

March 25, 2016

Everest Solar Systems, LLC
 3809 Ocean Ranch Blvd, Suite 111
 Oceanside, CA 92056
 Attn: Andy Neshat



RE: *CrossRail PV Panel Mounting System Evaluation*

To whom it may concern:

Per your request, Moment Engineering + Design has performed a comprehensive structural analysis of the Everest Solar CrossRail Solar PV Mounting System for typical installations in the State of California. When installed per the conditions and design criteria described herein, the CrossRail Solar PV Mounting System is compliant with the sections of the design reference documents noted below.

Design Reference Documents

- *2013 Triennial Edition of Title 24, California Code of Regulations*
 - *Based on 2012 International Building Code & 2012 International Residential Code*
- *ASCE/SEI 7-10 – Minimum Design Loads for Buildings and Other Structures*
- *2010 Aluminum Design Manual, by the Aluminum Association*
- Section and materials data provided by Everest Solar Systems
 - Rail section properties appear in the appendix to this report

Overview

The CrossRail PV-panel roof mounting system consists of aluminum support rails, module clamps, attachments, and fasteners spanning between points of attachment on an existing roof structure. For high snow load conditions, two additional extruded rails (X48) are used, for a total of four (4) per panel, and span lengths are limited to control excessive bending stresses and deflections.

Attachment of the CrossRail Mounting System to the existing roof structure shall be the responsibility of the installer, and should be analyzed by a registered design professional where required by the local authority having jurisdiction.

Methods & Design Parameters

Applicable combinations of dead, wind, and snow loads were evaluated in accordance with current code requirements to determine allowable rail span lengths, based on assumptions of simple-span conditions and maximum allowable deflection of $L/120$.

Design wind pressures were determined using Components and Cladding calculations in Chapter 26-30 of ASCE 7-10, using the loading parameters listed below. Configurations not conforming to these parameters will require additional analysis. Calculation of applicable roof snow load should be based upon ground snow load maps and equations and factors of ASCE 7-10, Chapter 7 and applicable sections of the 2013 CBC. For designated Case Study areas noted in the 2013 Triennial Edition of Title 24, California Code of Regulations, refer to local jurisdiction requirements for snow and wind load determination. Seismic criteria were considered per provisions of ASCE 7-10 Chapter 13 with parameters specified below. While seismic effects did not appear to govern the capacity of this system, applicable seismic detailing requirements should be satisfied when installed per the manufacturer instructions and additional installation notes specified herein.

Loading Parameters:

- Ground snow load: Varies
- Roof snow load: 100 psf
- Ultimate 3-second gust wind speed (V): 110-140 mph
- Building roof mean height: 30 ft. or less
- Roof wind pressure region: Zone 1 - Zone 3
- Structural risk category: II
- Wind exposure: B, C
- Panel orientation: Portrait or Landscape
- Panel installation angle: Flush with roof slope
- Roof slope (θ): 0-7°, >7-27°, >27-45°

Design Results

The allowable span lengths of the system are principally controlled by applicable wind and snow loads to the structure. Refer to the CrossRail span tables in the appendix to this document for recommended rail configurations based on combinations of these loading parameters. Note that reaction loads provided in the attached tables are only applicable when used with the corresponding span length recommendations provided therein. These reactions may be scaled linearly when shorter spans are used.

Installation Notes

The following guidelines apply to all installations using the CrossRail product line:

- Tables assume two independent support rails per row with either panel orientation.
- Maximum end cantilever of aluminum support rail shall not exceed one-third (1/3) of allowable span in the roof wind pressure zone of the cantilever.
- Rails shall be continuous (not spliced) over a minimum of two supports.
- Installation over roof overhangs or within 10" of any roof edge is not advised.
- Observe all local jurisdictional requirements regarding roof setback requirements.
- Ensure that actual span length does not exceed capacity of roof attachment.

