



Designation: C 1167 – 96

Standard Specification for Clay Roof Tiles¹

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1. Scope

1.1 This specification covers clay tiles intended for use as roof covering where durability and appearance are required to provide a weather-resistant surface of specified design.

1.2 Tiles are manufactured from clay, shale, or similar naturally occurring earthy substances and subjected to heat treatment at elevated temperatures (firing). The heat treatment must develop a fired bond between the particulate constituents to provide the strength and durability requirements of this specification (see *firing* and *fired bond* in Terminology C 43).

1.3 Tiles are shaped during manufacture by molding, pressing, or extrusion and it is permitted to use the shaping method to describe the tiles.

1.4 Tiles are generally planar or undulating rectangular shapes available in a variety of cross-sectional profiles, shapes, sizes, surface textures, and colors.

1.5 Three grades of tile having various degrees of resistance to weathering are covered in this specification. Three types of tile are defined to cover the features that influence appearance.

1.6 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards*:

C 43 Terminology of Structural Clay Products²

C 67 Test Methods of Sampling and Testing Brick and Structural Clay Tile²

C 297 Test Method for Tensile Strength of Flat Sandwich Constructions in Flatwise Plane³

C 554 Test Method for Craze Resistance of Fired Glazed Ceramic Whitewares by a Thermal Shock Method⁴

3. Terminology

3.1 *Definitions*—For definitions of terms relating to structural clay products, and clay roof tiles, see Terminology C 43.

¹ This specification is under the jurisdiction of ASTM Committee C-15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.06 on Roofing Tile.

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² *Annual Book of ASTM Standards*, Vol 04.05.

³ *Annual Book of ASTM Standards*, Vol 15.03.

⁴ *Annual Book of ASTM Standards*, Vol 15.02.

4. Classification

4.1 Clay roof tiles covered by this specification are classified by grade for durability and type for appearance as follows:

4.1.1 *Grades*:

4.1.1.1 *Grade 1*—Providing resistance to severe frost action.

4.1.1.2 *Grade 2*—Providing resistance to moderate frost action.

4.1.1.3 *Grade 3*—Providing negligible resistance to any frost action.

4.1.1.4 Grades relate to exposure to weather as defined in Table 1.

4.2 *Types*:

4.2.1 *Type I*—High-profile tiles—tiles having a rise-to-width ratio greater than 1:5.

4.2.2 *Type II*—Low-profile tiles—tiles having a rise-to-width ratio equal to, or less than 1:5.

4.2.3 *Type III*—All other tiles, including flat.

5. Material and Finish

5.1 Colors and textures produced by application of inorganic coatings to the faces of the tiles are permissible provided that evidence satisfactory to the purchaser is furnished regarding the durability of the coatings. Tiles that are colored by flashing or textured by sanding, where the sand does not form a continuous coating, are not considered as surface-colored tiles for the purpose of this specification.

NOTE 1—When surface colored tiles (other than sanded or flashed) are specified, data satisfactory to the purchaser shall be submitted showing that after 50 cycles of freezing-thawing (5.2) there is no observable difference in the applied finish when viewed from a distance of 40 ft (12 m) under an illumination of not less than 50 fc (538 lm/m²) by an observer with normal vision. It is permitted to present service records of the performance of the particular coated tiles in appropriate locations in place of the freezing and thawing test, with the consent of the purchaser.

5.2 The tiles shall be free of defects, deficiencies, or bloating, that would interfere with the proper laying of the tiles, the performance of the roof, or the requirements of this specification.

5.2.1 Tiles, when broken, may have a dark area that has a steely appearance and is sharply delineated from the surrounding normal color of tile. This area is known as black heart or black core. Black heart is generally the result of the reduction

TABLE 1 Grade Classification for Clay Roof Tiles

Grade (All Types)	Weathering Index (see Annex A1)
1	500 and greater
2	50 to 500
3	less than 50

of iron minerals during the firing process. Its presence, regardless of the size in the tile that otherwise meets the physical performance of this specification, shall not be cause for rejection.

