April 6, 2018

Quick Mount PV
Attn: Marshall Green (email)
2700 Mitchell Drive
Walnut Creek, CA 94598

Job No: 11304

Job Name: Quick Mount PV On-Call Lab Testing
Walnut Creek, CA

Subject: Quick Mount PV Load Testing - L-Mount with QMPV Dual Drive Structural Screw
[QMPV# 20170517-Revision E]

Mr. Green,

In accordance with your authorization, Construction Testing Services (CTS) performed load testing on the Quick Mount PV L-Mount with QMPV Dual Drive Structural Screw (P/N #0214/0215). Structural tests included tensile (uplift) and lateral (Parallel and perpendicular to rafter). The L-Mount was fastened to a 2"x4" Douglas Fir Rafter using a single 5/16" diameter by 4-1/2" long QMPV Dual Drive Structural Screw. Testing was conducted in general accordance with industry standard testing procedures, including ASTM D1761-12, D2395-14, and ICC AC13.

Test Equipment

Equipment used to perform the various tests include:

- Instron 100HDX Universal Tensile/Compression Machine; Calibrated 09/1/2017
- Delmhorst BD-2100 Moisture Meter; Calibrated daily
- Quincy Lab Inc. 21-250 Oven; Calibrated 02/6/2018
- Digital Caliper AB11881; Calibrated 02/6/2017
- AE Adam PGL 30001 Scale; Calibrated 02/5/2017

Sample Description

(31) 16”x16” wood test boards were delivered to our laboratory on February 20, 2018. Each specimen was made up of 2”x4” lumber, topped with ½” OSB, 30 lb. felt paper, and comp shingles layered to represent typical installation applications. The L-Mount was fastened to a 2”x4” Douglas Fir Rafter using a single 5/16” diameter by 4-1/2” long QMPV Dual Drive Structural Screw. Test loads were applied directly to the L-Foot for tensile. Lateral test loads were applied to a block attached to the L-Foot to represent typical transfer of load from the rail into the L-Foot. See Figure 1 for a typical test board.