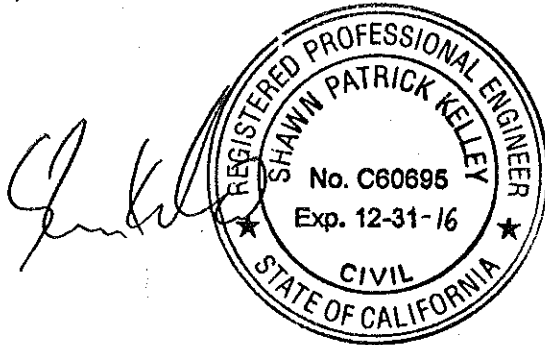
Summary

This assessment has provided design validation for code-compliant installations of the CrossRail PV Mounting System in the State of California. For the configurations and design loadings noted previously, the attached span tables represent maximum span lengths based on allowable stresses and deflection criteria. For all other configurations, refer to Everest Solar Systems for engineering support.

This report does not provide analysis of roof attachment hardware, nor of any existing structures, as may be required by the local authority having jurisdiction.

We appreciate the opportunity to have assisted you with this project. Should you have any further questions regarding this analysis, please feel free to contact us by phone or email.

Best Regards,



Shawn P. Kelley, P.E.

Principal

moment ENGINEERING + DESIGN

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Table 1: Allowable Span and Maximum Reaction Loads							
Exposure B	Design Wind Speed, V (mph)	Rail Type	Roof Snow Load (psf)	Allowable span (in)	Max. uplift (lb.)	Max. downforce (lb.)	Max. shear (lb.)
Roof Wind Pressure Zone 1	110	X48	100	38	-99	898	0
	115	X48	100	38	-110	898	0
	120	X48	100	38	-121	898	0
	130	X48	100	38	-144	898	0
	140	X48	100	38	-170	898	0
Roof Wind Pressure Zone 2	110	X48	100	38	-176	898	0
	115	X48	100	38	-194	898	0
	120	X48	100	38	-213	898	0
	130	X48	100	38	-252	898	0
	140	X48	100	38	-295	898	0
Roof Wind Pressure Zone 3	110	X48	100	38	-273	898	0
	115	X48	100	38	-300	898	0
	120	X48	100	38	-327	898	0
	130	X48	100	38	-387	898	0
	140	X48	100	38	-451	898	0

Table 2: Allowable Span and Maximum Reaction Loads							
Exposure B	Design Wind Speed, V (mph)	Rail Type	Roof Snow Load (psf)	Allowable span (in)	Max. uplift (lb.)	Max. downforce (lb.)	Max. shear (lb.)
Roof Wind Pressure Zone 1	110	X48	100	34	-81	728	339
	115	X48	100	34	-90	728	339
	120	X48	100	34	-99	728	339
	130	X48	100	34	-118	728	339
	140	X48	100	34	-139	728	339
Roof Wind Pressure Zone 2	110	X48	100	34	-150	728	339
	115	X48	100	34	-165	728	339
	120	X48	100	34	-181	728	339
	130	X48	100	34	-215	728	339
	140	X48	100	34	-251	728	339
Roof Wind Pressure Zone 3	110	X48	100	34	-228	728	339
	115	X48	100	34	-250	728	339
	120	X48	100	34	-274	728	339
	130	X48	100	34	-323	728	339
	140	X48	100	34	-377	728	339

Table 3: Allowable Span and Maximum Reaction Loads								
Exposure B	Design Wind Speed, V (mph)	Rail Type	Roof Snow Load (psf)	Allowable span (in)	Max. uplift (lb.)	Max. downforce (lb.)	Max. shear (lb.)	
ROOFS >27° TO 45°	Roof Wind Pressure Zone 1	110	X48	100	33	-89	631	458
		115	X48	100	33	-98	631	458
		120	X48	100	33	-107	631	458
		130	X48	100	33	-128	631	458
		140	X48	100	33	-150	631	458
	Roof Wind Pressure Zone 2	110	X48	100	33	-105	631	458
		115	X48	100	33	-116	631	458
		120	X48	100	33	-127	631	458
		130	X48	100	33	-151	631	458
		140	X48	100	33	-177	631	458
	Roof Wind Pressure Zone 3	110	X48	100	33	-105	631	458
		115	X48	100	33	-116	631	458
		120	X48	100	33	-127	631	458
		130	X48	100	33	-151	631	458
		140	X48	100	33	-177	631	458

