

ENGINEERING EVALUATION REPORT

REPORT NUMBER T615-2

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MODEL NUMBER: Inspire Slate Roof Shingles

1) Introduction

Quality Auditing Institute Ltd. (QAI) was retained by Tapco International Corporation to conduct an Engineering Evaluation in accordance with the requirements of the 2005 National Building Code (NBC) on Inspire Slate Roof Shingle Product. The purpose of this evaluation was to compare the roofing product to the applicable standards for products of similar application. The Inspire product was also compared to a similar polymer roofing product compliant with past Canadian Construction Materials Centre (CCMC) requirements.

2) Product Description

The Inspire Slate Roof Shingles are compression-molded from a proprietary blend of polymer-based materials to emulate natural slate tile roofing. The shingles are nominally 12 inches wide by 17 inches in length by ¼ inches thick. Inspire slate shingles are offered in a variety of different standard or premium colors and also in several color blends. The shingles are available in either a Class "A" or Class "C" fire rating.

The formulation for the Inspire Slate Roof Shingles is kept on file at QAI under Intertek Report No. 3094086-QCM2.

3) Reference Documents and Standards

- Intertek Quality Control Manual – 3094086-QCM2 (Dated April 27, 2007)
- Intertek Test Report – 3096431COQ-002 (Dated October 24, 2006)
- Radco Test Report – RAD-4557 (Dated July 6, 2009)
- Radco Test Report – RAD-4639 (Dated November 20, 2009)
- National Building Code 2005
- ASTM D792 "Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement"
- CGSB-37.58-M86, para 7.2.3 "Membrane, Elastomeric, Cold-Applied Liquid, for Non-Exposed Use in Roofing and Waterproofing"
- ASTM C272 "Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions"
- ASTM D790 "Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials"
- ASTM G154 "Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials"
- ASTM G155 "Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials"
- TAS 100-95 "Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems"
- ASTM D1037 "Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials"
- ASTM C666/C666M "Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing"
- ASTM E661 "Standard Test Method for Performance of Wood and Wood-based Floor and Roof Sheathing Under Concentrated Static and Impact Loads"

4) Engineering Evaluation

Density

Test Standard: ASTM D792
Requirement: Report value

Inspire Tested Standard: -
Result: Class A Shingle $\approx 757 \text{ kg/m}^3$
Class C Shingle $\approx 662 \text{ kg/m}^3$

Evaluation: The finished product dimensions for each tile are 12 inches \pm 0.125 wide by 17.5 inches \pm 0.125 long by 1/4" thick. The weight for the Class A Shingle is 23 oz. \pm 1.0 and Class C Shingle is 20 oz. \pm 1.0. This satisfies the requirements of CCMC.

Dimensional Stability

Test Standard: CGSB-37.58-M86, para 7.2.3
Requirement: 5.0% maximum dimensional change
3.0% maximum average mass change

Inspire Tested Standard: CGSB-37.58-M86, para 7.2.3 (as per Radco Report #RAD-4639)
Result: 0.04% average length change
-0.08% average width change
-0.71% average thickness change
0.06% average mass change

Evaluation: Five 18" x 12" (457mm x 305mm) Inspire Roofing Tile specimens were tested to the above standard. The shingle was within the maximum dimensional and mass change of the standard. This satisfies the requirements of CCMC.

Water Absorption

Test Standard: As per CCMC Technical Guide
Requirement: $\leq 3.0\%$

Inspire Tested Standard: ASTM C272 (as per Radco Report #RAD-4557)
Result: No appreciable weight gain

Evaluation: Past CCMC test criteria required the samples to be placed in a vacuum of $2.5 \pm 0.5 \text{ kPa}$ for 2 hours and then immersed in water for 24 hours. ASTM C272 requires the sample to be cooled in a desiccator and then immersed in water for 24 hours. The Inspire Slate Roof Shingle is a closed cell compressed polymer product and has very little water absorption capabilities. When tested to ASTM C272, the product did not absorb a measureable amount of water. It can be concluded that when tested to the Water Absorption test method of CCMC, the results will be within the 3.0% requirement.

