March 19th, 2015

Mr. Bryan Espiritu — Project Number 114490C
QUICKMOUNT PV
2700 Mitchell Dr., Bldg. 2
Walnut Creek, CA 94598

Subject: Laboratory Load Test of the QMHSB with 6061 Base Plate

Dear Mr. Espiritu:

As requested, Applied Materials & Engineering, Inc. (AME) has completed load-testing the QMHSB hardware with 6061 base plate. The purpose of our testing was to evaluate the tensile (uplift), compression, and lateral (perpendicular and parallel to rafter) load capacity of the QMHSB attached to a 2"x4" Douglas Fir rafter using two 5/16"Ø x 3.5" lag bolts in 6061 base plate.

SAMPLE DESCRIPTION

Samples were assembled in our laboratory between February 6th, February 14th and March 2nd, 2015. Mockup configuration consisted of three 16" long rafters at 4.5"o.c., screwed to 1/2" Structural I plywood. The QMHSB is attached through the plywood into a rafter with two 5/16"ø x 3.5" fasteners installed at the farthest point on the 6061 base plate. QMHSB and the 6061 base plate configurations are provided in Appendix A.

TEST PROCEDURES & RESULTS

1. Compressive Load Test

A total of six tests were conducted for compressive load capacity on February 14th, 2015 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a compressive load was applied to the hook. The samples were loaded in compression at a constant rate of axial deformation of 0.09 in. /min. without shock until the hook was bent and came in contact with the test board; displacement at maximum load was recorded. Based on the above testing, the average maximum compression load of the QMHSB attached to a 2"x4" Douglas Fir rafter using two 5/16"ø x 3.5" lag bolts was determined to be 1086 lbf. Detailed results are provided in Table I. Test setup and mode of failure are provided in Appendix B, Figure 1.

The specific gravity and moisture content of the rafters was tested in accordance with ASTM D2395, Method A (oven-dry). The average specific gravity and moisture content was determined to be 0.391 and 8.6 %, respectively.

2. Tensile (Uplift) Load Test

A total of six tests were conducted for tensile load capacity on March 2nd, 2015 using a United Universal testing machine. Samples were rigidly attached to the testing machine and an uplift load was applied to the hook. The samples were loaded in tension at a constant rate of axial deformation of 0.09 in. /min. without shock until failure occurred; displacement at maximum load was recorded. Based on the above testing, the average maximum tensile load of the QMHSB attached to a 2"x4" Douglas Fir rafter using two 5/16”Ø x 3.5” lag bolts was determined to be 1402 lbf. Detailed results are provided in Table II. Test setup and mode of failure are provided in Appendix B, Figure 2.

The specific gravity and moisture content of the rafters was tested in accordance with ASTM D2395, Method A (oven-dry). The average specific gravity and moisture content was determined to be 0.458 and 4.7 %, respectively.

3. Shear (Lateral) Load Test Parallel to Rafter

Six samples were tested for shear strength parallel to rafter on February 6th, 2015 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a shear load was applied to the hook parallel to the rafter. The samples were loaded at a constant rate of axial deformation of 0.09 in./min. without shock until failure occurred. Based on the above testing, the average ultimate load, of the QMHSB attached to a 2"x4" Douglas Fir rafter using two 5/16”Ø x 3.5” lag bolts was determined to be 1195 lbf. Detailed results are provided in Table III. Test setup and mode of failure are provided in Appendix B, Figure 3.

The specific gravity and moisture content of the rafters was tested in accordance with ASTM D2395, Method A (oven-dry). The average specific gravity and moisture content was determined to be 0.413 and 4.9 %, respectively.

4. Shear (Lateral) Load Test Perpendicular to Rafter

Six samples were tested for shear strength perpendicular to rafter on February 12th, 2015 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a shear load was applied to the hook perpendicular to rafter. The samples were loaded at a constant rate of axial deformation of 0.09in./min. without shock until failure occurred. Based on the above testing, the average ultimate shear load, of the QMHSB attached to a 2"x4" Douglas Fir rafter using two 5/16”Ø x 3.5” lag bolts was determined to be 1785 lbf. Detailed results are provided in Table IV. Test setup and mode of failure are provided in Appendix B, Figure 4.

