



Designation: C1674 – 23

Standard Test Method for Flexural Strength of Advanced Ceramics with Engineered Porosity (Honeycomb Cellular Channels) at Ambient Temperatures¹

This standard is issued under the fixed designation C1674; 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 the flexural strength (modulus of rupture in bending) at ambient conditions of advanced ceramic structures with 2-dimensional honeycomb channel architectures.

1.2 The test method is focused on engineered ceramic components with longitudinal hollow channels, commonly called “honeycomb” channels (see Fig. 1). The components generally have 30 % or more porosity and the cross-sectional dimensions of the honeycomb channels are on the order of 1 mm or greater. Ceramics with these honeycomb structures are used in a wide range of applications (catalytic conversion supports (1),² high temperature filters (2, 3), combustion burner plates (4), energy absorption and damping (5), etc.). The honeycomb ceramics can be made in a range of ceramic compositions—alumina, cordierite, zirconia, spinel, mullite, silicon carbide, silicon nitride, graphite, and carbon. The components are produced in a variety of geometries (blocks, plates, cylinders, rods, rings).

1.3 The test method describes two test specimen geometries for determining the flexural strength (modulus of rupture) for a porous honeycomb ceramic test specimen (see Fig. 2):

1.3.1 *Test Method A*—A 4-point or 3-point bending test with user-defined specimen geometries, and

1.3.2 *Test Method B*—A 4-point- $\frac{1}{4}$ point bending test with a defined rectangular specimen geometry (13 mm $\times$ 25 mm $\times$ > 116 mm) and a 90 mm outer support span geometry suitable for cordierite and silicon carbide honeycombs with small cell sizes.

1.4 The test specimens are stressed to failure and the breaking force value, specimen and cell dimensions, and

loading geometry data are used to calculate a nominal beam strength, a wall fracture strength, and a honeycomb structure strength.

1.5 Test results are used for material and structural development, product characterization, design data, quality control, and engineering/production specifications.

1.6 The test method is meant for ceramic materials that are linear-elastic to failure in tension. The test method is not applicable to polymer or metallic porous structures that fail in an elastomeric or an elastic-ductile manner.

1.7 The test method is defined for ambient testing temperatures. No directions are provided for testing at elevated or cryogenic temperatures.

1.8 The values stated in SI units are to be regarded as standard (IEEE/ASTM SI 10). English units are sparsely used in this standard for product definitions and tool descriptions, per the cited references and common practice in the US automotive industry.

1.9 *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.*

1.10 *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:*³

C373 Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for

¹ This test method is under the jurisdiction of ASTM Committee C28 on Advanced Ceramics and is the direct responsibility of Subcommittee C28.04 on Applications.

Current edition approved June 1, 2023. Published July 2023. Originally approved in 2008. Last previous edition approved in 2016 as C1674 – 16. DOI: 10.1520/C1674-23.

² The boldface numbers in parentheses refer to the list of references at the end of this standard.

³ 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.

