October 26, 2017

SunModo Corp.
14800 NE 65th St
Vancouver, WA 98682
Attn: Roland Jasmin

RE: SunModo – EZ Flat Tile Multi-Screw Hook Evaluation

To whom it may concern:
Per your request, Moment Engineering + Design has reviewed recent testing for a new EZ Flat Tile Multi-Screw Hook. The EZ Tile Hook consists of a stainless steel base plate that is secured with lag bolts to the roof framing. The vertical mounting tab is used to mount the rail. Based on our review of the test data provided on the EZ Flat Tile Hook component, it is our opinion that the Tile Hook itself can safely support the following design loads under the following conditions:

- Allowable loads listed below consider a safety factor of 2.0 from ultimate load from testing data
- Maximum downforce force shall not exceed 181 lbs.
- Maximum uplift force shall not exceed 1,105 lbs.
- Maximum shear force shall not exceed 318 lbs.
- All connections shall be in accordance with manufacturer’s specifications including required torque, bolts and screws.
- It should be noted that some table values reported in SunModo’s literature may report reaction values exceeding those of the EZ Tile Hook. Where this occurs, consult SunModo Corp. for project specific design solutions.

This report does not provide analysis of any existing structures, as may be required by the local authority having jurisdiction. We appreciate the opportunity to have assisted you with this project. Should you have any further questions regarding this analysis, please feel free to contact us by phone or email.

Best Regards,

Shawn P. Kelley, P.E.
Principal
moment ENGINEERING
spkelley@msegllc.com

Reference Document:

August 2, 2017

Mr. Clifford Schrock

SUNMODO
14800 NE 65th St.
Vancouver, WA 98682

Subject: Flat Tile Multi-Screw Hook
Part #K10174-001 Laboratory Load Testing

Dear Mr. Schrock:

As requested, Applied Materials & Engineering, Inc. (AME) has completed load-testing the Flat Tile Multi-Screw Hook (Part #K10174-001); see Appendix A, Figure A1. The purpose of our testing was to evaluate the compressive, tensile (uplift), and shear load capacity of the Flat Tile Multi-Screw Hook attached to a 2”x4” Douglas Fir rafter using two ¼”Øx4” lag screws.

SAMPLE DESCRIPTION

Mockup samples were delivered to our laboratory on July 6, 2017. Mockup configuration consisted of three 12” long rafters at 6.5”o.c., screwed to 1/2” Structural I plywood. The Flat Tile Multi-Screw 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 August 1, 2017 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 0.10 in. /min. without shock until the hook was bent and came in contact with the test board; displacement at maximum load before coming in contact with the test board was recorded.

Based on the above testing, the average maximum compressive load of the Flat Tile Multi-Screw Hook attached to a 2”x4” Douglas Fir rafter using two ¼”Øx4” lag screws was determined to be 362 lbf. Detailed results are provided in Table I and Figure 1. Test setup and mode of failure are provided in Appendix B, Figure B1.

The specific gravity and moisture content of a single rafter used for each compression test was tested in accordance with ASTM D2395, Method A (oven-dry). The specific gravity and moisture content of the rafter were determined to be 0.412 and 4.3%, respectively.
2. Tensile (Uplift) Load Test

A total of three tests were conducted for tensile (uplift) load capacity on August 1, 2017 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 0.10 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 Multi-Screw Hook attached to a 2"x4" Douglas Fir rafter using two ¼"Øx4" lag screws was determined to be 2210 lbf. Detailed results are provided in Table II and Figure 2. Test setup and mode of failure are provided in Appendix B, Figure B2.

The specific gravity and moisture content of the rafters were tested in accordance with ASTM D2395, Method A (oven-dry). The average specific gravity and average moisture content of the three samples were determined to be 0.406 and 4.6%, respectively.

3. Shear (Lateral) Load Test Parallel to Rafter

A total of three tests were conducted for shear load capacity on August 1, 2017 using a United Universal testing machine. Samples were rigidly attached to the testing machine and a shear load (parallel to the rafter) was applied to the hook. 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 shear load of the Flat Tile Multi-Screw Hook attached to a 2"x4" Douglas Fir rafter using two ¼"Øx4" lag screws was determined to be 635 lbf. Detailed results are provided in Table III and Figure 3. Test setup and mode of failure are provided in Appendix B, Figure B3.

The specific gravity and moisture content of the rafters were tested in accordance with ASTM D2395, Method A (oven-dry). The average specific gravity and average moisture content of the three samples were determined to be 0.398 and 4.2%, respectively.

