



January 8, 2016
Revised March 19, 2018

Mr. Connor Morrison
UNIRAC
1411 Broadway Blvd. NE
Albuquerque, NM 87102

Project Number 1160001C

Subject: Flat Tile Mount (#KS-RH-AT1) Laboratory Load Testing

Dear Mr. Morrison:

As requested, Applied Materials & Engineering, Inc. (AME) has completed load-testing the Flat Tile Mount (see Appendix A, Figure 1). The purpose of our testing was to evaluate the compressive, tensile (uplift), and shear load capacity of the Flat Tile Mount (Part #KS-RH-AT1) attached to a 2"x4" Douglas Fir Rafter using two #14 screws (3/8" x 3" T17 302 SS).

SAMPLE DESCRIPTION

Fully assembled mockup samples were delivered to our laboratory on January 5, 2016. Additional samples for shear testing were delivered on March 16, 2018. Mockup configuration consisted of three 12" long rafters at 5.25"o.c., screwed to 1/2" Structural I plywood. The Flat Tile Mount 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 January 7, 2016 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 Mount attached to a 2"x4" Douglas Fir rafter using two #14 screw (3/8" x 3" T17 302 SS) was determined to be 135 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 were determined to be 0.338 and 13.7 %, respectively.

2. Tensile (Uplift) Load Test

A total of three tests were conducted for tensile (uplift) load capacity on January 7, 2016 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 uplift load of the Flat Tile Mount attached to a 2"x4" Douglas Fir rafter using two #14 screw (3/8" x 3" T17 302 SS) was determined to be 1865 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 were determined to be 0.440 and 12.2 %, respectively.

3. Lateral (Shear) Load Test – Hook Perpendicular to Direction of Load

A total of three tests were conducted for lateral (shear) load capacity on March 19, 2018 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a lateral load was applied to the hook. For each test, the hook and rafter were oriented perpendicularly to the direction of the downward force. The samples were loaded in shear at a constant rate of axial deformation of 0.10 in./min. without shock until failure occurred; displacement at maximum load was recorded. Based on the above testing, the average maximum lateral load of the Flat Tile Mount in the perpendicular configuration attached to a 2"x4" Douglas Fir rafter using two #14 screw (3/8" x 3" T17 302 SS) was determined to be 217 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 were determined to be 0.383 and 13.7 %, respectively.

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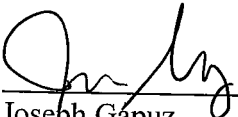
4. Lateral (Shear) Load Test – Hook Parallel to Direction of Load

A total of three tests were conducted for lateral (shear) load capacity on March 19, 2018 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a lateral load was applied to the hook. For each test, the hook and rafter were oriented parallel with the direction of the downward force. The samples were loaded in shear at a constant rate of axial deformation of 0.10 in./min. without shock until failure occurred; displacement at maximum load was recorded. Based on the above testing, the average maximum lateral load of the Flat Tile Mount in the parallel configuration attached to a 2"x4" Douglas Fir rafter using two #14 screw (3/8" x 3" T17 302 SS) was determined to be 392 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 rafter was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content were determined to be 0.389 and 11.3 %, respectively.

Respectfully Submitted,

APPLIED MATERIALS & ENGINEERING, INC.


Joseph Gapuz
Laboratory Manager



Reviewed By:

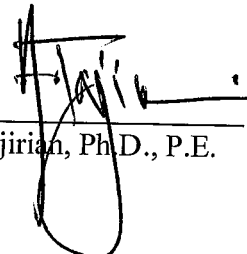

Armen Tajirian, Ph.D., P.E.
Principal

TABLE I
COMPRESSIVE LOAD TEST RESULTS
FLAT TILE MOUNT (#KS-RH-AT1)
PROJECT NUMBER 1160001C

SAMPLE ID	MAXIMUM COMPRESSIVE LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	MODE OF FAILURE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
C-1	135	1.6	Hook Contact w/Plywood	0.333	13.7
C-2	137	1.6		0.332	13.4
C-3	132	1.5		0.349	14.1
AVERAGE	135	1.6	..	0.338	13.7

Note: All failure mode consisted of ductile bending of hook.

TABLE II
TENSILE (UPLIFT) LOAD TEST RESULTS
FLAT TILE MOUNT (#KS-RH-AT1)
PROJECT NUMBER 1160001C

SAMPLE ID	MAXIMUM TENSILE LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	MODE OF FAILURE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
T-1	2087	6.1	Broken Fastener	0.460	12.7
T-2	1985	6.4		0.403	12.7
T-3	1522	6.6		0.456	11.3
AVERAGE	1865	6.3	..	0.440	12.2

Note: All failure mode consisted of ductile bending of hook.

