



DOTec ENGINEERING

A DIVISION OF DOTEC CORPORATION

STRUCTURAL TESTING AND ANALYSIS (STATIC LOAD RESULTS)

Project: Spider Rax Black Widow and Red Widow Roof Mounting System for Pitched Rooftops (Oregon)
Location: State of Oregon
Client: Spider Rax

Applicable Codes:

- 2012 International Building Code
- ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, by ASCE/SEI, 2010
- 2008 National Design Specifications (NDS) for Wood Construction
- 2012 International Residential Code

Material Specifications for testing

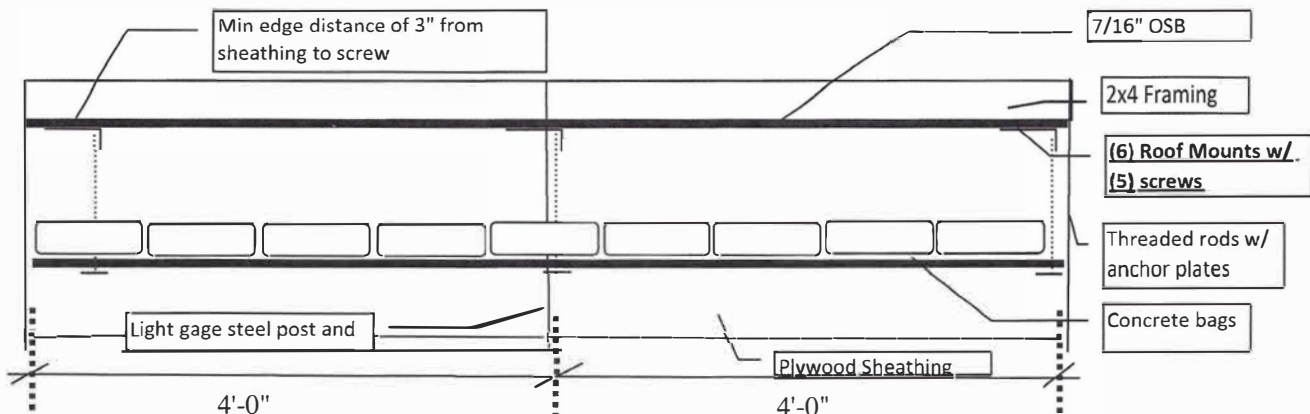
- 7/16" thick OSB sheathing, 24/16 Panel Index. 4ft wide by 8ft long
- Extruded Aluminum (See specifications). Includes bracket (foot/panel mount) and clamp
- Kwikseal II Woodbinder #12 x2" screw (5 per mount). See specifications
- #14 wood screw to connect 2x4 framing
- 2x4 Doug Fir-Larch framing
- 3/8" A307 Threaded rod, nut and washer
- 5/8" thick Plywood sheathing
- Light gage steel framing (Posts, ties and clips)
- 90 lbs concrete mix bags (19 total)

Test Objectives

Roof mounts tested to verify capacity (and factor of safety) against pull out and lateral shear forces, as well as deflections.

Test setup (Pull out forces)

2x4 doug fir framing is attached to light gage steel framing. OSB Sheathing is attached to 2x4 doug fir framing. Mounts are attached to OSB sheathing with WoodBinder Kwikseal II #12 screws, 3in min from edge of OSB. Threaded rod is connected to roof mount and attached to plywood sheathing loading platform.





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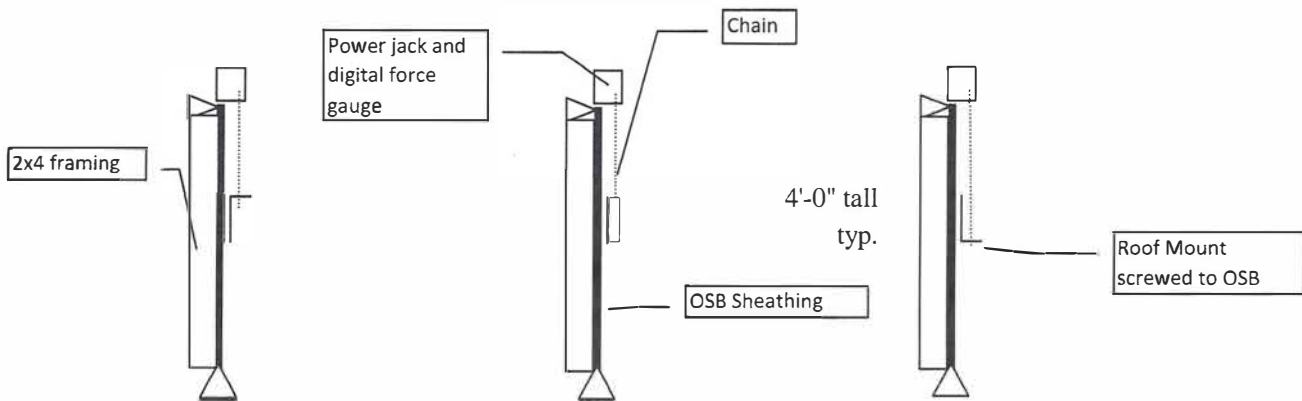
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Test procedure and results (Pull out forces)