Respectfully Submitted,

APPLIED MATERIALS & ENGINEERING, INC.

Joseph Gapuz
Laboratory Manager
TABLE I
COMPRESSIVE LOAD TEST RESULTS
FLAT TILE MULTI-SCREW HOOK
(PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS)
PROJECT NUMBER 1170521C

<table>
<thead>
<tr>
<th>TEST NUMBER</th>
<th>MAXIMUM COMPRESSION LOAD (lb)</th>
<th>DISPLACEMENT AT MAXIMUM LOAD (in.)</th>
<th>MODE OF FAILURE</th>
<th>RAFTER SPECIFIC GRAVITY</th>
<th>RAFTER MOISTURE CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>149</td>
<td>365</td>
<td>1.6</td>
<td>Hook</td>
<td>0.412</td>
<td>4.3</td>
</tr>
<tr>
<td>150</td>
<td>360</td>
<td>1.6</td>
<td>Contacted Plywood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>151</td>
<td>360</td>
<td>1.6</td>
<td></td>
<td>0.412</td>
<td></td>
</tr>
<tr>
<td>AVERAGE</td>
<td>362</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 1

K10174-001 FLAT TILE MULTI-SCREW HOOK COMPRESSION LOAD TEST
Load-Deflection Curve
Note: Maximum deflection and peak load taken before sharp increase in load, when hook contacts plywood test board

TABLE II

TENSILE (UPLIFT) LOAD TEST RESULTS

FLAT TILE MULTI-SCREW HOOK
(PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS)

PROJECT NUMBER 1170521C

<table>
<thead>
<tr>
<th>TEST NUMBER</th>
<th>MAXIMUM TENSILE LOAD (lbf)</th>
<th>DISPLACEMENT AT MAXIMUM LOAD (in.)</th>
<th>MODE OF FAILURE</th>
<th>RAFTER SPECIFIC GRAVITY</th>
<th>RAFTER MOISTURE CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>146</td>
<td>2205</td>
<td>3.4</td>
<td>Lag Screw Pull-out</td>
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<tr>
<td>147</td>
<td>2433</td>
<td>3.5</td>
<td></td>
<td>0.412</td>
<td>4.8</td>
</tr>
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<td>1992</td>
<td>3.4</td>
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<td>0.419</td>
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</tr>
<tr>
<td>AVERAGE</td>
<td>2210</td>
<td>3.4</td>
<td>..</td>
<td>0.406</td>
<td>4.6</td>
</tr>
</tbody>
</table>

FIGURE 2
TABLE III

SHEAR LOAD TEST RESULTS

FLAT TILE MULTI-SCREW HOOK
(PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS)

PROJECT NUMBER 1170521C

<table>
<thead>
<tr>
<th>TEST NUMBER</th>
<th>MAXIMUM TENSILE LOAD (lbf)</th>
<th>DISPLACEMENT AT MAXIMUM LOAD (in.)</th>
<th>MODE OF FAILURE</th>
<th>RAFTER SPECIFIC GRAVITY</th>
<th>RAFTER MOISTURE CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>152</td>
<td>593</td>
<td>0.5</td>
<td>Bent Hook</td>
<td>0.364</td>
<td>3.8</td>
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<td>153</td>
<td>660</td>
<td>0.6</td>
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<td>0.429</td>
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<tr>
<td>154</td>
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<td>0.6</td>
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<td>5.1</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>635</td>
<td>0.6</td>
<td>..</td>
<td>0.398</td>
<td>4.2</td>
</tr>
</tbody>
</table>

FIGURE 3
REFERENCES


APPENDIX A

FIGURE A1

FLAT TILE MULTI-SCREW HOOK
(PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS)

PROJECT NUMBER 1170521C
APPENDIX B

FIGURE B1
FLAT TILE MULTI-SCREW HOOK
PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS

COMPRESSIVE LOAD TEST SETUP

PROJECT NUMBER 1170521C

Figure B1a. Test Setup

Figure B1b. Typical Failure Mode

FIGURE B2

FLAT TILE MULTI-SCREW HOOK
(PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS)

TENSILE LOAD TEST SETUP

PROJECT NUMBER 1170521C

**Figure B2a.** Test Setup

**Figure B2b.** Typical Failure Mode

**FIGURE B3**

FLAT TILE MULTI-SCREW HOOK
(PART #K10174-001 w/ TWO 1/4"Øx4" LAG SCREWS)

SHEAR LOAD TEST SETUP

PROJECT NUMBER 1170521C

Figure B3a. Test Setup

Figure B3b. Typical Failure Mode