TABLE III
LATERAL (SHEAR) LOAD TEST RESULTS
HOOK PERPENDICULAR TO DIRECTION OF LOAD
FLAT TILE MOUNT (#KS-RH-AT1)
PROJECT NUMBER 1160001C

SAMPLE ID	MAXIMUM LATERAL LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	MODE OF FAILURE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
S-1	180	5.7	Broken Fastener	0.365	12.8
S-2	226	7.5		0.382	14.4
S-3	246	7.7		0.402	14.0
AVERAGE	217	7.0	..	0.383	13.7

Note: All failure mode consisted of ductile bending of hook.

TABLE IV
LATERAL (SHEAR) LOAD TEST RESULTS
HOOK PARALLEL TO DIRECTION OF LOAD
FLAT TILE MOUNT (#KS-RH-AT1)
PROJECT NUMBER 1160001C

SAMPLE ID	MAXIMUM LATERAL LOAD (lbf)	DISPLACEMENT AT MAXIMUM LOAD (in.)	MODE OF FAILURE	RAFTER SPECIFIC GRAVITY	RAFTER MOISTURE CONTENT (%)
P-1	463	0.5	Bent Hook	0.375	11.9
P-2	365	0.5		0.387	11.2
P-3	349	0.6		0.405	10.6
AVERAGE	392	0.5	..	0.389	11.3

Note: All failure mode consisted of ductile bending of hook.

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.

REVISION HISTORY

March 20, 2018: Additional testing for lateral (shear) load capacity in two different configurations was performed on March 19, 2018 and reported in revision March 20, 2018. The additional testing scope is described in (3) and (4) of “Testing Procedures & Results” and test values are reported in Table III and Table IV. Appendix B is revised to include images of test setups and failure modes of testing scopes (3) and (4).

March 20, 2018: Documents referenced for test procedures are listed under “References”.

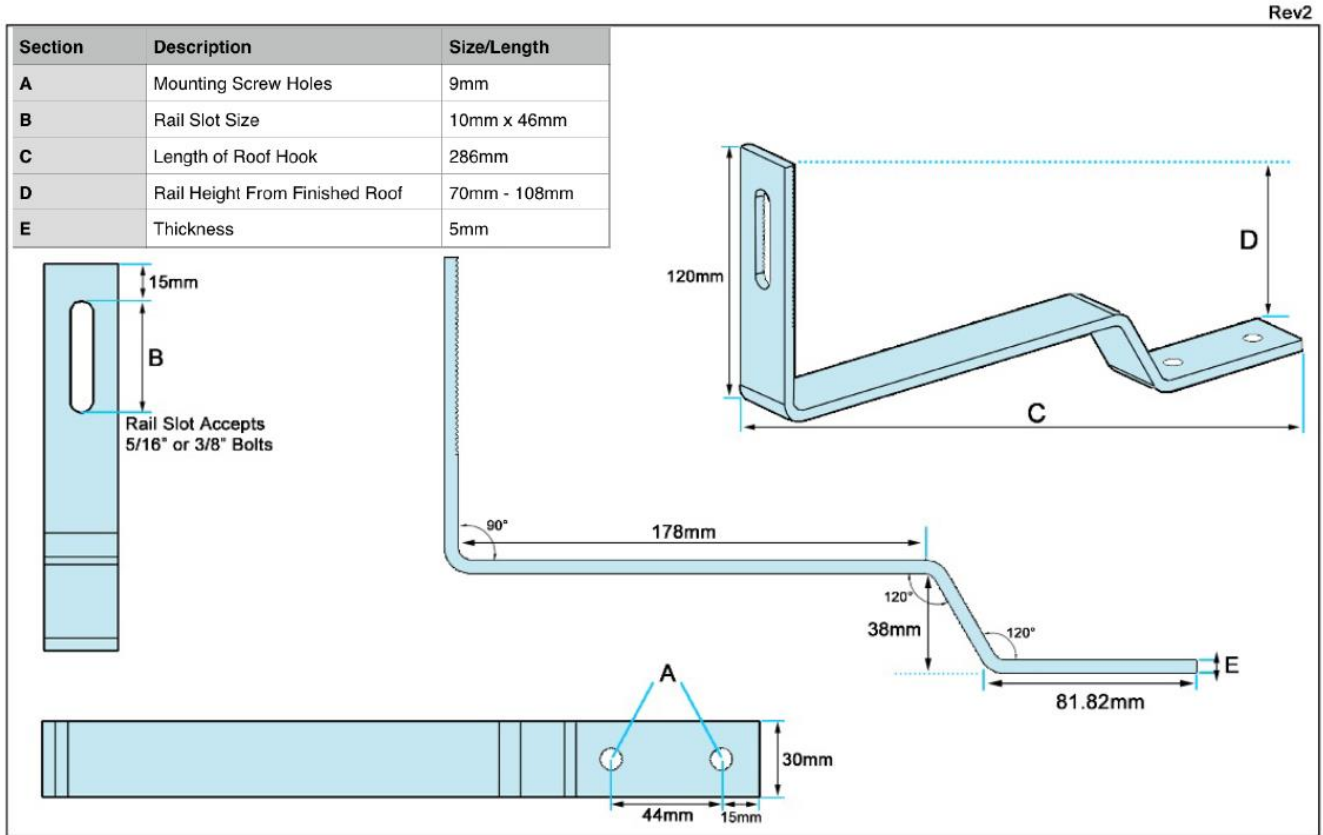
March 20, 2018: Part number “KS-RH-AT1” included in product description and subject title.