The specific gravity and moisture content of the rafters was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content was determined to be 0.411 and 7.8%, respectively.

If you have any questions regarding the above, please do not hesitate to call the undersigned.

Respectfully Submitted,

APPLIED MATERIALS & ENGINEERING, INC.

Darrius Shuemake
Laboratory Technician

Reviewed By:

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Principal

TABLE I

COMPRESSIVE LOAD TEST RESULTS

QMHSB- 6061 BASE PLATE

PROJECT NUMBER 114490C

SAMPLE ID	MAXIMUM COMPRESSIVE LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
C-1	1035	2.3	Hook Contact w/ Plywood	0.370	10.2
C-2	1065	2.4	Hook Contact w/ Plywood	0.385	9.8
C-3	1100	2.9	Hook Contact w/ Plywood	0.412	10.6
C-4	1140	2.9	Hook Contact w/ Plywood	0.389	6.9
C-5	1065	2.6	Hook Contact w/ Plywood	0.395	7.4
C-6	1111	2.6	Hook Contact w/ Plywood	0.399	6.8
AVERAGE	**1086**	**2.6**	..	**0.391**	**8.6**

TABLE II

TENSILE (UPLIFT) LOAD TEST RESULTS

QMHSB- 6061 BASE PLATE

PROJECT NUMBER 114490C

SAMPLE ID	MAXIMUM UPLIFT LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
T-1	1263	5.0	Lag Pullout	0.489	5.5
T-2	1366	4.9	Lag Pullout	0.439	4.6
T-3	2218	7.9	Lag Pullout	0.426	4.5
T-4	1187	4.9	Lag Pullout	0.421	4.4
T-5	1211	4.6	Lag Pullout	0.474	4.5
T-6	1167	4.4	Lag Pullout	0.499	4.9
AVERAGE	**1402**	**5.3**	**..**	**0.458**	**4.7**

TABLE III

SHEAR (LATERAL) LOAD TEST PARALLEL TO RAFTER TEST RESULTS

QMHSB- 6061 BASE PLATE

PROJECT NUMBER 114490C

SAMPLE ID	MAXIMUM LATERAL LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
Para-1	1122	3.2	Base Cracked	0.441	9.6
Para-2	1104	3.3	Base Cracked	0.404	9.3
Para-3	1155	5.7	Base Cracked	0.431	9.6
Para-4	1290	5.7	Base Cracked	0.406	9.6
Para-5	1306	6.0	Base Cracked	0.384	9.4
Para-6	1190	5.5	Base Cracked	0.413	9.5
AVERAGE	**1195**	**4.9**	..	**0.413**	**9.5**

TABLE IV

SHEAR (LATERAL) LOAD TEST PERPENDICULAR TO RAFTER TEST RESULTS

QMHSB- 6061 BASE PLATE

PROJECT NUMBER 114490C

SAMPLE ID	MAXIMUM LATERAL LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
Perp-1	1657	6.6	Bending of hook, plate, and lag.	0.393	8.3
Perp-2	1877	6.8	Bending of hook, plate, and lag.	0.436	8.2
Perp-3	1800	6.7	Bending of hook, plate, and lag.	0.407	7.7
Perp-4	1796	6.9	Bending of hook, plate, and lag.	0.407	7.8
Perp-5	1852	7.0	Bending of hook, plate, and lag	0.404	7.4
Perp-6	1725	6.5	Bending of hook, plate, and lag	0.419	7.3
AVERAGE	**1785**	**6.7**	**..**	**0.411**	**7.8**

REFERENCES

AC13-2010, "*Acceptance Criteria for Joist Hangers and Similar Devices*", ICC Evaluation Service.

AC85-2008, "*Acceptance Criteria for Test Reports*", ICC Evaluation Service.

ASTM D1761-2006, "*Standard Test Methods for Mechanical Fasteners in Wood*", ASTM International.