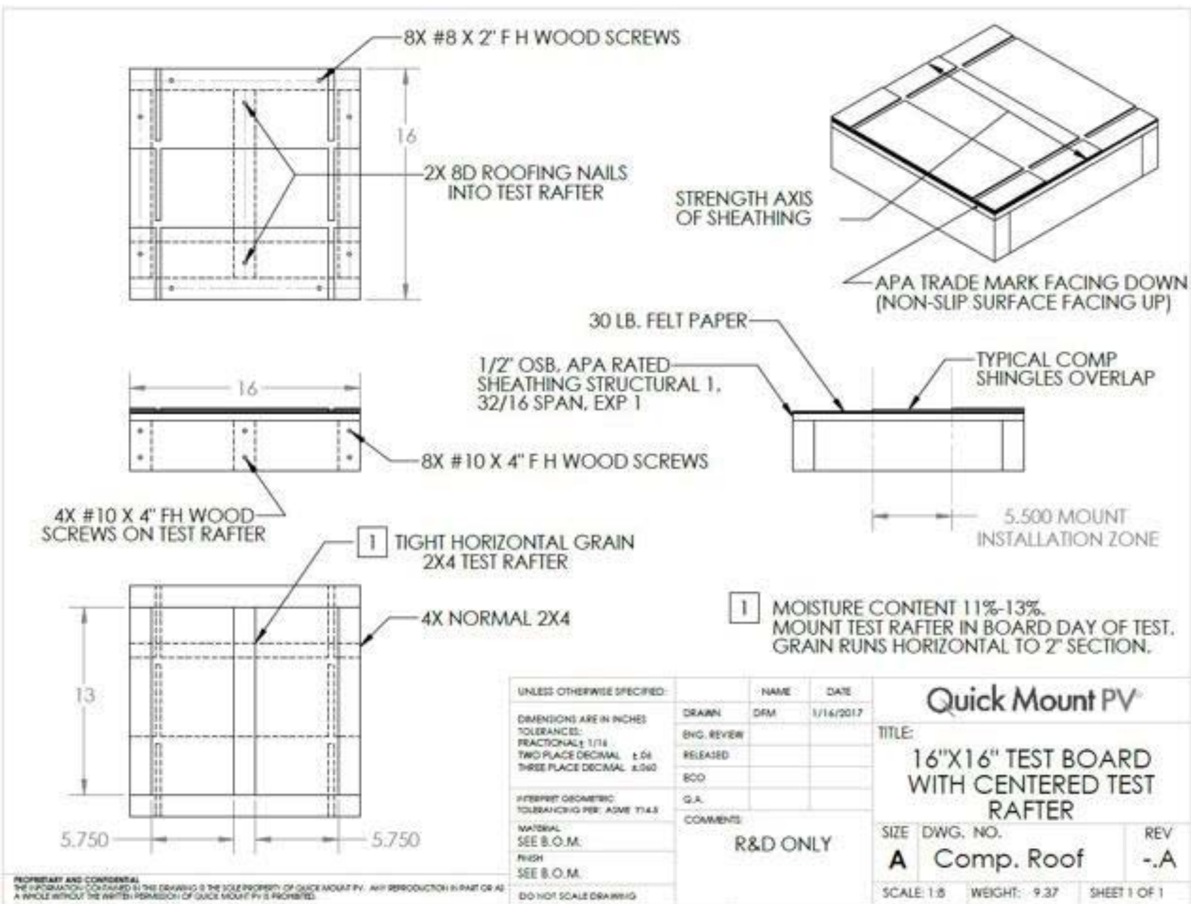

Figure 1: Typical Test Board

Structural Test Configurations and Results

Tensile (Uplift)

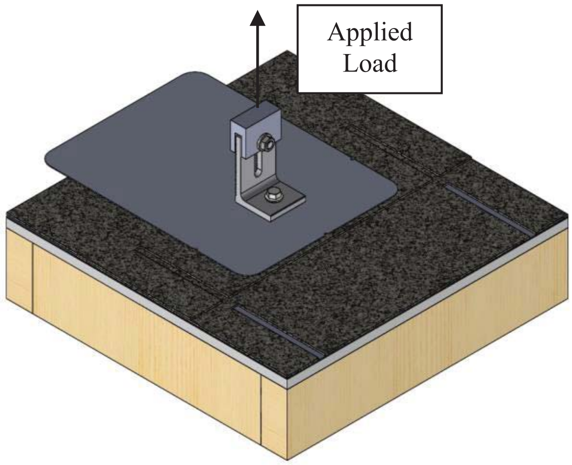

Figure 2: Tensile Load

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
DDSS.T1	0.4598	12.2	2620	0.7175	Lag Screw Pull Out
DDSS.T2	0.4513	12.7	1982	0.418	Lag Screw Pull Out
DDSS.T3	0.4997	13.0	2531	0.5377	Lag Screw Pull Out
DDSS.T4	0.4563	12.7	2314	0.5167	Lag Screw Pull Out
DDSS.T5	0.4561	12.2	2508	0.5138	Lag Screw Pull Out
DDSS.T6	0.4628	12.7	2314	0.4300	Lag Screw Pull Out
Average			2378		

Photo 1: Tensile Load (pre-test)

Photo 2: Tensile Load (post-test)

