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Standard Test Method for Wind Resistance of Concrete and Clay Roof Tiles (Air Permeability Method)[1]

This standard is issued under the fixed designation C1570; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The air permeability of tile roofing systems is a critical factor in determining the wind resistance of tile roofing as applied to a roof. This Standard describes a procedure for measuring the air permeability of clay and concrete tile and slate roof systems when applied to a small section of roof deck in accordance with the manufacturer's instructions.

1.2 This test procedure measures the air permeability of a laid array of unsealed clay or concrete roof tiles or slates. The tiles or slates shall have a thickness between ⅛-in. (3-mm) and 2-in. (51-mm).

1.3 The text of this test method references notes and footnotes, which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~C43 Terminology of Structural Clay Products (Withdrawn 2009)[3]~~
C1167 Specification for Clay Roof Tiles
C1232 Terminology for Masonry
C1492 Specification for Concrete Roof Tile

2.2 *SBCCI Standard:*

SBCCI SSDT 11, SBCCI Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles

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[1] This test method is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.06 on Roofing Tile.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

NOTE 1—This standard is based on the International Code Council's ICC/SBCCI SSTD 11 and work derived from the tile industry's testing programs completed in the Redland Wind Tunnel in the UK.

2.3 *ASCE Standard:*
ASCE 7, Minimum Design Loads for Buildings and Other Structures[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method refer to Terminology ~~C43~~C1232, and Specifications C1167 and C1492.

4. Principle of the Test Method

4.1 Air pressure is applied to the underside of an air permeable assembly of a specified type of roofing elements. The difference in air pressure across the assembly and the volume air flow rate are measured and used to determine the air permeability of the assembly.

5. Significance and Use

5.1 The air permeability of roofing systems constructed from discrete elements, as is the case for clay and concrete tile and slate roof systems, is a critical factor in determining the wind resistance of the roof system. The ability of the roof system to relieve wind-induced uplift pressures as a result of the overall air permeability of the roof assembly relates to the resistance of the roof system to damage induced by wind.

5.2 Natural wind conditions differ with respect to intensity, duration, and turbulence; these conditions are beyond the means of this test method to simulate.

6. Apparatus

6.1 A plenum chamber is a rectangular box with a depth of not less than 1.64 ft (500 mm) or one-third of the least lateral dimension, whichever is the greater. The plenum chamber shall be made airtight except for an open upper face to receive a mounting board or cover panel, a tapping for a pressure difference gage (relative to atmospheric pressure) and a connection to an air delivery pipe. The tapping shall be positioned to avoid direct alignment with the air delivery pipe. The shape and area of the mounting surface shall be capable of accepting the number of test samples specified in 8.1 as a minimum. A schematic of the air permeability apparatus is shown in Fig. 1.

6.2 An airtight removable cover panel shall be secured airtight to the plenum chamber.

6.3 An open face mounting board to receive the roofing substrate and test samples.

6.4 A controllable air flow generator shall be capable of continuously delivering air at a rate such that the uplift overturning moment on the roofing elements induced by the pressure in the plenum chamber by the air flow is equal and opposite to the dead weight restoring moment.

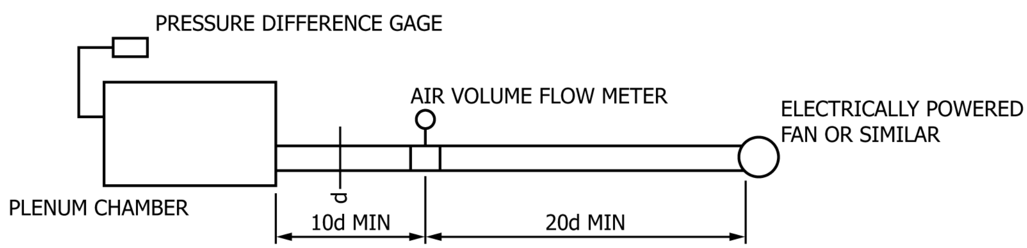

FIG. 1 Air Permeability Test Apparatus

[3] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

6.5 An airflow meter capable of measuring air volume flow rates in the delivery pipe and having an accuracy of 0.1 ft^3/s (0.003 m^3/s) or better.

6.6 A pressure difference measuring device (such as a manometer) connected to the inside and outside of the plenum chamber, capable of measuring a pressure difference of not less than 0.15 psi (1000 Pa).

6.7 Airtight seals for pipe connections, mounting board and cover panels, and at joints and edges of the roofing assembly.

6.8 A weighing device capable of measuring the dead weight of the roofing elements to the nearest 0.1 lbm (0.05 kg).

7. Check on Air-tightness of the Apparatus

7.1 Close the top of the plenum chamber by attaching and sealing the edges of the mounting board or cover panel so that the plenum chamber is air-tight except where connected to the delivery pipe.

7.2 Supply air from the airflow generator to induce a pressure difference between the inside and outside of the plenum chamber at test pressure but not less than 10.5 lbf/ft^2 (500 Pa). The air tightness of the plenum chamber shall be considered satisfactory if this pressure difference is maintained with an air flow-rate not exceeding 0.15 ft^3/s (0.004 m^3/s).

8. Test Specimen

8.1 Select, at random, sufficient roofing elements and half width elements, where appropriate, to assemble an array with a minimum of 4 unsealed elements. Roofing elements for covering the perimeter of the mounting board shall be provided and are to be air-sealed at their appropriate laps, front and side joints.

NOTE 2—A typical array illustrated for tiles or slates is shown in Fig. 2. This shows 5 unsealed tiles (5 unsealed headlaps and 5 unsealed sidelaps).

