October 30, 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 – Shared Rail Composition Mount
[QMPV# 20180904-Revision A]

Mr. Green,

In accordance with your authorization, Construction Testing Services (CTS) performed load testing on the Quick Mount PV Shared Rail Composition Mount (P/N #0357/0359). Structural tests included tensile (uplift), compressive (down force), and lateral (parallel and perpendicular to rafter). The Shared Rail Composition Mount was fastened to a 2"x4" Douglas Fir Rafter using two 5/16" diameter by 4" long lag bolts. 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 09/5/2018
- 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

(19) 16”x16” and (7) 24”x16” wood test boards were delivered to our laboratory on September 14, 2018. Each specimen was made up of 2”x4” lumber, topped with ½” OSB, 30 lb. felt paper, and composition shingles layered to represent typical installation applications. The Shared Rail Composition Mount was fastened to a 2”x4” Douglas Fir Rafter using two 5/16” diameter by 4” long lag bolts. Test loads were applied directly to the L-Foot for tensile on a 16”x16” test board. Compressive and lateral (parallel to rafter) test loads were applied to a block attached to the L-Foot on a 16”x16” test board to represent typical transfer of load from the rail into the L-Foot. Lateral (perpendicular to rafter) test loads were applied directly to a rail mounted between (2) mounts on the 24”x16” test board. See Figure 1a and 1b for a typical test board.

