APPLIED MATERIALS & ENGINEERING, INC.
980 41st Street
Oakland, CA 94608
Tel: (510) 420-8190
FAX: (510) 420-8186
e-mail: info@appmateng.com

July 28, 2014

Mr. Joel Schafer
MOUNTING SYSTEMS, INC.
820 Riverside Parkway
Sacramento, CA 95605

Project Number 114364C

Subject: Flat Tile Roof Hook (Part# 805-0052) Laboratory Load Testing

Dear Mr. Schafer:

As requested, Applied Materials & Engineering, Inc. (AME) has completed load-testing the Flat tile roof hook (see Appendix A, Figure 1). The purpose of our testing was to evaluate the tensile (uplift), compression and lateral (perpendicular and parallel to rafter) load capacity of the Flat Tile Roof Hook attached to a 2"x4" Douglas Fir Rafter using two 6x80 A2 pan-head Torx screws.

SAMPLE DESCRIPTION

Mockup samples were delivered to our laboratory on June 23, 2014. Mockup configuration consisted of three 12" long rafters at 4.5"o.c., screwed to 1/2" Structural I plywood. The Flat tile roof hook is attached through the plywood into a rafter with two fasteners.

TEST PROCEDURES & RESULTS

1. Compressive Load Test

A total of three tests were conducted for compressive load capacity on July 15, 2014 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 Flat tile roof hook attached to a 2"x4" Douglas Fir rafter using two 6x80 A2 pan-head Torx screws was determined to be 152 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 rafter was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content was determined to be 0.399 and 8.4 %, respectively.

2. Tensile (Uplift) Load Test

A total of three tests were conducted for compressive load capacity on July 15, 2014 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 occured; displacement at maximum load was recorded. Based on the above testing, the average maximum uplift load of the Flat tile roof hook attached to a 2"x4" Douglas Fir rafter using two 6x80 A2 pan-head Torx screws was determined to be 1293 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 rafter was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content was determined to be 0.361 and 8.2 %, respectively.

3. Shear Load Test Parallel to Rafter

Three samples were tested for shear strength on July 14, 2014 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a shear load was applied to the hook. The samples were loaded parallel to rafter 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 shear load, parallel to rafter, of the Flat tile roof hook attached to a 2"x4" Douglas Fir rafter using two 6x80 A2 pan-head Torx screws was determined to be 712 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 rafter was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content was determined to be 0.393 and 7.8 %, respectively.

4. Shear Load Test Perpendicular to Rafter

Three samples were tested for shear strength on July 12, 2014 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a shear load was applied to hook. The samples were loaded perpendicular to rafter 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, perpendicular to rafter, of the Flat tile roof hook attached to a 2"x4" Douglas Fir rafter using two 6x80 A2 pan-head Torx screws was determined to be 622 lbf. Detailed results are provided in Table IV. Test setup and mode of failure are provided in Appendix B, Figure 4.

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The specific gravity and moisture content of the rafter was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content was determined to be 0.380 and 8.3 %, respectively.

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

Respectfully Submitted,

APPLIED MATERIALS & ENGINEERING, INC.

Mohammed Faiyaz
Laboratory Manager

Reviewed By:

Armen Tajirian, Ph.D., P.E.
Principal

TABLE I

COMPRESSIVE LOAD TEST RESULTS

FLAT TILE ROOF HOOK (PART # 805-0052)

PROJECT NUMBER 114364C

SAMPLE ID	MAXIMUM COMPRESSIVE LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE
C-1	142	1.7	Bent Hook
C-2	155	1.7	Bent Hook
C-3	158	1.8	Bent Hook
AVERAGE	**152**	**1.7**	**..**

TABLE II

TENSILE (UPLIFT) LOAD TEST RESULTS

FLAT TILE ROOF HOOK (PART # 805-0052)

PROJECT NUMBER 114364C

SAMPLE ID	MAXIMUM TENSILE LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE
T-1	1271	7.4	Fastener pullout
T-2	1102	6.2	Fastener pullout
T-3	1505	6.8	Fastener pullout
AVERAGE	**1293**	**6.8**	**..**

TABLE III

SHEAR (LATERAL) LOAD TEST RESULTS, PARALLEL TO RAFTER

FLAT TILE ROOF HOOK (PART # 805-0052)

PROJECT NUMBER 114364C

SAMPLE ID	MAXIMUM LATERAL LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE
PARA-1	664	1.7	Bent Hook
PARA-2	745	1.2	Bent Hook
PARA-3	728	2.8	Bent Hook
AVERAGE	**712**	**1.9**	**..**