Flexural Strength

Test Standard: ASTM D790 Procedure A
Requirement: >5.2 MPa (754.2 PSI) max

Inspire Tested Standard: ASTM D790 Procedure A (as per Radco Report #RAD-4639)
Result: 18.1 MPa (2624 PSI) – machine direction
17.4 MPa (2527 PSI) – cross direction

Evaluation: Five 4" x 0.5" (101.6mm x 12.7mm) Inspire Roofing Tile specimens were tested to the above standard. The shingles were tested in the machine and cross direction. Results in both directions were within allowable limits. This satisfies the requirements of CCMC.

Wind Uplift

Test Standard: As per CCMC Technical Guide
Requirement: No loss of integrity or damage

Inspire Tested Standard: Miami Dade County TAS 100-95 (as per PRI Report #MMLL-003-02-05 and MMLL-04-05)
Result: Up to 110 mph. No water infiltration through sheathing. No tiles blew off, tore or blew upward.

Evaluation: The CCMC requirement for Wind Uplift is a modified version of the Dade County Protocol PA 100-95 "Test procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems". The modifications involve a modified test frame size and the specified areas for observational notes to be taken. Overall, testing to TAS 100-95 is representative of testing to the modified version of the CCMC Wind Uplift requirement. As per the applicable test report, no tiles blew off, tore, or blew upward; therefore Inspire Roofing Product meets this requirement.

Dynamic Pressure Water Infiltration

Test Standard: As per CCMC Technical Guide
Requirement: No leakage or damage to assembly

Inspire Tested Standard: Miami Dade County TAS 100-95 (as per PRI Report #MMLL-003-02-05 and MMLL-04-05)
Result: Up to 110 mph. No water infiltration through sheathing. No tiles blew off, tore or blew upward.

Evaluation: When tested to TAS 100-95, which was the standard used to develop the CCMC Dynamic Pressure Water Infiltration CCMC requirement, the sample exhibited zero water infiltration. With the two test protocols being almost identical as noted above, the Inspire Roofing Product meets this requirement.

Nail Pull-Through

Test Standard: ASTM D1037 Paragraph 54-60
Requirement: > 440N (99 lbs)

Inspire Tested Standard: ASTM D1037 Paragraph 54-60 (as per Radco Report #RAD-4639)
Result: 841N (189 lbs)

Evaluation: Ten 3" x 6" (76mm x 152mm) Inspire Roofing Tile specimens were tested to the above standard. The shingles were tested using a 1-1/2" stainless steel ring shank hand nail. Results exceeded the minimum requirements. This satisfies the requirements of CCMC.

Accelerated Weathering

Test Standard: ASTM G155
Requirement: No deleterious effects

Inspire Tested Standard: ASTM G154 (as per Intertek Report #3096431COQ-002)
Result: Tile exhibited virtually no fade and with no trace of cracking, spalling or deformation.

Evaluation: The ASTM G154 and ASTM G155 both reproduce the weathering effects that occur when materials are exposed to sunlight (either direct or through window glass) and moisture as rain or dew. ASTM G155 uses xenon arc light, while ASTM G154 uses fluorescent UV light. It is of QAI's opinion that similar results would be seen when one product is subjected to both standards and that the Inspire roofing product would meet the CCMC requirements for accelerated weathering.

Traffic Load

Test Standard: As per CCMC Technical Guide
Requirement: >900N (202 lbs)

Inspire Tested Standard: ASTM E661 (as per Radco Report #RAD-4639)
Result: 6672N (1500 lbs) - no cracks or any signs of breakage

Evaluation: Forty-eight Inspire Roof tiles were installed using 1-1/2" ring shank nails to a 4ft x 8ft panel with a 7.5" exposure. Construction details were as noted in the test report. A 3" diameter metal disk was used to apply a load at a rate of 0.1" in/min. The CCMC Technical Guide requires the load to be applied using a 5" x 5" metal plate instead of the round disk. This will distribute the load over a greater area; therefore the 3" diameter metal disk is a worst case scenario. The concentrated load was applied to the top and bottom side of the deck. Results exceeded the minimum requirements. This satisfies the requirements of CCMC.