APPENDIX A

FIGURE 1

FLAT TILE MOUNT (PART #KS-RH-AT1)

PROJECT NUMBER 1160001C



APPENDIX B

FIGURE 1
FLAT TILE MOUNT
COMPRESSIVE LOAD TEST SETUP
PROJECT NUMBER 1160001C

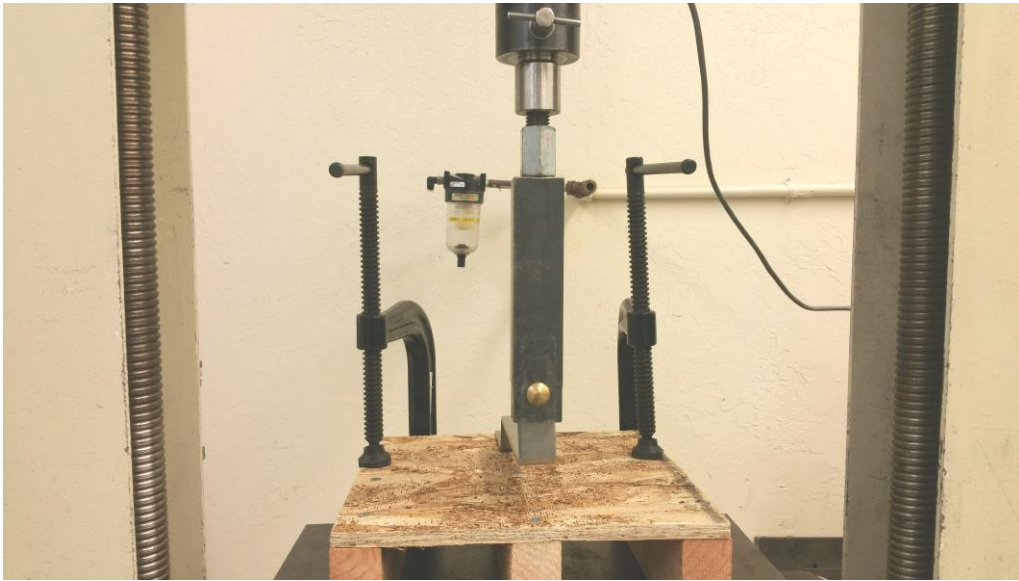


Figure 1a. Test Setup



Figure 1b. Typical Failure Mode

FIGURE 2
FLAT TILE MOUNT (#KS-RH-AT1)
UPLIFT LOAD TEST SETUP
PROJECT NUMBER 1160001C

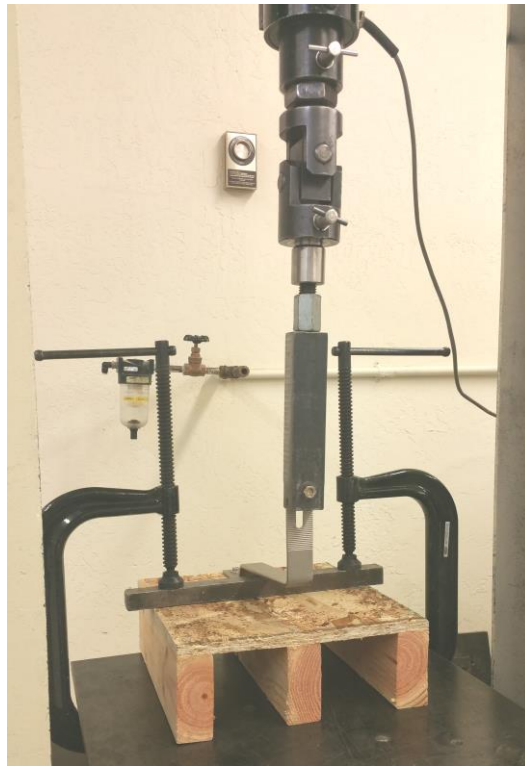


Figure 2a. Test Setup



Figure 2b. Typical Failure

FIGURE 3

FLAT TILE MOUNT (#KS-RH-AT1)

LATERAL (SHEAR) LOAD TEST SETUP
HOOK PERPENDICULAR TO DIRECTON OF LOAD

PROJECT NUMBER 1160001C



Figure 3a. Test Setup



Figure 3b. Typical Failure Mode

FIGURE 4

FLAT TILE MOUNT (#KS-RH-AT1)

LATERAL (SHEAR) LOAD TEST SETUP
HOOK PARALLEL TO DIRECTION OF LOAD

PROJECT NUMBER 1160001C



Figure 4a. Test Setup



Figure 4b. Typical Failure Mode