Table 4: Allowable Span and Maximum Reaction Loads								
Exposure C	Design Wind Speed, V (mph)	Rail Type	Roof Snow Load (psf)	Allowable span (in)	Max. uplift (lb.)	Max. downforce (lb.)	Max. shear (lb.)	
ROOFS 0° TO 7°	Roof Wind Pressure Zone 1	110	X48	100	38	-145	898	0
		115	X48	100	38	-159	898	0
		120	X48	100	38	-175	898	0
		130	X48	100	38	-208	898	0
		140	X48	100	38	-244	898	0
	Roof Wind Pressure Zone 2	110	X48	100	38	-253	898	0
		115	X48	100	38	-277	898	0
		120	X48	100	38	-304	898	0
		130	X48	100	38	-359	898	0
		140	X48	100	38	-419	898	0
	Roof Wind Pressure Zone 3	110	X48	100	38	-388	898	0
		115	X48	100	38	-426	898	0
		120	X48	100	38	-464	898	0
		130	X48	100	38	-548	898	0
		140	X48	100	38	-637	898	0

Table 5: Allowable Span and Maximum Reaction Loads							
Exposure C	Design Wind Speed, V (mph)	Rail Type	Roof Snow Load (psf)	Allowable span (in)	Max. uplift (lb.)	Max. downforce (lb.)	Max. shear (lb.)
Roof Wind Pressure Zone 1	110	X48	100	34	-118	728	339
	115	X48	100	34	-131	728	339
	120	X48	100	34	-143	728	339
	130	X48	100	34	-170	728	339
	140	X48	100	34	-200	728	339
Roof Wind Pressure Zone 2	110	X48	100	34	-215	728	339
	115	X48	100	34	-236	728	339
	120	X48	100	34	-259	728	339
	130	X48	100	34	-305	728	339
	140	X48	100	34	-356	728	339
Roof Wind Pressure Zone 3	110	X48	100	34	-324	728	339
	115	X48	100	34	-355	728	339
	120	X48	100	34	-388	728	339
	130	X48	100	34	-457	728	339
	140	X48	100	34	-533	728	339

Table 6: Allowable Span and Maximum Reaction Loads							
Exposure C	Design Wind Speed, V (mph)	Rail Type	Roof Snow Load (psf)	Allowable span (in)	Max. uplift (lb.)	Max. downforce (lb.)	Max. shear (lb.)
Roof Wind Pressure Zone 1	110	X48	100	33	-128	631	458
	115	X48	100	33	-141	631	458
	120	X48	100	33	-154	631	458
	130	X48	100	33	-183	631	458
	140	X48	100	33	-214	632	458
Roof Wind Pressure Zone 2	110	X48	100	33	-152	631	458
	115	X48	100	33	-166	631	458
	120	X48	100	33	-182	631	458
	130	X48	100	33	-216	631	458
	140	X48	100	33	-252	632	458
Roof Wind Pressure Zone 3	110	X48	100	33	-152	631	458
	115	X48	100	33	-166	631	458
	120	X48	100	33	-182	631	458
	130	X48	100	33	-216	631	458
	140	X48	100	33	-252	632	458

Table 7: CrossRail Section Properties		
	X48	(unit)
Cross Sectional Area (A)	0.7130	(in ²)
Moments of Inertia:		
Principal (Ix)	0.2518	(in ⁴)
Secondary (Iy)	0.2306	(in ⁴)
Section Moduli:		
Principal (Sx)	0.2457	(in ³)
Secondary (Sy)	0.2966	(in ³)
Material: AL EN AW 6063-T66		