

# ACCEPTANCE CRITERIA FOR ADHESIVE ATTACHMENT OF CONCRETE OR CLAY ROOFING TILES

AC152

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## PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (|) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (→) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

*Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.*

# ACCEPTANCE CRITERIA FOR ADHESIVE ATTACHMENT OF CONCRETE OR CLAY ROOFING TILES (AC152)

## 1.0 INTRODUCTION

**1.1 Purpose:** This acceptance criteria establishes requirements for recognition, in ICC Evaluation Service, LLC (ICC-ES), evaluation reports, of concrete or clay roofing tiles installed with adhesive set systems, under the 2009 and 2006 *International Building Code*<sup>®</sup> (IBC), the 2009 and 2006 *International Residential Code*<sup>®</sup> (IRC) and the 1997 *Uniform Building Code*<sup>™</sup> (UBC). Bases of recognition are IBC Section 104.11, IRC Section R104.11 and UBC Section 104.2.8.

The reason for the development of this criteria is to provide a guideline for the evaluation of adhered roof tiles, since the prescriptive requirements of Chapter 15 of the IBC, Chapter 9 of the IRC and Chapter 15 of the UBC do not provide requirements for the adhesives used to attach the tiles or for the use of self-adhered underlayments with the roof tiles.

**1.2 Scope:** The acceptance criteria is limited to expanding polyurethane used to adhesively attach clay or concrete roofing tiles to underlayment that is attached to roof decks complying with Section 1609.5.1 of the 2009 IBC [Section 1609.7.1 of the 2006 IBC]. The roof tile shall comply with the limitations of Sections 1507.3 and 1609.5.3 of the 2009 IBC [Section 1609.7.3 of the 2006 IBC], or shall comply with Section 1716.2.2 of the 2009 IBC [Section 1715.2.2 of the 2006 IBC]. The underlayment may consist of a mechanically attached 30-pound base sheet and a hot-mopped 90-pound cap sheet (30/90 hot-mopped system) or may be a self-adhering membrane. Underlayments in 30/90 hot-mopped systems shall be of materials complying with a standard recognized in the code; self-adhering membranes shall comply with the requirements in Section 3.1.2 of AC48. Roof tiles using adhesive set systems shall have at least two-thirds of the tile's area free of adhesive contact.

### 1.3 Codes and Referenced Standards:

**1.3.1** 2009 and 2006 *International Building Code*<sup>®</sup> (IBC), International Code Council.

**1.3.2** 2009 and 2006 *International Residential Code*, (IRC), International Code Council.

**1.3.3** 1997 *Uniform Building Code*<sup>™</sup> (UBC).

**1.3.4** SBCCI Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles, SSTD 11-99.

**1.3.5** ASCE 7-05, Minimum Design Loads for Buildings or Other Structures.

**1.3.6** Florida Building Code 2007 Test Protocols for High-velocity Hurricane Zones, TAS-100-95, Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems.

**1.3.7** ASTM C 67-07, Test Methods of Sampling and Testing Brick and Structural Clay Tile, ASTM International.

**1.3.8** ASTM C 297-94, Test Method for Flatwise Tensile Strength of Sandwich Constructions, ASTM International.

**1.3.9** ASTM D 1621-94, Test Method for Compressive Properties of Rigid Cellular Plastics, ASTM International.

**1.3.10** ASTM D 1622-93 (1995), Test Method for Apparent Density of Rigid Cellular Plastics, ASTM International.

**1.3.11** ASTM D 1623-78, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics, ASTM International.

**1.3.12** ASTM D 1970-01, Self-adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection, ASTM International.

**1.3.13** ASTM D 2126-94, Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging, ASTM International.

**1.3.14** ASTM D 2842-97, Test Method for Water Absorption of Rigid Cellular Plastics, ASTM International.

**1.3.15** ASTM D 4977-03, Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion, ASTM International.

**1.3.16** ASTM E 108-07a, Test Methods for Fire Tests of Roof Coverings, ASTM International.

**1.3.17** UL 790-04, Tests for Fire Resistance of Roof Covering Materials, Underwriters Laboratories Inc.

**1.3.18** ICC-ES Acceptance Criteria for Special Roofing Systems (AC07).

**1.3.19** ICC-ES Acceptance Criteria for Roof Underlayment for Use in Severe Climate Areas (AC48).

## 2.0 BASIC INFORMATION AND REPORTS OF TESTS

**2.1 Product Description:** Description of the materials and of the manufacturing process shall be submitted.

**2.2 Installation Instructions:** Installation instructions shall be submitted.

**2.3 Packaging and Identification:** Description of the method of packaging and identification of the materials shall be submitted.