TABLE IV

SHEAR (LATERAL) LOAD TEST RESULTS, PERPENDICULAR TO RAFTER

FLAT TILE ROOF HOOK (PART # 805-0052)

PROJECT NUMBER 114364C

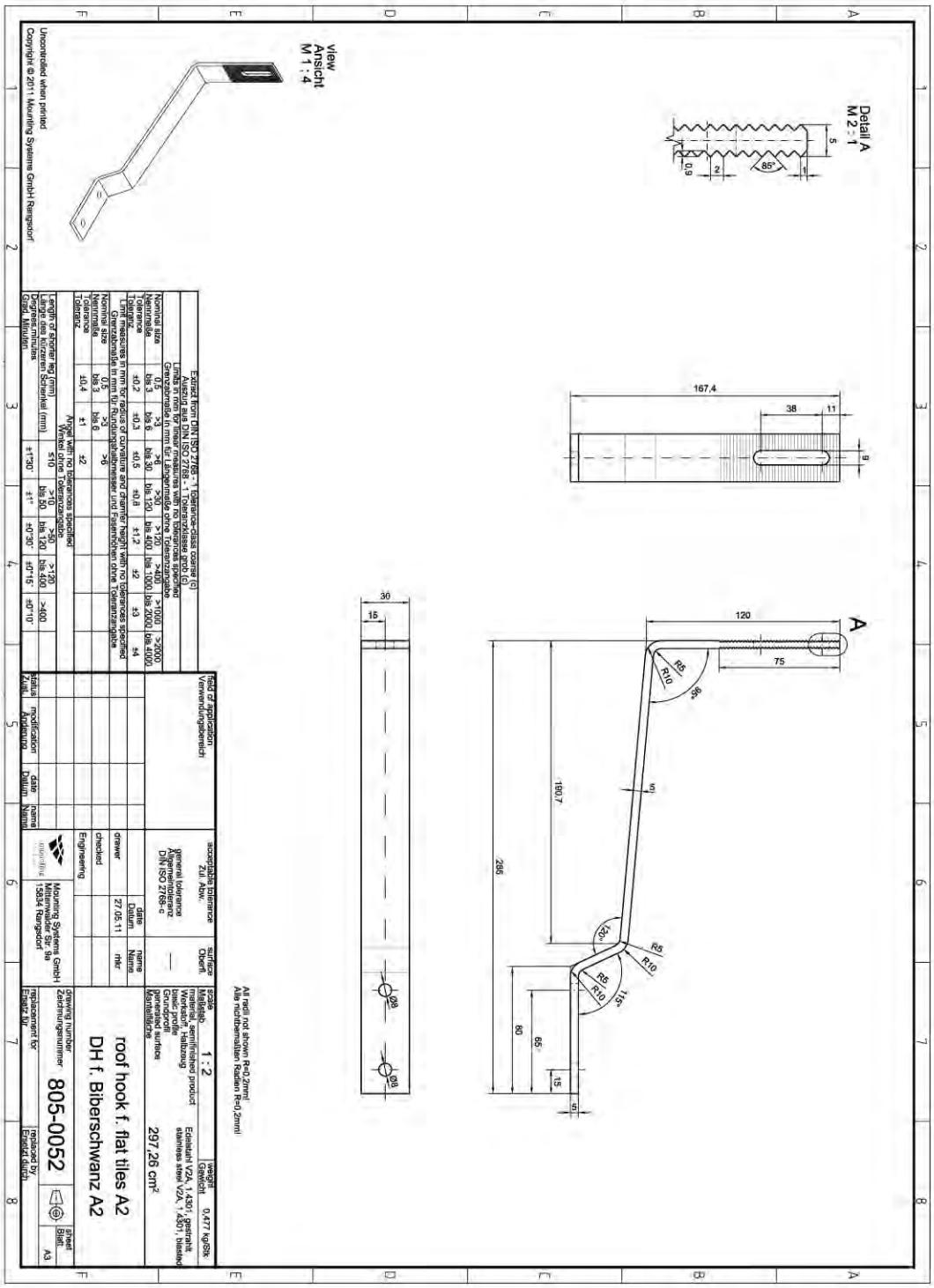
SAMPLE ID	MAXIMUM LATERAL LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	FAILURE MODE
PERP-1	621	8.1	Bent Hook and Fasteners
PERP-2	610	7.5	Bent Hook and Fasteners
PERP-3	635	9.4	Bent Hook and Fasteners
AVERAGE	**622**	**8.3**	**..**