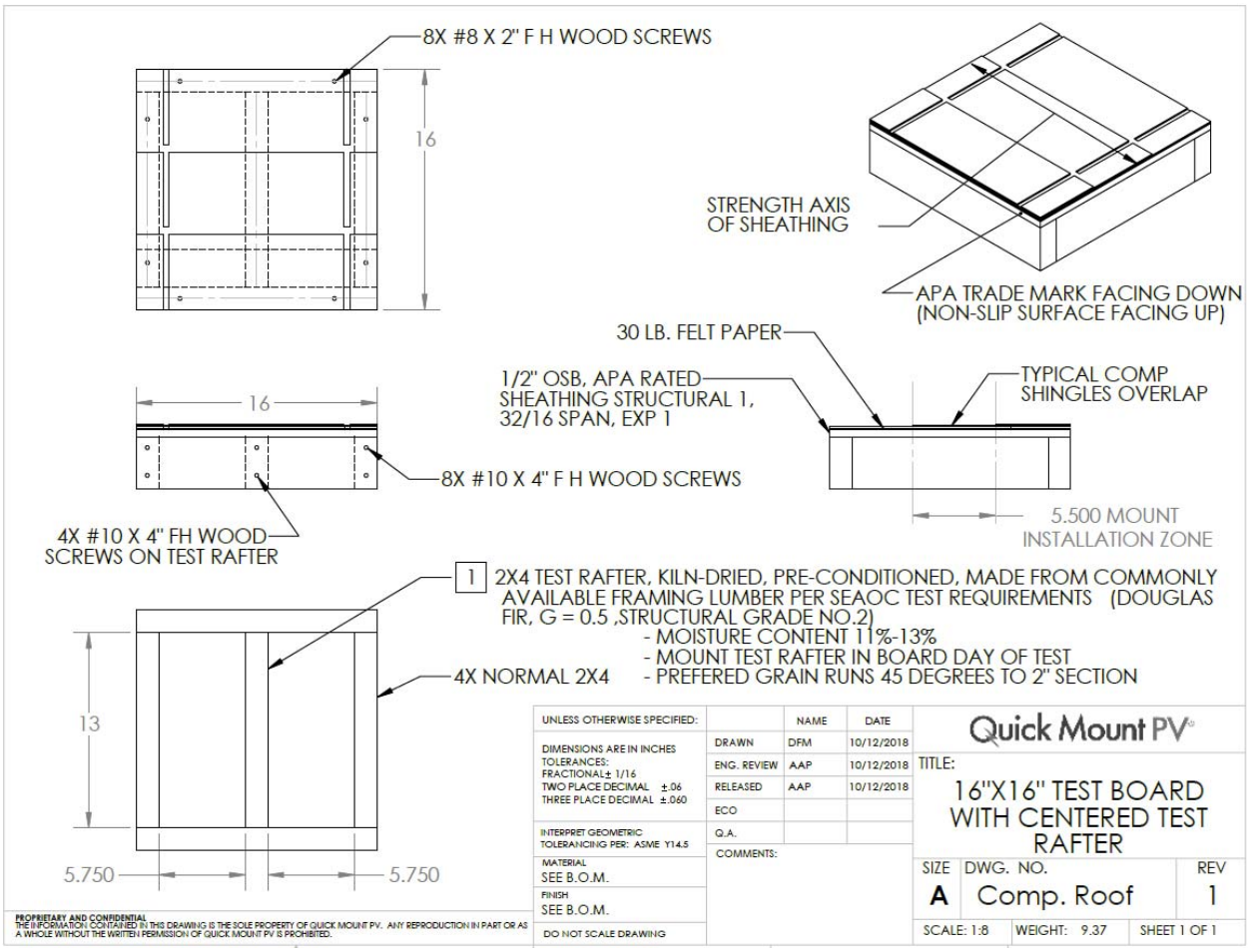


Figure 1a: Typical 16”x16” Test Board

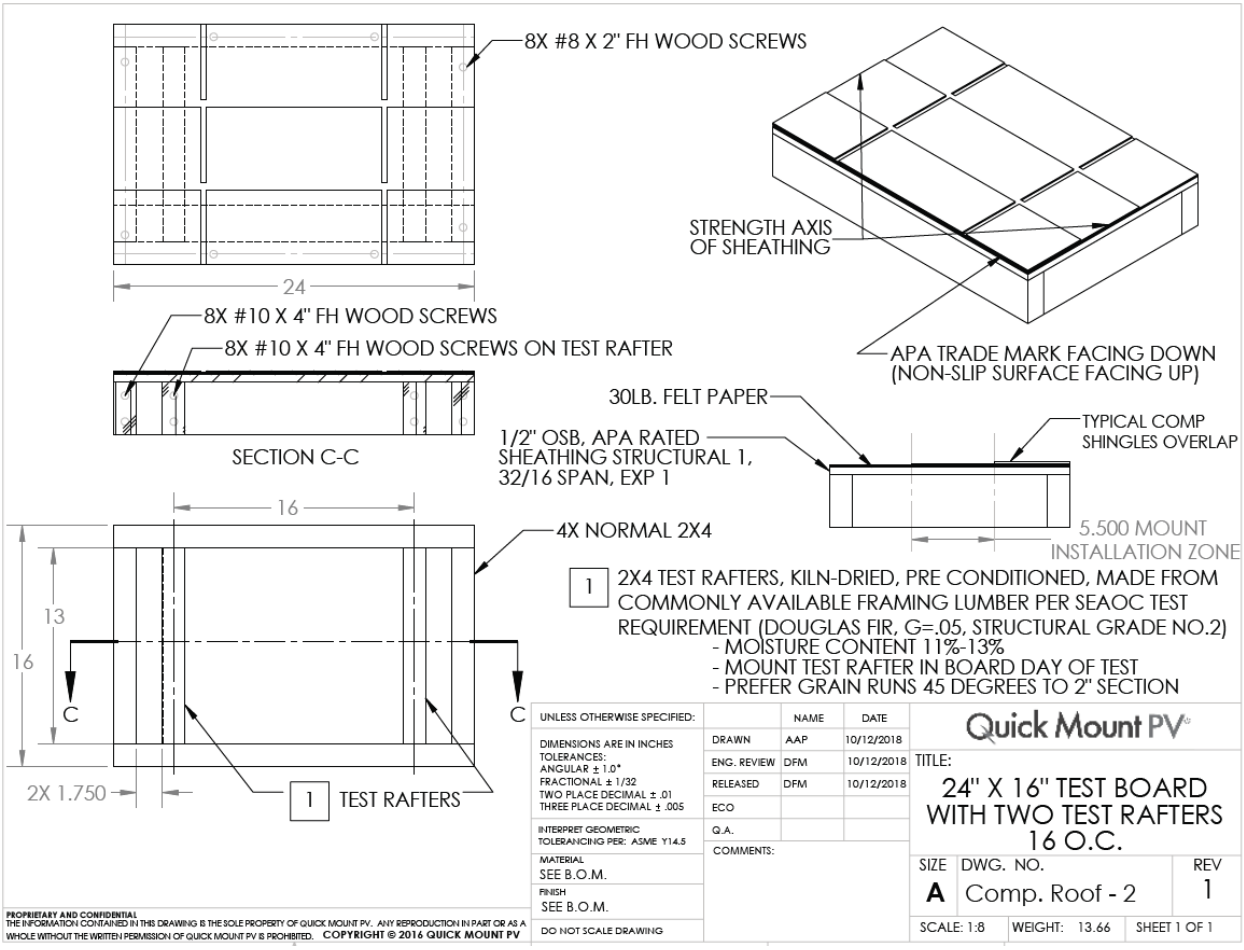


Figure 1b: Typical 24"x16" Test Board

Tensile (Uplift)

