

STRUCTURAL CERTIFICATION & SPAN TABLES FOR STANDARD (STD) LIGHT RAILS

for State of California

[WIND EXPOSURE D]

Prepared for: GripRac

Prepared By:



GETSTRUCTURAL
ENGINEERING AND CONSULTING

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GripRac

633 S. La Brea Ave.

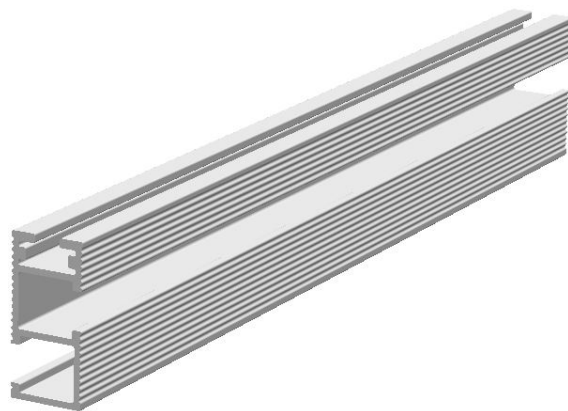
Los Angeles, CA 91320

RE: Structural Certification & Span Tables for GripRac STD Light Rails

The scope of this report focuses on providing a structural verification of aluminum extruded railing intended for mounting solar panels atop of rooftops for the STD light rails manufactured by GripRac.

The structural performance of the railing has been verified to be in compliance with the requirements of the 2019 California Building Code and ASCE 7-16 under prescribed wind and snow loading in the state of California. The construction and application of the aluminum railing shall be accordance with the installation guide for the solar mounting solutions provided by GripRac. Structural verification of the roof frame members and the solar panels are excluded and beyond the scope of this report.

Figure 1:



Rail Section Sketch

Design Approach

The railing section as illustrated in Figure 1: was modeled as a simply supported beam undergoing wind loads applied as a point load from the mid-clamps at the panel joints.

The resulting applied bending moments was then checked with the allowable bending moment of the aluminum rail section based on the equation below:

$$F_a = 0.6 F_y = 0.6 \times 35 \text{ ksi} = 21 \text{ ksi}$$

- $F_y = 35 \text{ ksi}$ (6005 T-5 Aluminum)

The applied bending stress from the worst case loading condition is based on the following equation, where the geometric properties were derived from engineering software (See Figure 2):

$$f = M \div S = M \times (I \div c)$$

- M is the moment based on the wind loads
- S is the section modulus of rail section

Figure 2:

Geometric Properties

Area	0.407 in ²
Ix	0.143 in ⁴
Ixy	-0.006 in ⁴
Iy	0.037 in ⁴
Sx+	0.175 in ³
Sx-	0.148 in ³
Sy+	0.090 in ³
Sy-	0.090 in ³
Xc	3.123 in
Yc	6.641 in
rx	0.592 in
ry	0.303 in

Principal Properties

I1	0.143 in ⁴
I2	0.037 in ⁴
S1+	0.171 in ³
S1-	0.146 in ³
S2+	0.081 in ³
S2-	0.079 in ³
r1	0.593 in
r2	0.302 in
α	3.224 deg

Polar Properties

Ip	0.180 in ⁴
rp	0.666 in

Overall Properties

Depth	1.780 in
Perimeter	10.958 in
Weight	0.001 K/ft
Width	0.830 in

Plastic Properties

Xpna	3.123 in
Ypna	6.665 in
Zx	0.216 in ³
Zy	0.115 in ³

Geometric Properties Output from ShapeBuilder Software (IES)

Worst case loading conditions were based on the following two load combinations per section 2.4 of ASCE 7-10:

1. $D + 0.6W$
2. $D + 0.75L + 0.4W + 0.75S (L=0)$

Where D is the dead load of the panels and racking equipment, W is the wind uplift loads at the anchors and S represents the ground snow load value. The tabulated results of the maximum rail span according to the worst case loading conditions are provided in this report (See Figure 3).

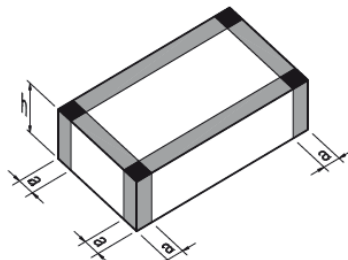
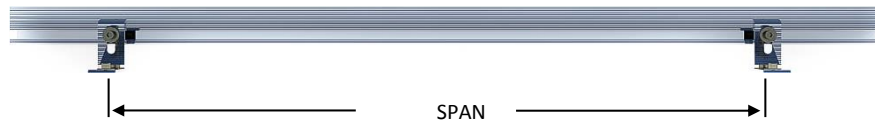
Design Criteria

The following parameters were considered in determining the values of the allowable span charts of the railing:

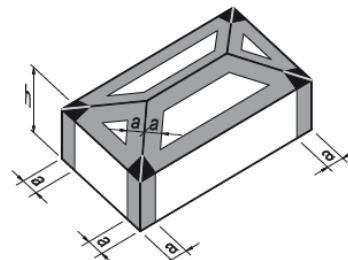
- Maximum Building Height Considered = 30 ft
- Exposure Categories Considered: C & D
- Wind Pressure Based on Section 30.4 (Method 1)
- Gust Factor, $G = 0.85$
- Topography Factor, $K_{zt} = 1.0$
- Directionality Factor, $K_d = 0.85$
- Importance Factor, $I = 1.0$
- Gable & Flat Roofs Type Considered
- Zone 2 Pressures Only Considered
- Minimum 2 Rails Per Panel
- Maximum Cantilever of Railing from Anchor = 12 inches
- Tilt Angles Considered: 0 to 30 degrees
- Performance Not Limited to Deflection
- Adequacy of Attachments Based on Evaluation Report By Others

Figure 3:

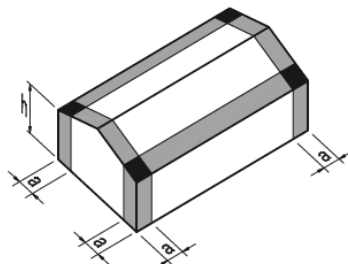
ZONE 2 (EXPOSURE C)						ZONE 2 (EXPOSURE D)					
LOAD		RAIL SPAN				LOAD		RAIL SPAN			
Snow (PSF)	Wind (MPH)	4'	6'	8'	10'	Snow (PSF)	Wind (MPH)	4'	6'	8'	10'
0-10	90	[Shaded]				0-10	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
20	90	[Shaded]				20	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
30	90	[Shaded]				30	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
40	90	[Shaded]				40	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
50	90	[Shaded]				50	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
60	90	[Shaded]				60	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
70	90	[Shaded]				70	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
80	90	[Shaded]				80	90	[Shaded]			
	110	[Shaded]					110	[Shaded]			
	130	[Shaded]	[Shaded]	[Shaded]	[Shaded]		130	[Shaded]	[Shaded]	[Shaded]	[Shaded]
90	90	[Shaded]	[Shaded]	[Shaded]	[Shaded]	90	90	[Shaded]	[Shaded]	[Shaded]	[Shaded]
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	110	[Shaded]	[Shaded]	[Shaded]	[Shaded]		110	[Shaded]	[Shaded]	[Shaded]	[Shaded]
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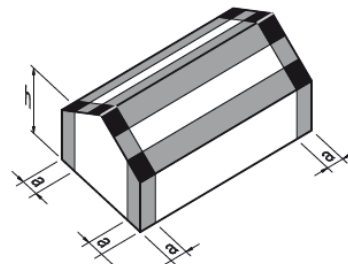
Flat Roof



Hip Roof ($7^\circ < \theta \leq 27^\circ$)



Gable Roof ($\theta \leq 7^\circ$)



Gable Roof ($7^\circ < \theta \leq 45^\circ$)

□ Interior Zones
Roofs - Zone 1 / Walls - Zone 4

■ End Zones
Roofs - Zone 2 / Walls - Zone 5

■ Corner Zones
Roofs - Zone 3

Design Code References

The following engineering references were considered in determining the values of the wind load conditions and material properties of the aluminum railing:

- IBC 2018
- ASCE 7-16 (Wind & Snow Loading)
- Aluminum Design: Aluminum Design Manual 2010

The structural verification and installation of the STD light rails shall be subject to the following qualification and conditions.

- There shall be a minimum of 2 rails provided per solar panel.
- Panels shall be considered slippery surface for accumulation of snow.
- All other components such as clamps and splices shall be installed per installation manual.
- The deflection of the railing has not been controlled in the design. If deflection is to be limited, then spacing shall be reduced as advised by a practicing structural engineer.
- Building is not a special occupancy structure such as a public school, public safety building or assembly building.
- The installation of the framing shall conform to relevant Building Codes, Manufacturer's specifications and good building practice.
- The cantilever span of the railing shall not exceed 12 inches.
- Attachment of lag screws shall be installed per the requirements of 2015 National Design (NDS).

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- Structural verification of the existing roof frame members and solar panels are excluded in this report.
 - Proper attachment to roof frame member shall be verified a qualified inspector or building official.
 - Dissimilar metals shall be separated with a suitable inert material to prevent galvanic corrosion.
 - The installation and fixings shall be periodically inspected and maintained.

Please feel free to contact us with any questions or concerns regarding the information provided in this report.

Respectfully Submitted,



GETSTRUCTURAL
ENGINEERING AND CONSULTING

Phong “Paul” Truong, P.E.
Principal