5.3 The exposed tile surface shall be free of chippage or other imperfections detracting from the appearance of the designated sample when viewed from a distance 40 ft (12 m) under an illumination of not less than 50 fc (538 lm/m²) by an observer with normal vision.

5.4 Unless otherwise agreed upon between the purchaser and the seller, a delivery of tiles shall contain not less than 95 % whole tiles. In this specification, the term *whole tiles* shall be understood to mean tiles meeting the appearance requirements of this specification.

5.5 After tiles are placed in usage, the manufacturer or his agent shall not be held responsible for compliance of tiles with the requirements of this specification for dimensional tolerances, finish, texture, or color.

6. Performance Requirements

6.1 *Durability*—The tiles shall conform to the physical requirements for the grade specified as prescribed in Table 2. Unless otherwise specified by the purchaser, tiles of a higher grade (greater weathering index) shall be accepted instead of a lower grade. It is permitted to waive the saturation coefficient requirement when the average cold water absorption of a random sample of five tiles does not exceed 6 %, no more than one tile of the sample exceeds 6 % and its cold water absorption is less than 8 %. When Grade 3 tiles are used in regions where the weathering index is less than 50 (see Annex A1), unless otherwise specified, the requirements for water absorption and for saturation coefficient shall be waived.

NOTE 2—Frost is of profound importance in mechanical weathering where its effectiveness is dependent on the frequency of temperature fluctuation across the freezing point in the presence of water. The ability of a tile to resist failure in a wet and freezing environment is, therefore, of paramount importance. If a tile fails in such an environment, its use will result in an unacceptable deterioration of appearance or more likely, a total failure to function (that is, protect the underlying structure from rain), or

TABLE 2 Physical Requirements

Grade	Absorption Requirements			
	Cold Water Absorption Maximum Percent		Maximum Saturation Coefficient ^A	
	Average of Five Tiles	Individual Tile	Average of Five Tiles	Individual Tile
1	6	8	0.74	0.76
2	11	13	0.80	0.82
3	13	15	0.84	0.86

^AThe saturation coefficient is the ratio of absorption by 24-h submersion in water at a temperature of 75 ± 10°F (24 ± 6°C) to that after 5 h submersion in boiling water.

both. Such a tile is completely unacceptable for use regardless of its other properties such as strength.

NOTE 3—The resistance of clay roof tiles to weathering cannot be predicted with complete assurance using any of the physical tests prescribed. However, practical experience has demonstrated satisfactory performance of clay roof tiles, some for hundreds of years, and this experience forms the basis of the prescriptive requirements of Table 2. There is generally excellent correlation between field performance and the requirements. However, it is possible that some tiles that meet this specification are not suitable for severe climates. Furthermore, it is also possible for other tiles that do not meet this specification to show acceptable serviceability in the most severe climates. The best indication of clay roof tile durability is the service record of experience with the specified product in the environment of its intended use.

6.1.1 Measure the water absorption, and calculate the saturation coefficient, in accordance with Test Methods C 67. The test specimen shall consist of five whole tiles.

6.1.2 The physical requirements in Table 2 shall be achieved as a result of the firing process and associated thermal reactions within the tile body (and glaze, if present) which include development of the fired bond, increase in density, increase in strength, and reduction in water absorption. Tiles shall not comply with this specification if other processes, for example, immersion in solutions of organic materials to effect impregnation or surface sealing, are used to change the physical properties which result from the firing process.

6.2 *Freezing and Thawing*—The requirements specified in 6.1 for water absorption (5-h boiling) and saturation coefficient shall not be required for all grades provided that a sample of five tiles, meeting all of the other requirements, experiences no breakage and not greater than 0.5 % loss in dry weight when subjected to 50 cycles of the freezing-and-thawing test of Test Methods C 67, modified in accordance with 6.2.1.