**2.4 Testing Laboratories, Reports of Tests and Product Sampling:**

**2.4.1** Testing laboratories shall comply Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the Rules of Procedure for Evaluation Reports.

**2.4.2** Test reports shall comply with AC85. All reports of tests shall be prepared by an independent testing laboratory accredited by the International Accreditation Service or otherwise acceptance to ICC-ES.

**2.4.3** Sampling of the roof tile adhesive for tests under this criteria shall comply with Section 3.2 of AC85.

## 3.0 REQUIRED DATA AND TEST REQUIREMENTS

Reports of the following tests shall be submitted:

**3.1 Physical Characteristics Tests:** Roof tile adhesives shall be tested and shall comply with the physical properties specified in Table 1. Tests shall be conducted using the underlayment for which recognition is sought. If a 30/90 hot-mopped system is qualified under this criteria, self-adhering underlayments may be qualified

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as equivalent to a 30/90 hot-mopped system under Section 3.4 of this criteria.

### 3.2 Performance Requirements:

**3.2.1 Overturning Moment Tests:** Tests shall be conducted in accordance with SSTD 11 for each tile type, tile size, underlayment, adhesive area and substrate combination for which recognition is sought.

#### 3.2.2 Wind Uplift:

**3.2.2.1 UBC:** For each combination of tile type, tile size, adhesive, underlayment, substrate, mean roof height, roof pitch and wind speed for which recognition is sought, the overturning moment determined in accordance with Section 3.2.1 of this acceptance criteria, or the aerodynamic overturning moment determined in accordance with either Section 800 or 900 of SSTD 11, shall be equal to or greater than the aerodynamic uplift moment calculated in accordance with the following formula:

$$M_a = L_a \cdot A \cdot C_e \cdot r \cdot C_q \cdot q_s \cdot I_w$$

where:

- $A$  = Exposed area, feet<sup>2</sup> (mm<sup>2</sup>).
- $C_e$  = Combined height, exposure and gust factor coefficient from Table 16-G of the code.
- $C_q$  = Pressure coefficient from Table 16-H of the code = 2.6.
- $I_w$  = Importance factor = 1.0.
- $L$  = Length of tile, feet (mm).
- $L_a$  = Moment arm, in feet (mm), from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width.
- $M_a$  = Aerodynamic uplift moment, ft.-lbf. (N-mm).
- $q_s$  = Wind stagnation pressure at standard height of 33 feet, from Table 16-F of the code, psf (kN/mm<sup>2</sup>).
- $r$  = Aerodynamic Moment ratio = 0.25.

**3.2.2.2 IBC:** For each combination of tile type, tile size, adhesive, underlayment, substrate, mean roof height, roof pitch and wind speed for which recognition is sought, the overturning moment determined in accordance with Section 3.2.1 of this acceptance criteria, or the aerodynamic overturning moment determined in accordance with either Section 800 or 900 of SSTD 11, shall be equal to or greater than the aerodynamic uplift moment calculated in accordance with Section 1609.5.3 of the IBC, as follows:

$$M_a = q_h \cdot C_L \cdot b \cdot L \cdot L_a \cdot [1.0 - GC_p]$$

For **SI**:  $M_a = q_h \cdot C_L \cdot b \cdot L \cdot L_a \cdot [1.0 - GC_p]/1,000$

where:

- $b$  = Exposed width of the roof tile, in feet (mm).
- $C_L$  = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by testing in accordance with either Section 800 or 900 of SSTD 11.
- $GC_p$  = Roof pressure coefficient for each applicable roof zone, determined from from the applicable

Figure in Chapter 6 of ASCE 7. Roof pressure coefficients shall not be adjusted for internal pressure.

- $L$  = Length of the roof tile, in feet (mm).
- $L_a$  = Moment arm, in feet (mm), from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width.
- $M_a$  = Aerodynamic uplift moment, in ft.-lbf. (N-mm), acting to raise the tail of the tile.
- $q_h$  = Wind velocity pressure, in psf (kN/m<sup>2</sup>), determined from Section 6.5.10 of ASCE 7.