The test setup was loaded with concrete mix bags up to failure. Concrete mix bags were placed on the plywood sheathing platform at a rate of 1 bag per minute. Each bag weighs 90 lbs. The total load on the system before failure was equivalent to 55 lbs/ft². The maximum roof mount deflection recorded was 0.25" at a point before failure.

Test setup (Lateral Shear forces for individual mount)

2x4 framing is braced vertically. OSB sheathing is attached to 2x4 framing. Hydraulic jack and digital force gauge were connected to roof mount with a chain. Roof mount was attached to OSB sheathing with Kwikseal screws. Roof mount was attached in (3) different configurations.



Test procedure and results (Lateral Shear forces per individual mount)

East test setup configuration was loaded at a rate of 100 lbs/min with a hydraulic jack and verified with a digital force gauge. The average shear load was 1191 lbs. per mount. Center of mounts were located 12" from rafter.

Design Assumptions and conclusions

- 1 Basic Wind Speed for Risk Category II per ASCE 7-10 (Strength level, excluding Special Wind Regions)
- 2 Maximum mean roof height of no more than 30'-0" as defined by ASCE 7-10
- 3 Exposure Category B, C or D as defined by ASCE 7-10
- 4 Dry service conditions (proper water proofing to be installed)
- 5 Roof sheathing minimum thickness of 7/16" OSB. Panel Index 24/16, with rafters spaced at 24" o.c. max.
- 6 Four PV mounts per PV module, such that adjacent modules share two PV mounts
- 7 Array may be located within zones 1, 2 for hip or gable roofs with a min pitch of 7° to a maximum pitch of 45°
- 8 *Snow load of no more than 50 lbs/ft²
- 9 Fasteners installed per manufactured specifications
- 10 **(6) fasteners per mount**
- 11 Structure is considered an enclosed building



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Design Assumptions

- 13 Analysis of the mount is based upon the maximum effects of either the largest gravity loads or wind uplift loads. The point loads (either positive or negative) can act in either direction depending on the type of loading (i.e. wind, snow... etc)
- 14 Modules may be installed in landscape or portrait orientation
- 15 Modules may have maximum dimensions of 39" in width and 77" in length
- 16 Terrain Topographic factor $K_{zt} = 1.0$

*Balboa Heritage Developments has reviewed the Spider Rax Black and Red Widow Roof Mounting system with **testing data and analytical procedures**, and certifies that the roof mounts, as specified above in the design assumptions, can withstand a wind pressure equivalent to a wind speed (strength level) of approximately **135mph****. The mounting fasteners performed as expected against axial and shear forces in the OS^D*

Sincerely

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This engineering report verifies that Balboa Heritage Development has provided independent observation for loads testing as described in this report. The results of this load test reflect actual deflection values and are generally accepted as the industry standard for testing module mounting systems. Balboa Heritage Developments does not field check installations or verify that the mounting system is installed as described in this engineering report.

Balboa Heritage Developments does not express an opinion as to the load bearing characteristics of the structure the mounting system/modules are being installed on.

Installer shall verify proper flashing and/or protection to weather of the roof mount after installation. Balboa Heritage Developments does not express an opinion of the after installation conditions of the equipment.

* Based on provisions on ASCE 7-10, Chapter 7. (Case Study areas are not considered)

** As described on Figure 26.5-1A of the ASCE7-10 Standard for Min. Design Loads for Buildings & other Structures
Values are nominal design 3-second gust wind speed in miles per hour

Attachments:

- 1 Related ASCE 7-10 tables and figures
- 2 Black and Red Widow Roof Mount specifications
- 3 Kwikseal II Wood Binder fastener specifications