Lateral (Parallel to Rafter) - Downslope

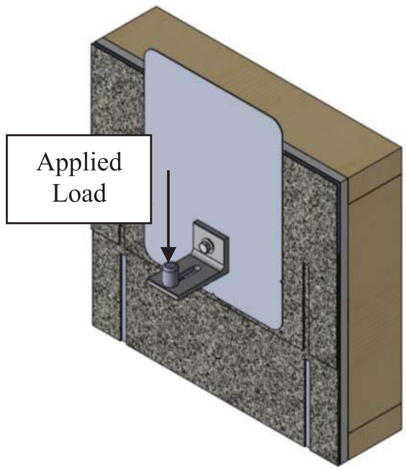

Figure 3: Lateral (Parallel to Rafter) - Downslope

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
DDSS.DS1	0.5903	11.5	651	0.7545	L-Foot Bending (Al Ductile)
DDSS.DS2	0.6142	12.2	655	0.7918	L-Foot Bending (Al Ductile)
DDSS.DS3	0.6115	12.0	633	0.7419	L-Foot Bending (Al Ductile)
DDSS.DS4	0.6281	11.2	618	0.8200	L-Foot Bending (Al Ductile)
Average			639		

Photo 3: Lateral Parallel to Rafter Eccentric Load (pre-test) - Downslope

Photo 4: Lateral Parallel to Rafter Eccentric Load (post-test) - Downslope

Lateral (Parallel to Rafter) - Upslope

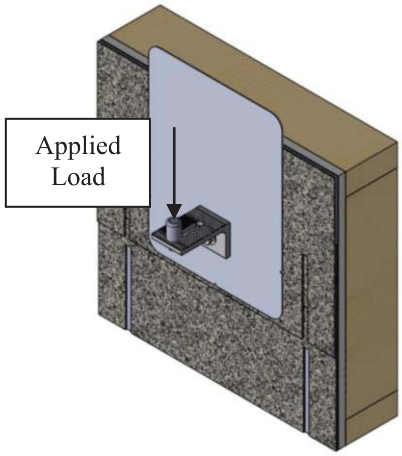

Figure 4: Lateral (Parallel to Rafter) - Upslope

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
DDSS.US1	0.5804	11.2	818	3.7510	Flashing Puncture/Lag Screw Pull Out
DDSS.US2	0.5947	12.1	676	4.5083	Flashing Puncture/Lag Screw Pull Out
DDSS.US3	0.6180	11.5	696	3.8030	Flashing Puncture/Lag Screw Pull Out
DDSS.US4	0.6277	11.6	696	3.9598	Flashing Puncture/Lag Screw Pull Out
DDSS.US5	0.5546	12.0	826	4.5253	Flashing Puncture/Lag Screw Pull Out
Average			742		

Photo 5: Lateral Parallel to Rafter Eccentric Load (pre-test) - Upslope

Photo 6: Lateral Parallel to Rafter Eccentric Load (post-test) - Upslope

Lateral (Perpendicular to rafter)

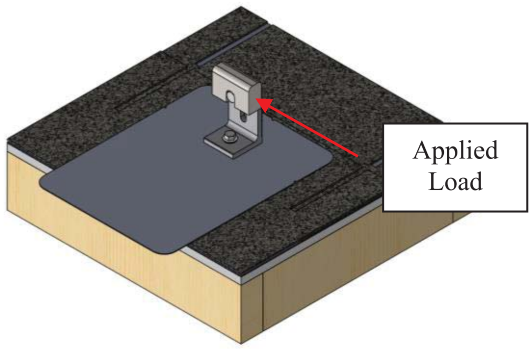

Figure 5: Lateral Perpendicular to Rafter Eccentric Load

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
DDSS.CS1	0.4480	11.6	713	1.0842	Flashing Puncture/Lag Screw Pullout
DDSS.CS2	0.4460	11.8	720	0.9852	Flashing Puncture/Lag Screw Pullout
DDSS.CS3	0.4546	11.3	652	0.7872	Flashing Puncture/Lag Screw Pullout
DDSS.CS4	0.6196	11.3	827	1.1642	Flashing Puncture/Lag Screw Pullout
DDSS.CS5	0.5669	11.4	928	1.2199	Flashing Puncture/Lag Screw Pullout
Average			768		

Photo 7: Lateral Perpendicular to Rafter Eccentric Load (pre-test) – Block Inside