**3.2.3 Lift Coefficient:** The lift coefficient,  $C_L$ , for rigid tile complying with Section 1609.5.3 of the IBC shall be 0.2. Accessory tiles, such as hip and ridge tiles, and tiles that do not satisfy the limitations for rigid tile in Section 1609.5.3 of the IBC, shall be tested in accordance with either Section 800 or 900 of SSTD-11, and the value of  $C_L$  shall be determined. As an alternative, the roof assembly shall be designed to withstand the wind uplift forces determined for cladding and components in the applicable code.

**3.2.4 Underlayment:** When the roof tiles are adhered to the underlayment, which is mechanically attached to the roof deck, data shall be submitted to demonstrate that the underlayment can support gravity loads resulting from the weight of the tile. When the underlayment is a 30/90 hot-mopped system, the method of attachment of the 30-pound base sheet to the roof deck shall be justified for the applicable wind loads.

**3.2.5 Wind-driven Rain Test:** Wind-driven rain tests shall be conducted when the expanding polyurethane adhesive is used as a weather blocking at hips and ridges. Tests shall be conducted in accordance with either Section 3.2.5.1, 3.2.5.2 or 3.2.5.3 of this acceptance criteria for each combination of tile type, tile size, adhesive, underlayment and substrate for which recognition is sought.

**3.2.5.1** Reports shall be provided of testing of hip and ridge applications in accordance with Section 4.10, Wind-driven Rain Test, of the ICC-ES Acceptance Criteria for Special Roofing Systems (AC07), with the following exceptions:

**3.2.5.1.1** The hip and ridge tiles shall be installed in accordance with the adhesive manufacturer's instructions.

**3.2.5.1.2** The wind velocity shall be determined at the hip or ridge.

**3.2.5.1.3** The condition of acceptance is that there shall be no leaking on the underside of the roof deck. The test report shall indicate the extent of tile fluttering during the test periods, and the cause of fluttering.

**3.2.5.1.4** Recognition in the evaluation report will be limited to areas subject to a maximum basic (3-second gust) wind speed of 100 miles per hour (161 km/h).

**3.2.5.2** Reports shall be provided of testing of the field tile application in accordance with Section 4.10 of AC07. Recognition in the evaluation report will be limited

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to areas subject to a maximum basic (3-second gust) wind speed of 100 miles per hour (161 km/h).

**3.2.5.3** Reports shall be provided of tests of hip and ridge tiles or field tiles, as applicable, in accordance with Dade County Protocol PA 100-95. The test specimens shall be representative of the assembly for which recognition is sought. Recognition in the evaluation report will be limited to areas subject to a maximum basic (3-second gust) wind speed of 130 miles per hour (209 km/h).

**3.2.6 Freeze-thaw Tests:** Freeze-thaw tests shall be conducted in accordance with both Section 8 of ASTM C 67, as specified for clay tile, and Sections 3.2.6.1 through 3.2.6.5 of this acceptance criteria.

**EXCEPTION:** Freeze-thaw tests are not required if tiles are restricted to areas in which the mean annual rainfall does not exceed 20 inches (508 mm) and the average of the daily lows for any month is at least 30°F (-1.1°C).

**3.2.6.1** Specimens shall be a minimum of 6 inches (152 mm) square and shall consist of the assembly for which recognition is sought, with respect to underlayment, adhesive and tile type. A minimum of ten specimens shall be prepared, five for freeze-thaw exposure and five for use as control specimens.

**3.2.6.2** The underlayment shall be solidly cemented to the substrate.

**3.2.6.3** During the water-soak phase, the samples shall be submerged in trays and containers of sufficient size to allow the tiles to be placed horizontally in the water, and submerged with the tile side of the sample down and the water touching the underlayment.

**3.2.6.4** At the conclusion of 50 freeze-thaw cycles, both the test specimens and the control specimens shall be tested in accordance with ASTM C 297.

**3.2.6.5 Condition of Acceptance:** Condition of acceptance is that the ultimate tensile strength of any one of the exposed specimens shall not be less than 50 percent of the average ultimate tensile strength of the control specimens.

