Designation: C1505 – 15 (Reapproved 2022)

Standard Test Method for Determination of Breaking Strength and Modulus of Rupture of Ceramic Tiles and Glass Tiles by Three-Point Loading[1]

This standard is issued under the fixed designation C1505; 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 This test method covers the determination of breaking strength and modulus of rupture of ceramic tiles and glass tiles by three-point loading.

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

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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]

C242 Terminology of Ceramic Whitewares and Related Products

3. Terminology

3.1 For the definitions of terms used on this test method, refer to Terminology C242.

4. Summary of Test Method

4.1 This test method consists of determining the breaking strength and modulus of rupture of ceramic tiles and glass tiles using a three-point loading method. The tiles are supported on two cylindrical support rods positioned to provide an appropriate span. A load is applied at a uniform rate using a third central cylindrical rod positioned at the midpoint between the support rods. The breaking strength and modulus of rupture are calculated using the load at which tile failure is observed, the dimensions of the tile specimen, and the span between the support rods. Optionally, the deflection at which the tile failure is observed may be reported.

5. Significance and Use

5.1 This test method is intended for determining the breaking strength and modulus of rupture of ceramic tiles and glass tiles for compliance with requirements that may appear in specifications.

6. Apparatus

6.1 *Testing Machine,* capable of loading at a uniform rate sufficient to increase the stress in the specimen at a rate of 1 ± 0.2 N/mm^2 (145 ± 29 psi) per second. At minimum, the testing machine shall record loading data at the point at which specimen failure is observed. Optionally, the testing machine may record deflection data. The rod support table of the testing machine shall be adjustable such that the cylindrical support rods can accommodate a variety of specimen sizes.

6.2 *Cylindrical Support Rods,* 2, of length, *w*, with a steel core of diameter, *d*, and a rubber bearing surface of 55 ± 3 Shore A durometer hardness and thickness, *t* (see Table 1). One rod shall be permitted to pivot slightly relative to its length and the other shall be permitted to rotate slightly relative to its axis (see Fig. 1).

6.3 *Central Cylindrical Rod,* of length, *w*, with a steel core of diameter, *d*, and a rubber bearing surface of 55 ± 3 Shore A durometer hardness and thickness, *t*. The rod shall be permitted to pivot slightly relative to its axis.

7. Sampling

7.1 The test sample shall consist of ten whole tiles, selected at random from the lot to be tested. Tiles too large to be tested whole may be cut; however, the cut specimens shall be square and as large as possible, though not larger than the rod length.

[1] This test method is under the jurisdiction of ASTM Committee C21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.06 on Ceramic 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.

TABLE 1 Length of Rod, Diameter of Core, Thickness of Rubber, and Overhang (See Fig. 2)

Minimum Dimension (mm)	Length of Rod, *w* (mm)	Diameter of Core, *d* (mm)	Thickness of Rubber, *t* (mm)	Length of Overhang, *l* (mm)
≥95	560	20	5 ± 1	10 ± 5
<95 but ≥52	130	10	2.5 ± 0.5	5 ± 2
<52 but ≥18	60	5	1 ± 0.2	2 ± 1

The centerpoint of the cut specimen shall coincide with the original centerpoint of the whole tile.

8. Procedure

8.1 Position the cylindrical support rods (6.2) on the rod support plate (6.2) with an appropriate span, *L*, so that the specimens will overhang each support rod by length, *l* (see Table 1). Place each specimen face up, unless otherwise specified, on the support rods. In the case of reversible tile, such as unglazed ceramic mosaic tile, it is immaterial which side of the specimen is up. If applicable, position each specimen so that the longer side or the directional back-pattern is at right angles to the supports. In the case were both conditions exist, the orientation of the longer side shall take precedence.

8.2 Position the central cylindrical rod (6.3) on the face of the specimen at the midpoint between the support rods. Load the specimen with the central rod at a uniform rate sufficient to increase the stress in the specimen at a rate of 1 ± 0.2 N/mm^2 (145 ± 29 psi) per second. The load rate in N/s can be determined by the following equation:

$$r = 2bh^2/3L \qquad (1)$$

where:

r = load rate, in N/s,
b = the width of the specimen, in mm,
h = the minimum thickness of the specimen, in mm, and
L = the span between the cylindrical support rods, in mm.

Record the load at which the specimen breaks into two or more pieces.

8.3 Record the load at which specimen failure is observed. Failure is defined as the specimen breaking into two or more pieces or when a reduction in load of 5% or greater is observed for the first time.

8.4 *Optional*—Record the deflection, in mm, at which specimen failure is observed.

8.5 Repeat the procedure until all specimens in the sample have been tested.

9. Calculation

9.1 Calculate the breaking strength of each specimen using the following equation:

$$B = PL/b \qquad (2)$$

where:

B = breaking strength, in N,
P = load at which specimen failure is observed, in N,
L = the span between the cylindrical support rods, in mm, and
b = the width of the specimen, in mm.

9.2 Calculate the modulus of rupture of each specimen using the following equation:

$$R = 3B/2h^2 \qquad (3)$$

where:

R = modulus of rupture, in N/mm^2,
B = breaking strength, in N, and
h = the minimum thickness of the test specimen, in mm.

9.3 Calculate the average breaking strength and modulus of rupture.

10. Report

10.1 The test report shall include the following information:

10.1.1 A description of the tiles;

10.1.2 The number of specimens;

10.1.3 The values of *w*, *d*, *t*, *l*, *L*, *b*, and *h* ;

10.1.4 The load, *P*, at which failure is observed on each specimen;

10.1.5 The breaking strength and modulus of rupture and modulus of rupture of each specimen;

10.1.6 The average breaking strength and modulus of rupture of all specimens.

10.1.7 *Optional*—The deflection at which failure is observed each specimen.

11. Precision and Bias

11.1 *Precision*[3]—A study has been conducted to provide an estimate of the repeatability standard deviation of this test method using a single laboratory with a single operator. The referenced study involved test conditions of three different types of tile: 12-in. x 12-in. porcelain, 4-in. x 8-in. quarry, and 4¼-in. x 4¼-in. wall tile. Three replicate tests were conducted for each condition, with the results as follows:

Test Condition	Average Breaking Strength, B (N)	Repeatability Standard Deviation for B	Average MOR, R (N/mm^2)	Repeatability Standard Deviation for R
Porcelain Tile	2144	79.0	48	1.8
Glazed Wall Tile	988	37.7	32	1.2
Quarry Tile	2440	36.6	26	0.4

11.2 No information can be presented on the bias of the procedure in this test method for determining breaking strength and modulus of rupture of ceramic tile and glass tile by three-point loading because the no material having an accepted reference value is available.

[3] An interlaboratory study of this method including large format tile and glass tile is being conducted and a complete precision statement is expected to be available on or before December 2016.