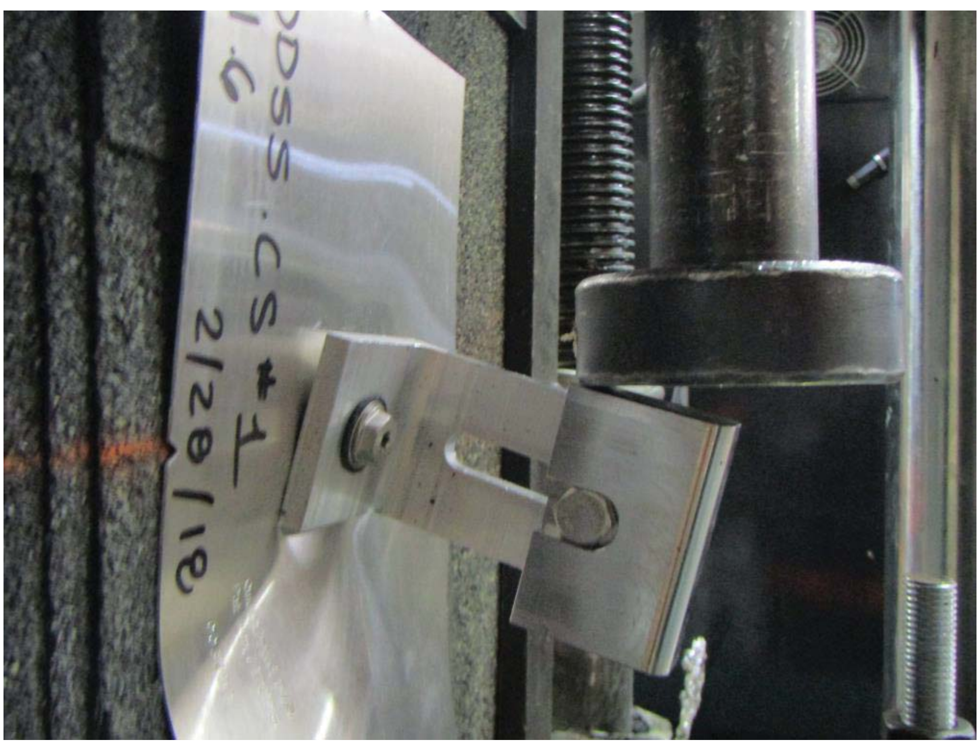

Photo 8: Lateral Perpendicular to Rafter Eccentric Load (post-test) – Block Inside