8.2 Provide sufficient roof element fastening systems, where appropriate.

8.3 Provide sufficient roof substrate materials, such as battens and their fasteners.

9. Determination of the Critical Uplift Pressure Difference, Δp_c, lbf/ft^2 (Pa)

9.1 Weigh each of the roofing elements in the air-dry condition.

9.2 Calculate the average weight (w_t), lbm (kg), of a roofing element.

9.3 Calculate the upward pressure difference, Δp_c, which is the critical pressure drop which will just fail to lift an array of unfixed samples from:

$$\Delta p_c = 0.9\left\{w_t L_g / (b g_a L_u)\right\} \tag{1}$$

where:

L_g = distance, ft (m), from the center of gravity of the sample to its uppermost line of support or the top edge of the batten,
b = exposed width, ft (m), of the roof tile or slate,
g_a = batten gage, ft (m) which is also the exposed length of the tile, and
L_u = distance, ft (m), from the center of the exposed area of the sample to its uppermost line of support or the top edge of the batten.

10. Preparation of the Test Assembly

10.1 Construct the roof substrate without underlayment, underlayment for spaced sheathing, or sheathing boards. Battens shall be laid across the rafters to provide support for the elements. Battens shall be used without sheathing to provide support for the elements regardless of the roof construction, direct deck or batten construction. Where the element may be laid to different gages and the test is to be carried out on only one gage, set out to the maximum specified gage.

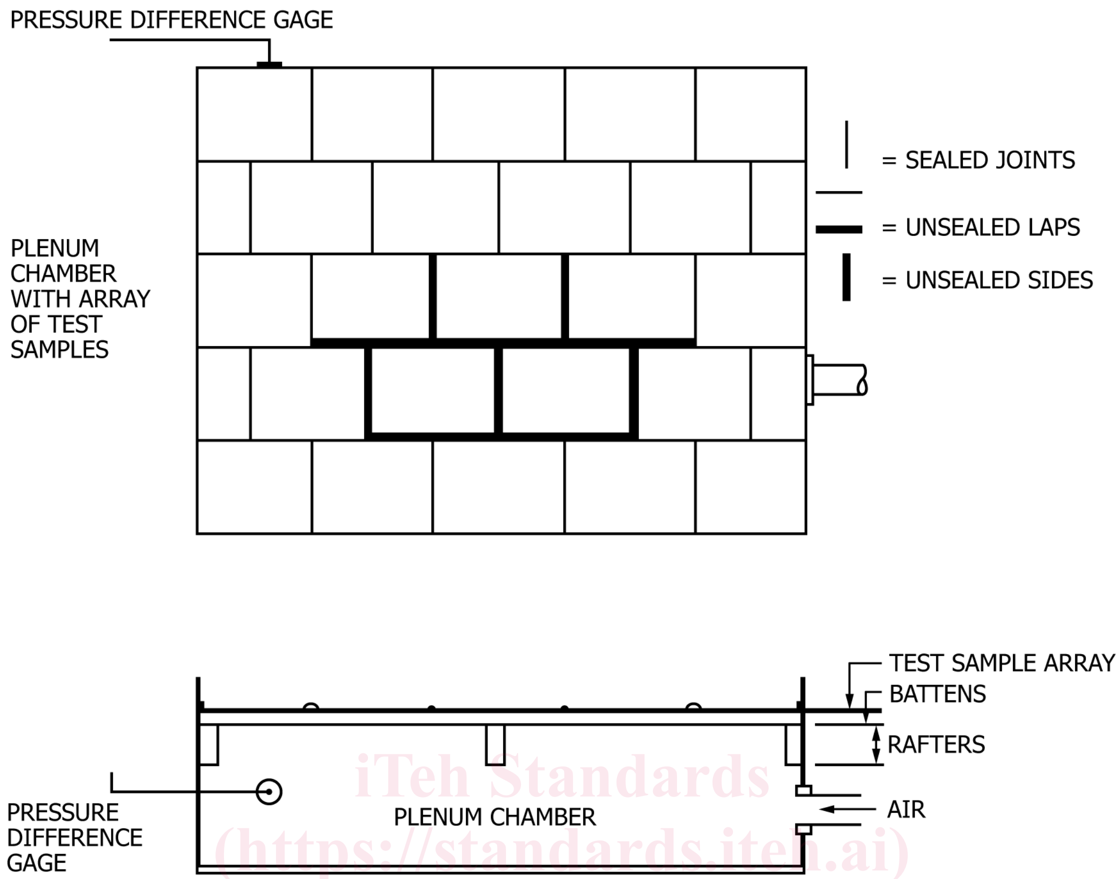

FIG. 2 Plenum Chamber Arrangement for Air Permeability Test

10.2 Lay and secure the roofing elements. For double lapped elements, lay elements with no gap between adjacent elements. For single lap elements, lay elements with maximum sidelap in order to produce the minimum exposed width. It is not necessary to secure the elements with clips unless these are essential to maintain appropriate headlap/sidelap gaps.

10.3 Seal against air leakage between peripheral elements to mounting board and to each other on all sides.

10.4 Adjust the level of the plenum chamber such that the mounting board surface is at 100 to the horizontal (±½°).

10.5 Determine the effective area *A*, ft^2 (m^2), of the roofing element assembly under test from the formula:

$$A = NBg_a \tag{2}$$

where:

N = number of unsealed roofing elements under test,
b = exposed width of the roof tile or slate, ft (m), and
g_a = batten gage, ft (m), which is also the exposed length of the tile.

11. Procedure

11.1 Check the air-tightness of the apparatus in accordance with Section 7.

11.2 Supply air from the airflow generator into the plenum chamber, gradually increasing the rate of supply until the pressure reaches a value equal to Δp_c. See Eq 1 in 9.3.