Retrofit member (where applies):		
Solar Panel Dead Load			Width, b	1.5	in
Distributed Load	2.7	psf	Depth, d	5.5	in
Linear load, w	5.4	plf	Area, A	8.3	in^2
Distance to surcharge, a	4	ft	Moment of Inertia, I	20.8	in^4
Surcharge length, b	7.5	ft	Section Modulus, S	7.6	in^3
Distance from surcharge, c	0	ft			
Reaction, R_1	13.2065217	lbs	**Deflection Criteria**		
Reaction, R_2	27.2934783	lbs	Under Total Load:	L / 120	

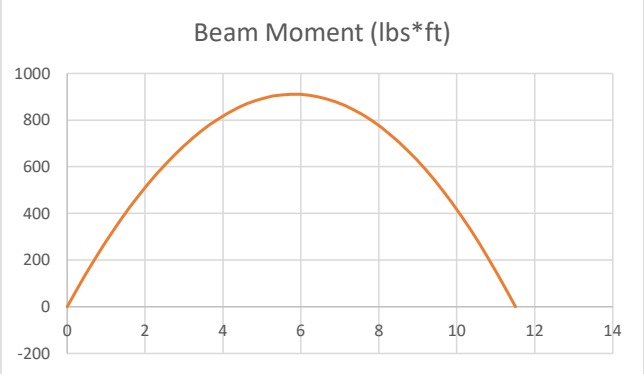
Total Demand			**Total Capacity**		
Shear	**480.8**	lbs	Shear	**2794.5**	lbs
Moment	**910.8**	lb*ft	Moment	**1580.8**	lb*ft
Deflection	**0.52**	in	Deflection	**1.15**	in

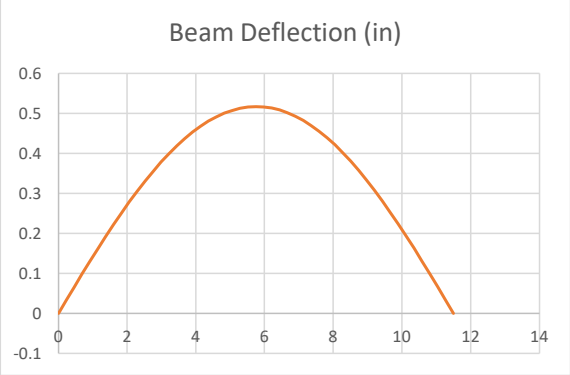
Note: Capacities are based on the sum of the properties of main and retrofit members.

Result: **Since calculated capacities are equal to or greater than calculated demands, the beam capacity is adequate for the increased demand from solar panels, after the specified retrofit is performed.**

The following page shows the shear, moment, and deflection values across the length of the beam.


Beam Shear (lbs)
400
300
200
100
0
-100
-200
-300
-400
0
2
4
6
8
10
12
14


Beam Moment (lbs*ft)
1000
800
600
400
200
0
-200
0
2
4
6
8
10
12
14


Beam Deflection (in)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
2
4
6
8
10
12
14

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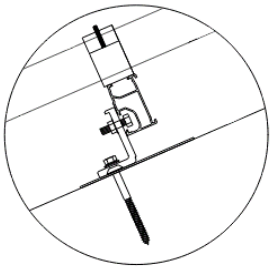
Pegasus Comp Mount Connection Calculation

This calculation justifies the connection of the solar panels to existing roof members, by showing the connection capacity is equal to or greater than the uplift force demands.

Connection Demand

Spacing perpendicular to rail	32.5	in	1/2 panel length
Roof Angle	20	degrees	
Roof Layout	Hip		
Wind Speed	98	mph	
Exposure Coefficient, K_z	0.57		
Topographic Factor, K_{zt}	1		
Directionality Factor, K_d	0.85		
Elevation Factor, K_e	1.00		
Velocity Pressure, q_z	16.0	psf	
Prying Coefficient	1		



	Zone 1	Zone 2n	Zone 3r		
Spacing parallel to rail	48	48	48	in	Max spacing
Effective Wind Area on each connection	10.8	10.8	10.8	ft^2	
GC_p (max)	2.00	2.95	3.54		
Exposed Panels? (γ_E = 1.5)	No	No	No		
Pressure Equalization Factor, γ_a	0.79	0.79	0.79		
Uplift Force	25.2	37.1	44.5	psf	
Max. Uplift Force / Connection (0.6 WL)	163.5	241.2	289.2	lbs	
Solar Dead Load (0.6 DL)	17.6	17.6	17.6	lbs	
Max. Uplift Force (0.6 WL - 0.6 DL)	**146.0**	**223.6**	**271.6**	**lbs**	

Connection Capacity

Pegasus Comp Mount

Fastener Type	Lag Screw		
Fastener Diameter	0.3125	in	
Embedment Length, min	2.5	in	
Lumber Species & Grade	DFL #2 (Assumed)		
Lumber Specific Gravity	0.5		
Nominal Withdrawal Capacity, W	665.0	lbs	NDS 12.2-1
# of Screws	1		
Load Duration Factor, C_D	1.6		
Adjusted Withdrawal Capacity, W'	**1064.0**	**lbs**	

Compare Adjusted Withdrawal Capacity to ASD Factored Demand

Zone 1	Zone 2n	Zone 3r
O.K.	O.K.	O.K.