6.2.1 Modify Test Methods C 67, Section 8, as follows: The test specimens shall consist of five whole tiles. The freezing trays and containers shall be of sufficient size and depth to allow the tiles to be completely submerged in water when placed horizontally. The tiles shall be completely submerged in water when the trays are placed in the freezing chamber. It is permitted to test individual tile or to stack tile on top of each other in the tray, provided that spacers at least ¼ in. (6 mm) thick are used between adjacent tiles and that the total stack is completely submerged.

NOTE 4—A large capacity freezer is generally necessary to accomplish freezing in the manner specified in Test Methods C 67 for trays containing more than one tile. It is permitted to use custom trays to enclose the tile(s) and minimize the volume of water required to completely submerge the tile(s).

6.2.2 A lot of tiles shall be given the Grade 1 rating without repeating a freezing and thawing test provided that a previous lot made by the supplier from similar materials, by the same process, at the same production plant, and within the previous 12 months, had passed the test, and provided also that a sample of five tiles selected from the lot has an average and individual minimum transverse strength not less than the previously graded sample and has average and individual maximum water absorption and saturation coefficient not greater than those of the previously graded sample.

NOTE 5—Unless specifically requested by the purchaser, the 50-cycle

freezing and thawing test is specified only as an alternative when tiles do not conform to either Table 2 requirements for maximum water absorption and saturation coefficient, or to the restrictive absorption requirements in 6.1.

6.3 *Strength*—The transverse breaking strength of tiles shall be determined as described for the Flexure Test in Test Methods C 67 except as modified in 6.3.1 to 6.3.7.

6.3.1 Five tiles shall be tested wet after a 24-h submersion in water at a temperature of $75 \pm 10^\circ\text{F}$ ($24 \pm 6^\circ\text{C}$) or five tiles shall be tested dry after heating in a ventilated oven for 24 h at a temperature of 230 to 239°F (110 to 115°C).

6.3.1.1 Tile shall be considered to comply with this specification when they pass the requirement of either the wet or the dry transverse strength test. The choice of method, wet or dry, shall be mutually agreed upon between specifier and supplier.

6.3.2 The span chosen for the test shall be 12 in. (30.5 cm) $\pm 5\%$ or $\frac{2}{3}$ of the length of the tile, whichever is greater. The span is measured between the centers of the lower support members (6.3.3 and Fig. 1).