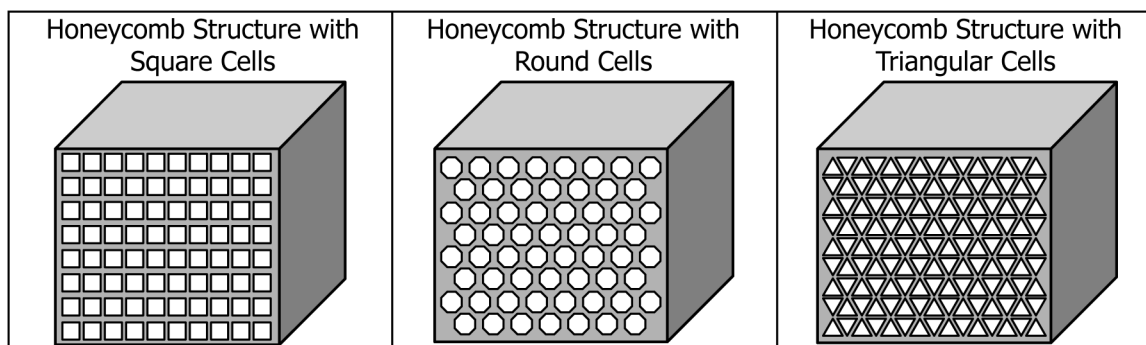
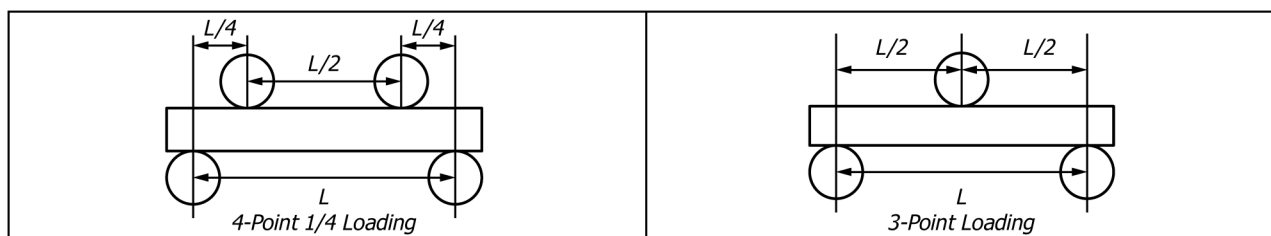


FIG. 1 General Schematics of Typical Honeycomb Ceramic Structures



L = Outer Span Length (for Test Method A, L = User defined; for Test Method B, L = 90 mm)

NOTE 1—4-Point- $1/4$ Loading for Test Methods A1 and B.

NOTE 2—3-Point Loading for Test Method A2.

FIG. 2 Flexure Loading Configurations

Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products

C1145 Terminology of Advanced Ceramics

C1161 Test Method for Flexural Strength of Advanced Ceramics at Ambient Temperature

C1198 Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Sonic Resonance

C1239 Practice for Reporting Uniaxial Strength Data and Estimating Weibull Distribution Parameters for Advanced Ceramics

C1259 Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Impulse Excitation of Vibration

C1292 Test Method for Shear Strength of Continuous Fiber-Reinforced Advanced Ceramics at Ambient Temperatures

C1341 Test Method for Flexural Properties of Continuous Fiber-Reinforced Advanced Ceramic Composites

C1368 Test Method for Determination of Slow Crack Growth Parameters of Advanced Ceramics by Constant Stress Rate Strength Testing at Ambient Temperature

C1525 Test Method for Determination of Thermal Shock Resistance for Advanced Ceramics by Water Quenching

C1576 Test Method for Determination of Slow Crack Growth Parameters of Advanced Ceramics by Constant Stress Flexural Testing (Stress Rupture) at Ambient Temperature

D2344/D2344M Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates

E4 Practices for Force Calibration and Verification of Testing Machines

E6 Terminology Relating to Methods of Mechanical Testing

E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI) (The Modern Metric System)

3. Terminology

3.1 The definitions of terms relating to flexure testing appearing in Terminology E6 apply to the terms used in this test method. The definitions of terms relating to advanced ceramics appearing in Terminology C1145 apply to the terms used in this test method. Pertinent definitions, as listed in Terminology C1145, Test Method C1161, and Terminology E6 are shown in the following section with the appropriate source given in brackets. Additional terms used in conjunction with this test method are also defined.

3.2 Definitions:

3.2.1 *advanced ceramic, n* —a highly engineered, high performance, predominately non-metallic, inorganic, ceramic material having specific functional attributes. **C1145**

3.2.2 *breaking force, $[F]$, n* —the force at which fracture occurs in a test specimen. **E6**

3.2.2.1 *Discussion*—In this test method, fracture consists of breakage of the test bar into two or more pieces or a loss of at least 50 % of the maximum force carrying capacity.