**3.2.7 Roofing Classification:** For each combination of tile type, tile size, adhesive, underlayment and substrate for which recognition is sought, tests shall be conducted in accordance with ASTM E 108 or UL790 (UBC Standard 15-1). Conditions of acceptance are as specified in ASTM E 108 or UL 790 (UBC Standard 15-1).

**3.2.8 Installation:** Installation shall be by installers qualified through the manufacturer's training program. Details of the training program shall be submitted. The manufacturer's training program shall include personal instruction and verification of proficiency and shall require requalification at intervals to be determined by the manufacturer. The manufacturer shall have a means to track performance of certified installers and shall have a means to decertify installers.

An installation card shall be completed by the installer and shall be presented to the building official, at the completion of each project. An exemplary copy of the card shall be included in the evaluation report. The installation card shall include, at a minimum, verification of installation in accordance with the manufacturer's instructions and the

evaluation report and shall include requirements for ensuring proper adhesion of the roof tiles.

**3.3 IRC:** Use of the tile adhesive under the the IRC is applicable where an engineered design is submitted to the code official in accordance with IRC Section R301.1.3.

**3.4 Alternate Underlayments:** For recognition of a self-adhering underlayment as an alternative to the 30/90 hot-mopped underlayment system recognized in the roof tile adhesive manufacturer's evaluation report, data as described in this section (Section 3.4) shall be submitted.

**3.4.1** The underlayment shall comply with Section 3.1.2 of AC48.

**3.4.2** Fastener penetrations shall be sealed by placing asphalt cement between the underlayment and the roof sheathing under each fastener penetration, or sealability of fasteners shall be tested in accordance with Section 4.1 of this criteria. Condition of acceptance is that there shall be no sign of water on the underside of the plywood, between the underlayment and the plywood or on the fastener shanks.

**3.4.3** Roof loading slippage resistance tests shall be conducted in accordance with Section 4.2 of this criteria. Condition of acceptance is that there shall be no tears or tile slippage on any portion of the underlayment.

**3.4.4** For self-adhering underlayment having a granular surface, granule adhesion tests shall be conducted in accordance with ASTM D 4977. Condition of acceptance is that granule displacement shall be no greater than 2.0 g.

**3.4.5** Tensile adhesion tests shall be conducted in accordance with Item 3 of Table 1 of this criteria, using the subject underlayment as the substrate.

**3.4.6** Roof classification tests in accordance with Section 3.2.7 shall be conducted on assemblies utilizing the self-adhering underlayment.

## 4.0 TEST METHODS

### 4.1 Sealability of Fastener Penetrations:

**4.1.1** Fastener penetrations shall be sealed by placing asphalt cement between the underlayment and the roof sheathing under each fastener penetration, or the underlayment shall pass the testing required by this section (Section 4.1).

**4.1.2** The test method assesses the ability of the underlayment sheet to seal around a roofing fastener and prevent standing water from leaking through to the underside of the sheet after the underlayment has been exposed to ultraviolet light for a period of time corresponding to the underlayment manufacturer's recommended maximum exposure prior to being covered by any roof covering. If the manufacturer does not provide a recommended maximum exposure, the test shall be done for a minimum exposure of 30 days.

**4.1.3** Preparation of test specimens and the conducting of the test shall be in accordance with Section 7.9 of ASTM D 1970.

### 4.1.4 Ultraviolet Light Conditioning:

**4.1.4.1** Ultraviolet light shall be produced by four 300-watt UV lamps. Lamps shall be Ultra-Vitalux, 300W, 220-230V, #E27, or Osram 300W lamps, or equivalent. The ultraviolet light shall be placed 24 inches (610 mm)

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from the specimen and adjusted to maintain a controlled surface temperature of 140°F ± 5°F (60°C ± 2°C).

**4.1.4.2** Specimens shall be exposed for 10 hours per day for each day of the manufacturer's maximum recommended underlayment exposure, but not less than 30 days.

**4.1.4.3** Specimen temperature shall be maintained between 140°F and 145°F (60°C and 62.7°C) during the hours the specimen is exposed to ultraviolet light under Section 4.1.4.2.

**4.1.4.4** The specimen shall equilibrate to 75°F ± 5°F (24°C ± 2°C) before the beginning of each 10 hours of ultraviolet light exposure.