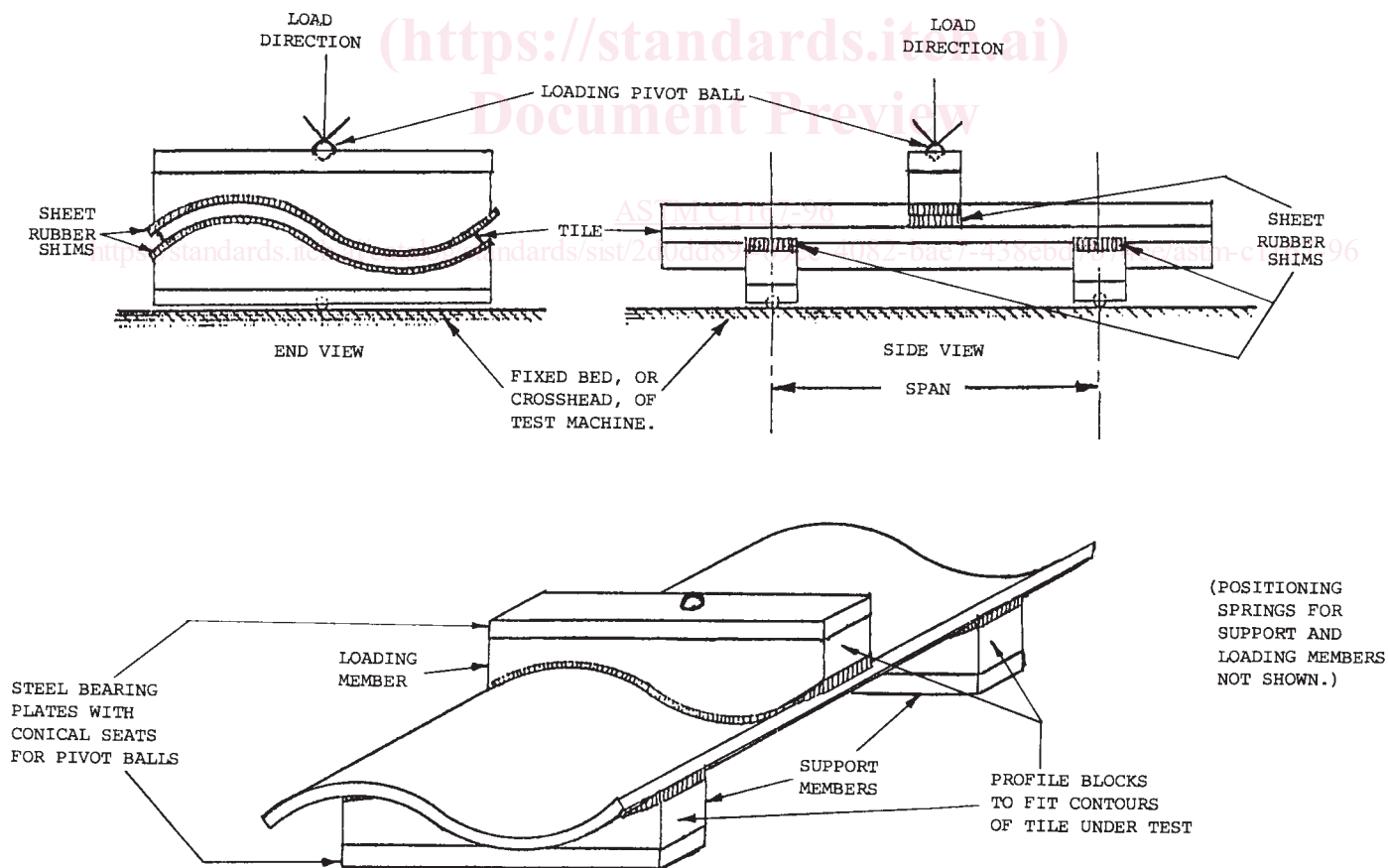
6.3.2.1 It is permitted to use a shorter span than required by 6.3.2 when the length of the tile to be tested is not sufficient to allow a 12 in. (30.5 cm) span to be used. In that case, a shorter span, not less than two-thirds of the length of the tile, shall be

used and the required minimum values in Table 3 shall be increased proportionately to the reduction in span, that is, multiplied by:

$$\frac{12}{\text{span used (in.)}} \quad (1)$$

6.3.3 The tile shall be tested in a three-point bending mode in a horizontal plane with the bottom surface of the tile resting on two lower support members and with the load being applied to the upper (exposed) surface of the tile by a third member moving in a direction perpendicular to the plane of the tile and at mid-span (that is, equidistant from each of the lower support members).

6.3.4 The two support members and the loading member shall be of metal or hardwood with 1 in. (25 mm) $\pm 5\%$ wide faces. The faces shall be shaped (see Note 6) to closely conform to the profile of the surface of the tile upon which they bear during the test (it is permitted to use different profiles for each member depending on the profile and cross-sectional shape of the tile). The total height of the members shall not be more than 1 in. (25 mm) greater than the rise of the tile profile and, if hardwood, they should be backed up with steel bearing plates at least $\frac{1}{2}$ in. (13 mm) thick. A rubber shim strip $\frac{3}{16}$ in. (4.8 mm) $\pm 10\%$ thick of hardness no greater than Shore



NOTE—See text for dimensions.

NOTE 1—See text for dimensions.

FIG. 1 Schematic of Assembly for Flexure Strength Testing