APPENDIX A

FIGURE 1

FLAT TILE ROOF HOOK (PART # 805-0052)

PROJECT NUMBER 114364C



APPENDIX B

FIGURE 1

FLAT TILE ROOF HOOK (PART # 805-0052))

COMPRESSIVE LOAD TEST SETUP

PROJECT NUMBER 114364C

Figure1a. Test Setup

Figure 1b. Typical Failure Mode

FIGURE 2

FLAT TILE ROOF HOOK (PART # 805-0052))

UPLIFT LOAD TEST SETUP

PROJECT NUMBER 114364C

Figure 2a. Test Setup

Figure 2b. Typical Failure Mode

FIGURE 3

FLAT TILE ROOF HOOK (PART # 805-0052))

SHEAR LOAD TEST, PARALLEL TO RAFTER

PROJECT NUMBER 114364C

Figure 3a. Test Setup

Figure 3b. Typical Failure Mode

FIGURE 4

FLAT TILE ROOF HOOK (PART # 805-0052))

SHEAR LOAD TEST, PERPENDICULAR TO RAFTER

PROJECT NUMBER 114364C

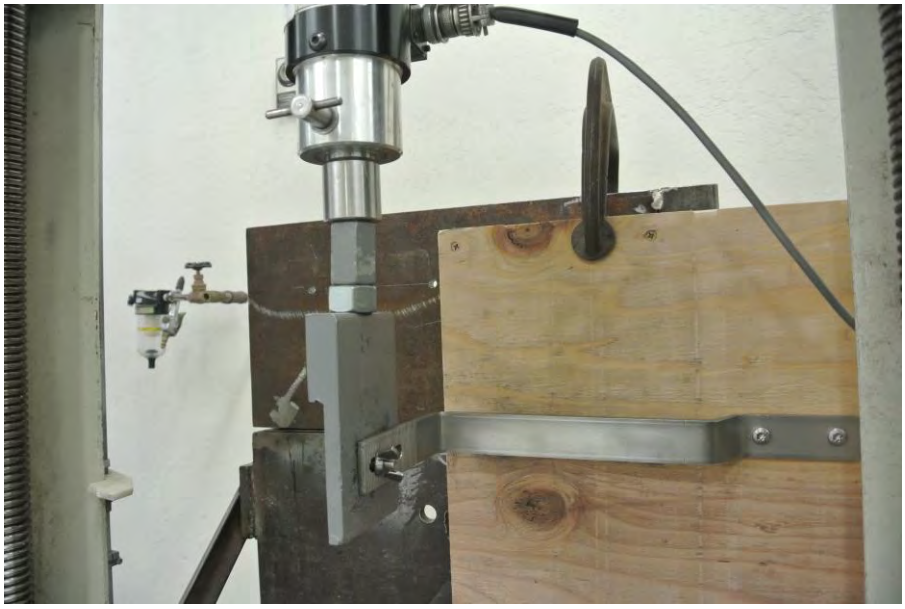


Figure 4a. Test Setup

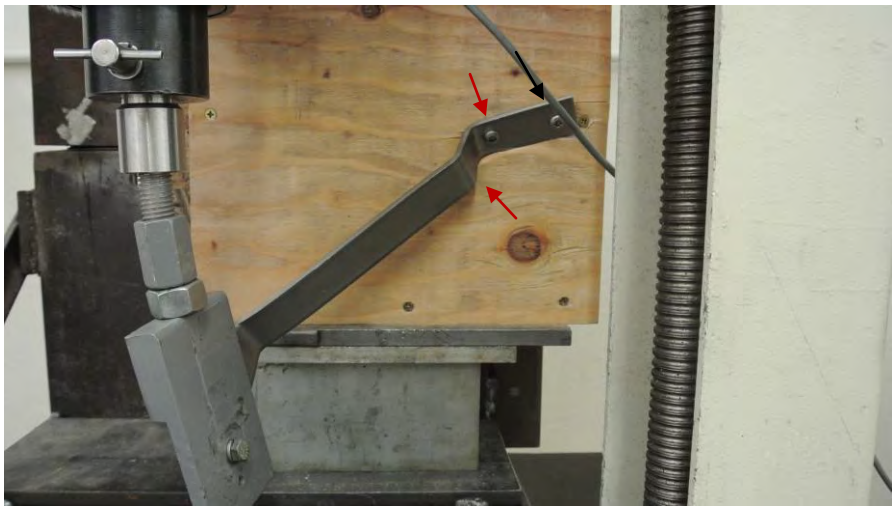


Figure 4b. Typical Failure Mode