Designation: C 1419 – 99a

Standard Test Method for Sonic Velocity in Refractory Materials at Room Temperature and Its Use in Obtaining an Approximate Young's Modulus[1]

This standard is issued under the fixed designation C 1419; 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 describes a procedure for measuring the sonic velocity in refractory materials at room temperature. The sonic velocity can be used to obtain an approximate value for Young's modulus.

1.2 The sonic velocity may be measured through the length, thickness, and width of the specimen.

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

2. Referenced Documents

2.1 *ASTM Standards:*

C 134 Test Methods for Size, Dimensional Measurements, and Bulk Density of Refractory Brick and Insulating Firebrick[2]

C 179 Test Method for Drying and Firing Linear Change of Refractory Plastic and Ramming Mix Specimens[2]

C 769 Test Method for Sonic Velocity in Manufactured Carbon and Graphite Materials for Use in Obtaining an Approximate Young's Modulus[2]

C 885 Test Method for Young's Modulus of Refractory Shapes by Sonic Resonance[2]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[3]

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)[3]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *longitudinal sonic pulse*, *n*—a sonic pulse in which the displacements are in the direction of propagation of the pulse.

3.1.2 *pulse travel time, (T_t)*, *n*—the total time, measured in microseconds, required for the sonic pulse to traverse the specimen being tested, and for the associated electronic signals to traverse the circuits of the pulse propagation circuitry.

3.1.3 *zero time, (T_o)*, *n*—the travel time (correction factor), measured in microseconds, associated with the electronic circuits in the pulse-propagation system.

4. Summary of Test Method

4.1 The velocity of sound waves passing through the test specimen is determined by measuring the distance through the specimen and dividing by the time lapse between the transmitted pulse and the received pulse.[4,5] An approximate value for Young's modulus can be obtained as follows:

$$E = \rho v^2 \quad (1)$$

where:

E = Young's modulus of elasticity, Pa,
ρ = density, kg/m^3, and
v = signal velocity, m/s.

4.2 Strictly speaking, the elastic constant given by this measurement is not E but C_{33}, provided the sonic pulse is longitudinal and the direction of propagation is along the axis of symmetry.[4,5]

5. Significance and Use

5.1 This test method is used to determine the sonic velocity and approximate Young's modulus of refractory shapes at room temperature. Since this test is nondestructive, specimens may be used for other tests as desired.

5.2 This test method is useful for research and development, engineering application and design, manufacturing quality and process control, and for developing purchasing specifications.

6. Apparatus

6.1 *Driving Circuit*, which consists of an ultra sonic pulse generator capable of producing pulses in a frequency range from 0.5 to 2.5 MHz.

[1] This test method is under the jurisdiction of ASTM Committee C-8 on Refractories and is the direct responsibility of Subcommittee C08.01 on Strength.

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[2] *Annual Book of ASTM Standards*, Vol 15.01.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] Schreiber, Anderson, and Soga, "Elastic Constants and Their Measurement," McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1973.

[5] *American Institute of Physics Handbook*, 3rd ed., McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1972, pp. 3–98ff.