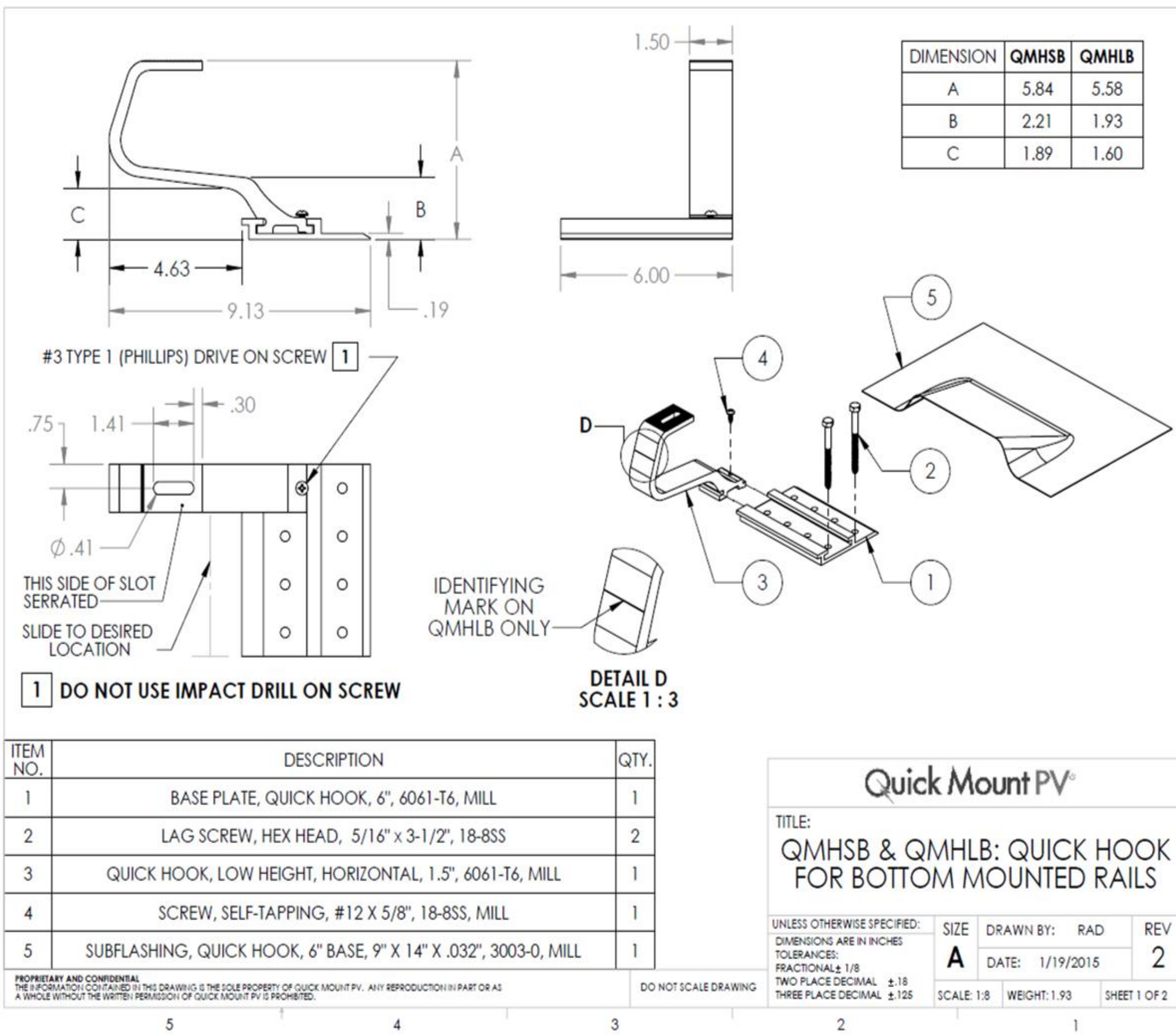
ASTM D2395-2007, *"Standard Test Method for Specific Gravity of Wood and Wood-Based Materials"*, ASTM International.