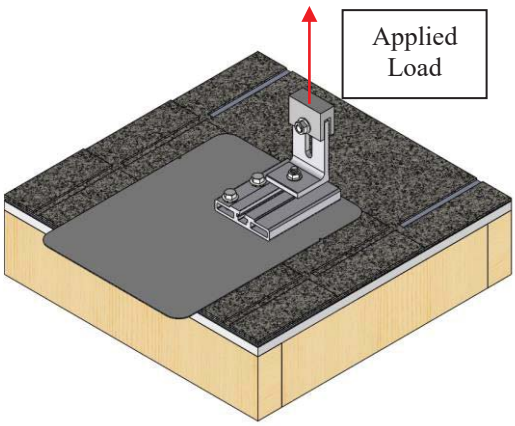


Figure 2: Tensile Load

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
T-1-11.2	0.4238	11.2	1648	0.8925	Lag Screw Withdrawal
T-2-11.5	0.4473	11.5	2033	1.0265	Lag Screw Withdrawal
T-3-11.2	0.4410	11.2	1942	1.0543	Lag Screw Withdrawal
T-4-12.0	0.4366	12.0	1845	0.9366	Lag Screw Withdrawal
T-5-12.0	0.4416	12.0	1996	0.9977	Lag Screw Withdrawal
T-6-11.9	0.4443	11.9	1714	0.8915	Lag Screw Withdrawal
T-7-11.1	0.4338	11.1	1759	2.755	Lag Screw Withdrawal
T-8-12.0	0.4415	12.0	1789	1.0025	Lag Screw Withdrawal
Average			1841		

Photo 1: Tensile Load (pre-test)

Photo 2: Tensile Load (post-test)

Compressive (Down Force)

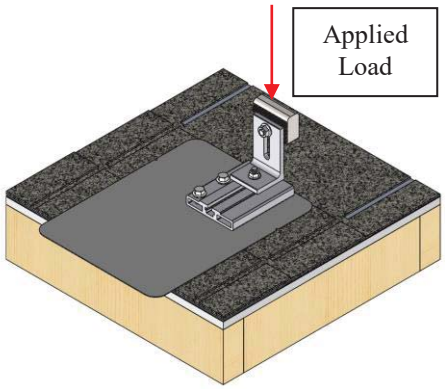


Figure 3: Compressive Load

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
C-1-11.1	0.4382	11.1	3143	0.4455	L-Foot Bending (Al Ductile)
C-2-11.4	0.4337	11.4	2342	0.3620	L-Foot Bending (Al Ductile)
C-3-11.2	0.4436	11.2	1964	0.3822	L-Foot Bending (Al Ductile)
C-4-11.3	0.4353	11.3	3024	0.3608	L-Foot Bending (Al Ductile)
C-5-11.7	0.4624	11.7	2097	0.3591	L-Foot Bending (Al Ductile)
C-6-11.7	0.4438	11.7	2451	0.4058	L-Foot Bending (Al Ductile)
C-7-11.6	0.4593	11.6	2161	0.4202	L-Foot Bending (Al Ductile)
Average			2455		

Photo 3: Compressive Load (pre-test)

Photo 4: Compressive Load (post-test)

Lateral (Parallel to Rafter)

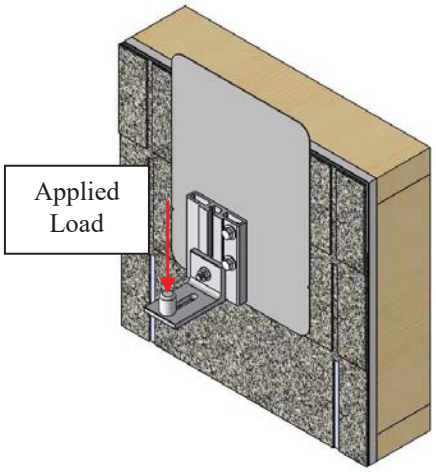


Figure 4: Lateral (Parallel to Rafter)