2118 Rheem Drive, Pleasanton, CA 94588 • Phone (925) 462-5151 • Fax (925) 462-5183
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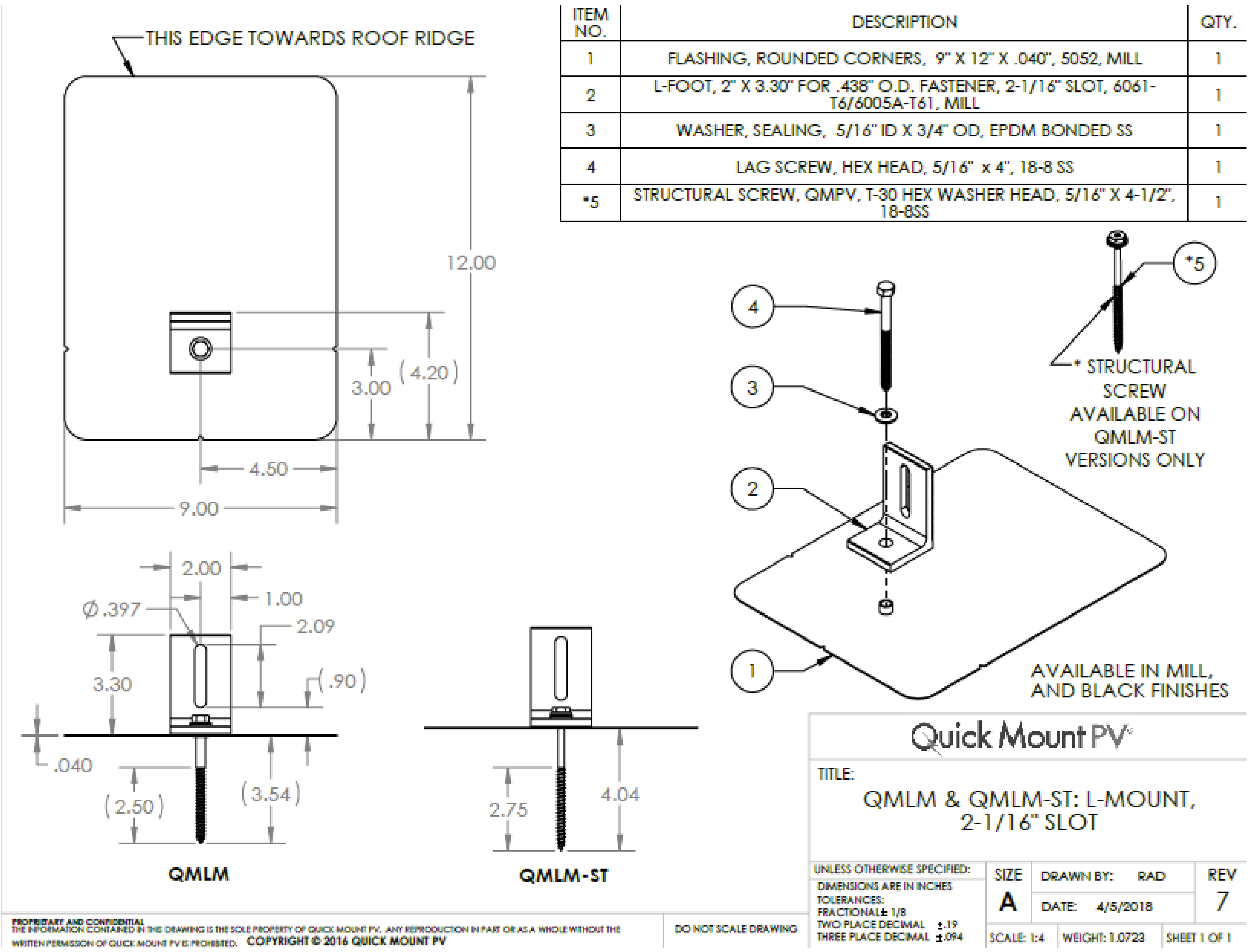
246 30th St., Suite 101, Oakland, CA 94601 • Phone (510) 444-4747 • Fax (510) 835-1825

Installation Drawings



ITEM NO.	DESCRIPTION	QTY.
1	FLASHING, ROUNDED CORNERS, 9" X 12" X .040", 5052, MILL	1
2	L-FOOT, 2" X 3.30" FOR .438" O.D. FASTENER, 2-1/16" SLOT, 6061-T6/6005A-T61, MILL	1
3	WASHER, SEALING, 5/16" ID X 3/4" OD, EPDM BONDED SS	1
4	LAG SCREW, HEX HEAD, 5/16" x 4", 18-8 SS	1
*5	STRUCTURAL SCREW, QMPV, T-30 HEX WASHER HEAD, 5/16" X 4-1/2", 18-8SS	1

Figure 6: Installation Drawing

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Limitations: Testing was conducted in general accordance with industry standard testing procedures, including ASTM D1761-12, D2395-14, and ICC AC13. The data provided is the result of those tests. CTS assumes no liability and makes no warranty, expressed or implied, as to the usefulness of any information, product, apparatus, or process disclosed.

REGISTERED PROFESSIONAL ENGINEER
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STATE OF CALIFORNIA

4/6/2018

Reviewed by Daniel Ventura, PE — Date
Associate Engineer

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