<u>APPENDIX A</u>

FIGURE 1

QMHSB- 6061 BASE PLATE

PROJECT NUMBER 114490C



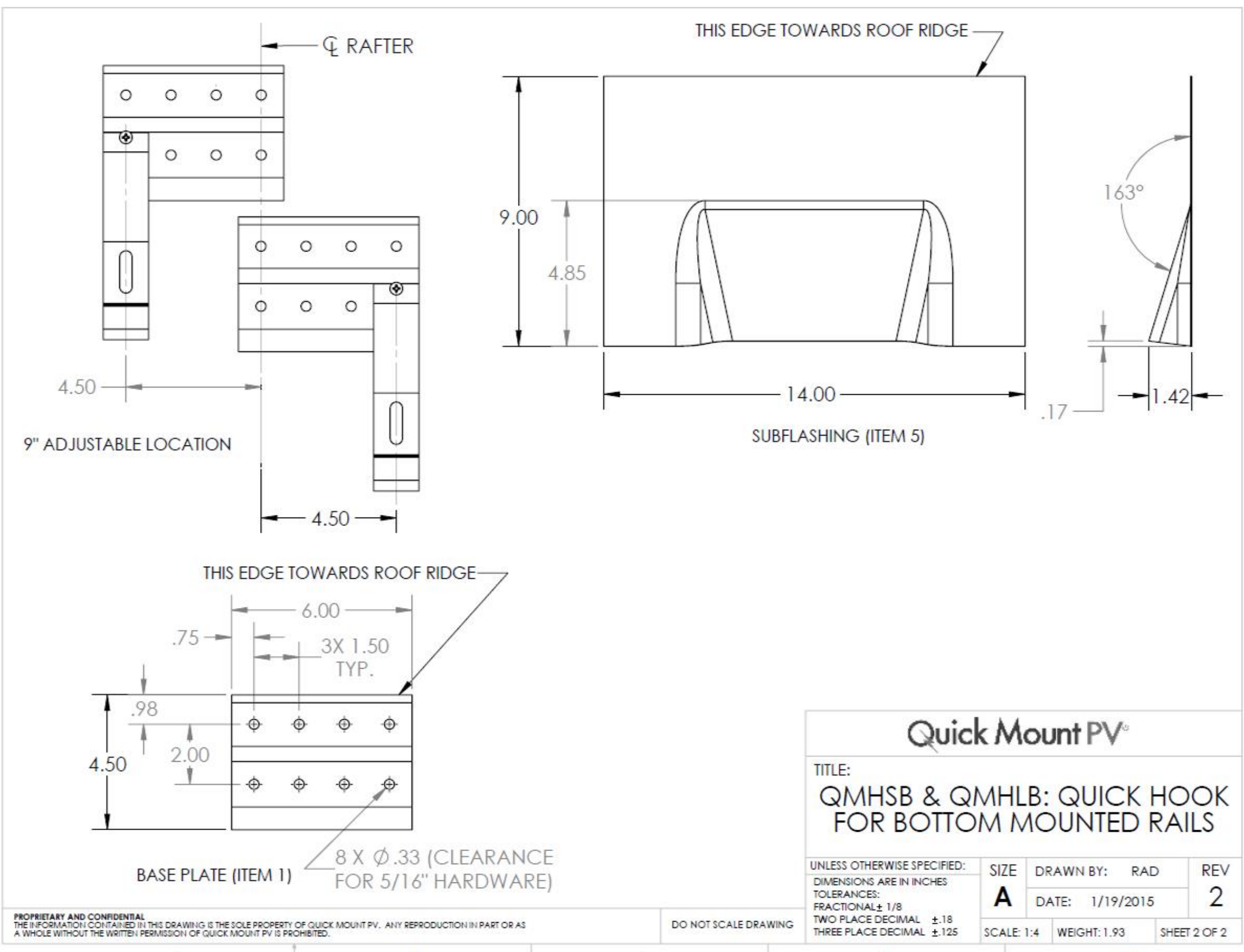
DIMENSION	QMHSB	QMHLB
A	5.84	5.58
B	2.21	1.93
C	1.89	1.60