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
LD-1-11.8	0.4349	11.8	667	1.5725	L-Foot Bending (Al Ductile)
LD-2-11.2	0.4501	11.2	587	0.882	L-Foot Bending (Al Ductile)
LD-3-11.1	0.4597	11.1	567	0.7632	L-Foot Bending (Al Ductile)
LD-4-11.2	0.4354	11.2	624	0.8086	L-Foot Bending (Al Ductile)
Average			611		

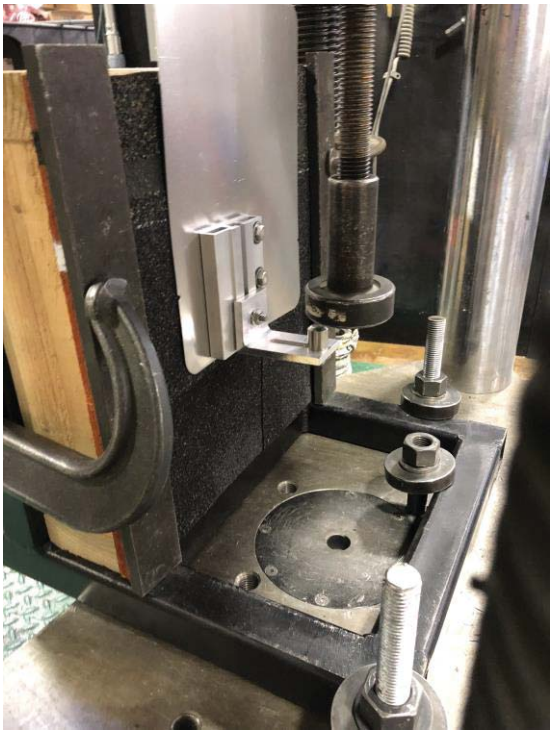


Photo 5: Lateral Parallel to Rafter Eccentric Load (pre-test)

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

Lateral (perpendicular to rafter)

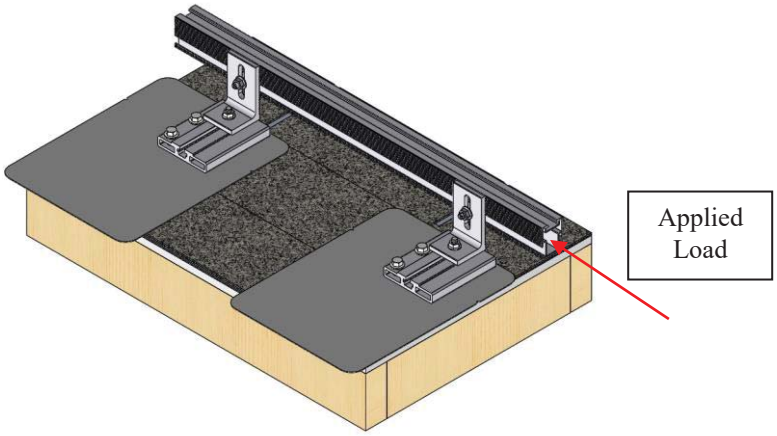


Figure 5: Lateral (Perpendicular to Rafter)

Sample Number	Rafter Specific Gravity at Moisture	Test Rafter Moisture Content [%]	Peak Load [lbs]	Deflection at Peak Load [in]	Failure Mode
VC-3	0.4657	11.8	1807	2.7182	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4541	12.5			
VC-4	0.4193	11.8	1466	2.2117	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4220	11.4			
VC-5	0.4490	11.2	1650	2.6252	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4478	11.2			
VC-6	0.5242	11.5	1565	2.8827	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4360	12.5			
VC-8	0.4612	11.9	1604	2.5045	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4321	12.2			
VC-9	0.4647	12.1	1826	3.2260	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4360	12.5			
VC-10	0.4660	11.6	1342	2.1570	Rail Fracture at T-Bolt Location (Al Brittle)
	0.4636	11.6			
Average			1609		

Note: Top row of each test represents the rafter closest to the applied load.