Freeze Thaw Cycle

Test Standard: 24 cycles as per CCMC Technical Guide
Requirement: No deleterious effects

Inspire Tested Standard: ASTM C666/C666M (as per Radco Report #RAD-4557)
Result: No signs of damage or cracking after 350 cycles

Evaluation: The Freeze-Thaw requirements of CCMC involve cycling the product from 15°C to -20°C for the first 12 cycles and then 15°C to -5°C for the next 12 cycles. ASTM C666 involves cycling the product from 4.44°C to -17.78°C for 350 cycles. Both standards evaluate the effects of rapid freezing and thawing cycles. Based on the number of cycles and temperature change, the ASTM C666 standard is a more severe test requirement. Since the Inspire Roofing Product passed the requirements of ASTM C666, it would also meet the CCMC requirements for Freeze-Thaw Cycle.

The Slate Roof Shingles described in this report and manufactured by the Tapco Group (dba Inspire Roofing Products) has been evaluated by QAI to Section 9.26.2.1 of the 2005 National Building Code.

The objective statements for each sentence have been tabulated below:

| Table 1: Objective Statements for Roofing Materials Section 9.26.2.1 of the 2005 NBC | | | |
|---|-----------------------------|------------------|---|
| Sentence | Functional Statement | Objective | Summary of Area of Performance |
| 9.26.2.1 | F61 | OH1.1 | To resist the ingress of precipitation, water or moisture from the exterior or from the ground so it does not affect indoor air quality |
| | F61 | OH1.2 | To resist the ingress of precipitation, water or moisture from the exterior or from the ground so it does not affect the thermal performance of the exterior wall |
| | F61 | OH1.3 | To resist the ingress of precipitation, water or moisture from the exterior or from the ground to keeps the interior dry |
| | F61 | OS2.3 | To resist the ingress of precipitation, water or moisture from the exterior or from the ground so there is no damage or deterioration to building elements. |
| 9.26.2.2 | F20 | OH1.1 | To support and withstand expected loads and forces so it does not affect indoor air quality |
| | F20 | OH1.2 | To support and withstand expected loads and forces so it does not affect the thermal performance of the exterior wall |
| | F20 | OH1.3 | To support and withstand expected loads and forces to keeps the interior dry |
| | F20 | OS2.3 | To support and withstand expected loads and forces so there is no damage or deterioration to building elements. |
| | F80 | OH1.1 | To resist deterioration resulting from expected service conditions so it does not affect indoor air quality |
| | F80 | OH1.2 | To resist deterioration resulting from expected service conditions so it does not affect the thermal performance of the exterior wall |
| | F80 | OH1.3 | To resist deterioration resulting from expected service conditions to keeps the interior dry |
| | F80 | OS2.3 | To resist deterioration resulting from expected service conditions so there is no damage or deterioration to building elements. |

QAI has interpreted the objective and functional statements applicable to the Inspire Slate Roof Shingle Product. The interpretations and the alternative solutions of the Division B requirements are tabulated below:

| Table 2: Confirmation of Level of Performance | | |
|---|--|--|
| Division B Requirement (Description of Level of Performance Div. B Achieves) | Objective Statements for Roofing Materials Section 9.26.2 | Alternative Solution (Description of Alternative Solution Level of Performance Achieved) |
| The intent of the code is that the roofing system is able to withstand wind loads and forces that they may be subject to. | F61 - OH1.1 | Inspire has conducted wind load testing as per the Miami Dade Protocol TAS100-95. The wind load requirement for this standard is intended for hurricane zones with extreme wind conditions. This requirement is much more severe than the conditions that would be encountered in Canada, therefore the Inspire Slate Roof Shingles would meet this criteria of the National Building Code |
| There are no direct requirements for this product to control inadequate indoor air quality. | F61 - OH1.2 | The roofing system is separated from the interior environment by several systematic layers. The air quality is not affected by this product. |
| There are no direct requirements for this product to control inadequate thermal comfort. | F61 - OH1.3 | The Inspire product is not a primary component of the thermal wall barrier system. |
| The intent of the code is to resist the ingress of precipitation, water or moisture from the exterior or the ground. | F61 - OS2.3 | This product has been tested to Dynamic Pressure Water Infiltration requirements of TAS100-95 and Water Absorption requirements of ASTM 272. Both these protocols/standards evaluated the products ability to resist the ingress of precipitation from the interior of the building. The Inspire Slate Roof Shingles met the criteria of the National Building Code. |

Table 2: Continued

| | | |
|---|---|---|
| <p>The intent of the code is that the roofing shingle is capable of withstanding impact and sustained loads when installed on a roof.</p> | <p>F20 - OH1.1 F20 - OH1.2 F20 - OH1.3 F20 - OS2.3</p> | <p>The product has been subjected to the flexural strength test. When tested to ASTM D790 Procedure A "Standard Test Methods for Fire Tests of Roof Coverings" for flexural strength, samples obtained an average rating of 18.1 MPa and 17.4 MPa in the machine and cross direction respectively. Similar materials are required to meet a flexural strength of 5.2 MPa minimum by the CCMC.</p> <p>The product has also been tested to ASTM E661 "Standard Test Method for Performance of Wood and Wood-based Floor and Roof Sheathing Under Concentrated Static and Impact Loads" and achieved maximum loads of 6672N. Similar materials are required to meet a traffic load strength of 900N minimum by the CCMC.</p> <p>Nail pull-through testing was performed to evaluate the products ability to stay fastened to the substrate. The standard used was ASTM D1037 "Standard Test Methods for Evaluation Properties of Wood-Base Fiber and Particle Panel Materials". Using a 1-1/2" stainless steel ring shank hand nail, the average result was 841N ultimate load. Similar materials are required to meet a minimum requirement of 440N by the CCMC.</p> <p>The Inspire Slate Roof Shingles met the criteria of the National Building Code.</p> |
| <p>The intent of the code is that the roofing material is durable and will not deteriorate significantly over time.</p> | <p>F80 - OH1.1 F80 - OH1.2 F80 - OH1.3 F80 - OS2.3</p> | <p>The product has been subjected to the Freeze-thaw resistance test. This test evaluates the ability of the product to resist temperature cycling while not showing any signs of cracking or deterioration. When tested to ASTM C666/C666M, the product showed no signs of any deleterious effects.</p> <p>The product has also been tested to ASTM G154 "Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials" which evaluates the shingle materials ability to withstand UV fluorescent light and moisture. After testing to this requirement, the product showed no signs of fading, cracking, spalling or deformation.</p> <p>The Inspire Slate Roof Shingles met the criteria of the National Building Code.</p> |

5) Comments/Conclusions

QAI was retained by Tapco International Corporation to conduct an Engineering Evaluation in accordance with requirements of the 2005 National Building Code (NBC) on Inspire Slate Roof Shingle Product. The Inspire product was also compared to a similar polymer roofing product compliant with the Canadian Construction Materials Centre (CCMC).

The report relates only to the items specified. Test results in this report may not be reproducible in the field.

Person(s) Authorizing Report:

| | | | |
|------------------|--------------------|----------|-----------------|
| _____ | <u>Kevin Saito</u> | Division | |
| Name (Signature) | Name (Printed) | Manager | <u>25/11/09</u> |
| | | Title | (dd/mm/yy) |

Reviewed by:

| | | | |
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| _____ | <u>Lawrence Gibson, P.Eng</u> | President | <u>26/11/09</u> |
| Name (Signature) | Name (Printed) | Title | (dd/mm/yy) |