**4.2 Roof Slippage Resistance:**

**4.2.1** This test is intended to assess the maximum allowable roof pitch for the underlayment before tile slippage occurs or before construction loading will damage the underlayment. The maximum allowable roof pitch shall be determined for the underlayment without any mechanical fasteners. Battens shall be required at each row of tiles for installations when the roof pitch is greater than the maximum allowable roof pitch determined under this section (Section 4.2) and for roof pitches greater than 7:12.

**4.2.2 Specimens:**

**4.2.2.1** Three 4-foot-wide-by-8-foot-long (1.25 m by 2.5 m) specimens shall be prepared with a 4-inch (102 mm) overlap seam across the center of the 8-foot (2.5 m) length. Two sections of each specimen shall be taken, one from one edge of the roll and one from the center of the roll. The length of each specimen shall be in the "machine direction" of the roll.

**4.2.2.2** The underlayment shall be tested on each substrate for which recognition is sought.

**4.2.2.3** The underlayment shall be applied to the substrate in accordance with the manufacturer's installation instructions.

**4.2.2.4** The test specimens shall be conditioned in an oven or under heat lamps (see Section 4.1.4.1) maintained at 140°F ± 5°F (60°C ± 2°C) for a minimum of four hours. Thereafter, the deck shall be cooled for three hours at 75°F ± 5°F (57°C ± 2°C).

**4.2.2.5** After conditioning, the test deck shall be positioned at the desired slope to be tested. Individual test slope can be predetermined or multiple tests can be performed at various pitches. The minimum slope is 2:12. The incline can be raised incrementally up to and including 7:12.

**4.2.2.6** The roof component shall be placed on each sloped test deck as a roof is typically stacked on a roof plane; or one stack of flat concrete tiles having a minimum total weight of 100 pounds (45.3 kg) is put in place, along with one stack of profiled tile having a minimum total weight of 100 pounds (45.3 kg). The roof tiles shall have "lugs" on the underside of each tile. The tile stacks shall sit on the underlayment surface for 72 hours while a controlled surface temperature of 140°F ± 5°F (60°C ± 2°C) is maintained. The temperature shall be monitored by a surface-mounted thermocouple.

**4.2.2.7** Tears or tile slippage on any portion of the underlayment shall be reported.

**4.2.2.8** Before-and-after photographs of each specimen shall be included in the final test report.

**4.2.3 Conditions of Acceptance:** There shall be no tile slippage or damage to the underlayment when tested at the maximum roof pitch for which recognition is sought.

**5.0 QUALITY CONTROL**

**5.1** The adhesive shall be manufactured under a quality control program documented in accordance with the ICC-ES Acceptance Criteria for Quality Documentation (AC10).

**5.2** Third-party follow-up inspections by an accredited inspection agency are required under this criteria. ■

**TABLE 1—PHYSICAL PROPERTIES FOR ROOF TILE ADHESIVES**

NO.	PROPERTY	TEST METHOD	CONDITION	NO. OF SPECIMENS	REQUIREMENT
1	Compressive Strength	ASTM D 1621	Per standard	5	8 psi, min.
2	Density	ASTM D 1622	Per standard	Per standard	1.5 pcf, min.
3	Tensile Adhesion	ASTM D 1623, Type B or C	180°F, 65% relative humidity	5 per substrate per test period (7, 14, 30, 60, 90 and 120 days) <sup>1</sup>	15 psi, min.
4	Water Absorption	ASTM D 2842	Per standard	3	10 percent, max.
5	Thermal and Humid Aging	ASTM D 2126	158°F, 100% relative humidity	3, per test period (1, 7 and 14 days)	Percent change: ± 12%
			-40°F, ambient relative humidity	3, per test period (1, 7 and 14 days)	Percent change: ± 6%

For SI: 1 psi = 6.8948 kPa, 1 pcf = 16.018 kg/m<sup>3</sup>, 1°F = <sup>5</sup>/<sub>9</sub>(°C) + 32.0

<sup>1</sup>Substrate specimens include those with concrete tile to concrete tile, clay tile to clay tile, concrete tile to 90-pound (440.2 kg/m<sup>2</sup>) mineral-surface roll roofing, and clay tile to 90-pound (440.2 kg/m<sup>2</sup>) mineral-surface roll roofing.