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

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

Installation Drawings

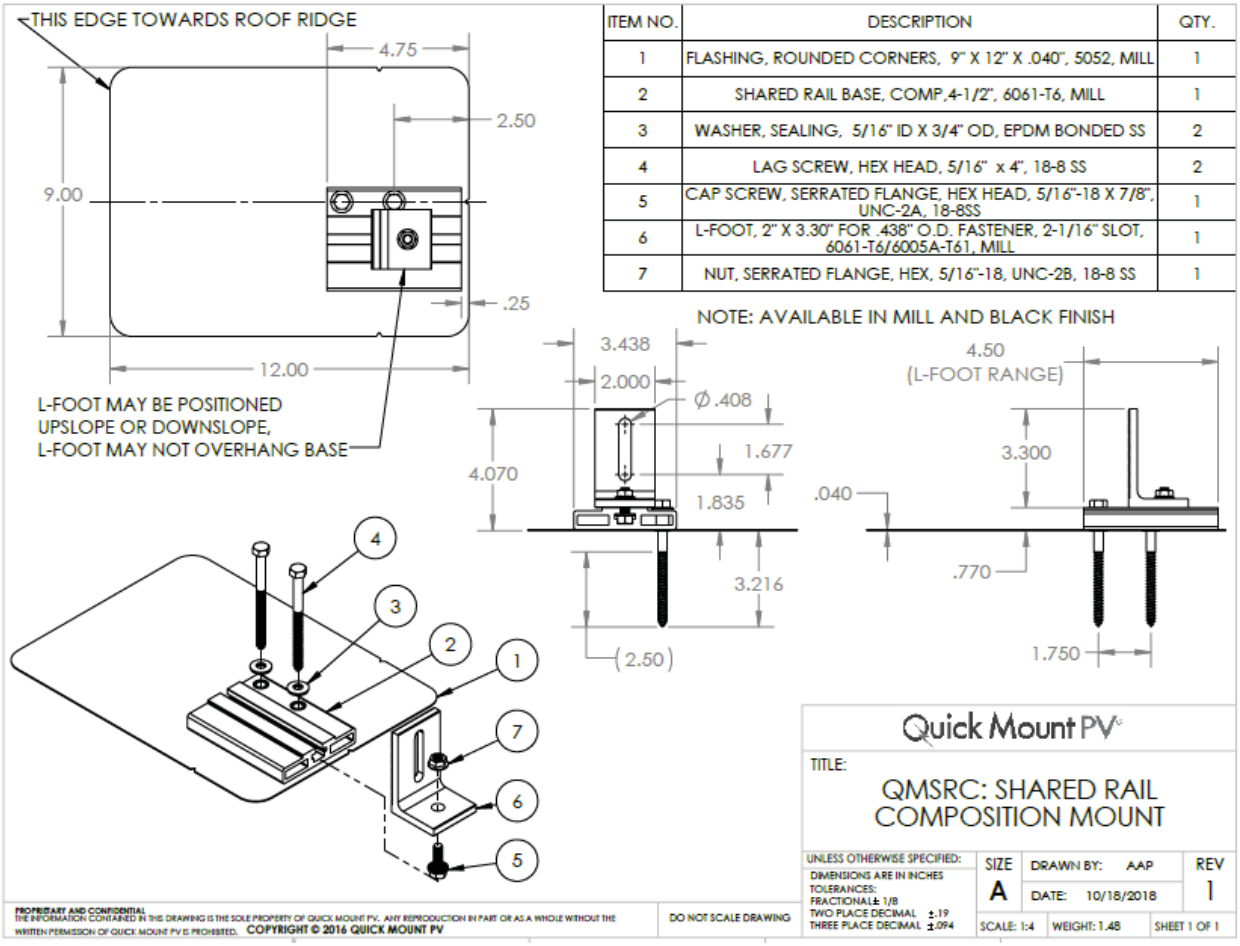
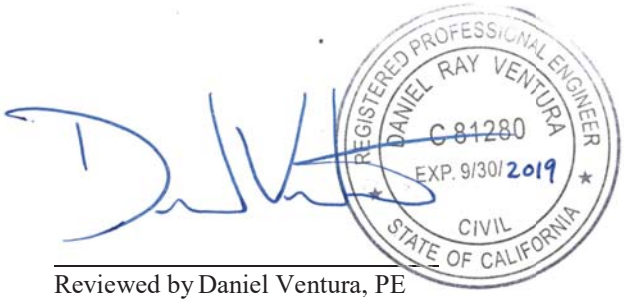


Figure 6: Installation Drawing

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.



Reviewed by Daniel Ventura, PE — 10/30/2018
Engineering Department Manager — Date

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