ITEM NO.	DESCRIPTION	QTY.
1	BASE PLATE, QUICK HOOK, 6", 6061-T6, MILL	1
2	LAG SCREW, HEX HEAD, 5/16" x 3-1/2", 18-8SS	2
3	QUICK HOOK, LOW HEIGHT, HORIZONTAL, 1.5", 6061-T6, MILL	1
4	SCREW, SELF-TAPPING, #12 X 5/8", 18-8SS, MILL	1
5	SUBFLASHING, QUICK HOOK, 6" BASE, 9" X 14" X .032", 3003-0, MILL	1

FIGURE 2

QMHSB- 6061 BASE PLATE

PROJECT NUMBER 114490C



APPENDIX B

FIGURE 1

QMHSB- 6061 BASE PLATE

COMPRESSIVE LOAD TEST SETUP

PROJECT NUMBER 114490C

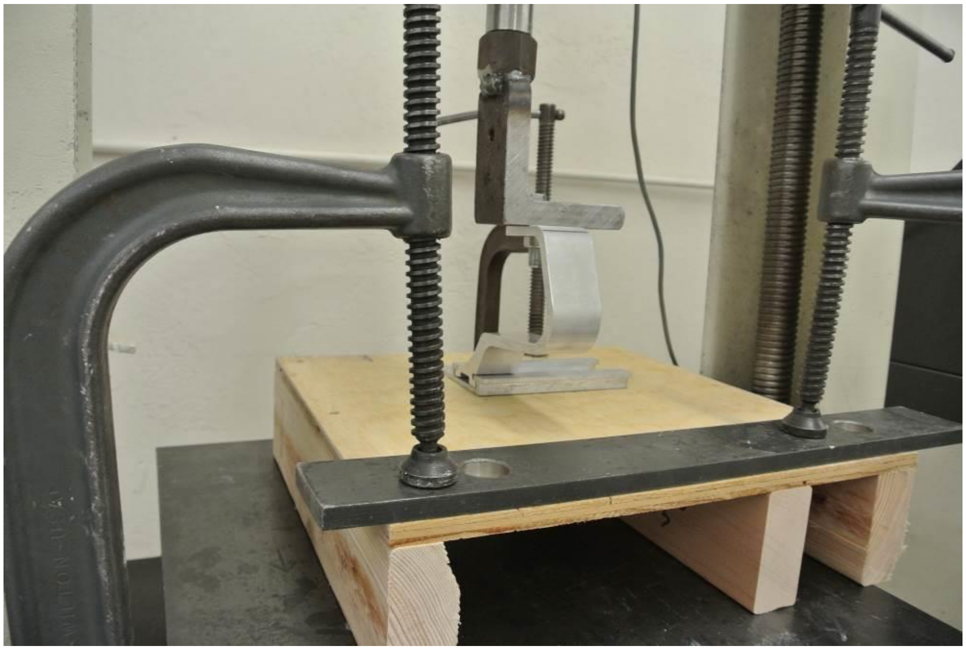


Figure 1a. Test Setup

Figure 1b. Typical Failure Mod

FIGURE 2

QMHSB- 6061 BASE PLATE

TENSIL (UPLIFT) LOAD TEST SETUP

PROJECT NUMBER 114490C

Figure 2a. Test Setup

Figure 2b. Typical Failure Mode

FIGURE 3

QMHSB- 6061 BASE PLATE

SHEAR (LATERAL) LOAD TEST PARALLEL TO RAFTER

PROJECT NUMBER 114490C

Figure 3a. Test Setup

Figure 3b. Typical Failure Mode

FIGURE 4

QMHSB- 6061 BASE PLATE

SHEAR (LATERAL) LOAD TEST PERPENDICULAR TO RAFTER

PROJECT NUMBER 114490C

Figure 4a. Test Setup

Figure 4b. Typical Failure Mode