



Standard Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio of Refractory Materials by Impulse Excitation of Vibration¹

This standard is issued under the fixed designation C 1548; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This test method covers the measurement of the fundamental resonant frequencies for the purpose of calculating the dynamic Young's modulus, the dynamic shear modulus (also known as the modulus of rigidity), and the dynamic Poisson's ratio of refractory materials at ambient temperatures. Specimens of these materials possess specific mechanical resonant frequencies, which are determined by the elastic modulus, mass, and geometry of the test specimen. Therefore, the dynamic elastic properties can be computed if the geometry, mass, and mechanical resonant frequencies of a suitable specimen can be measured. The dynamic Young's modulus is determined using the resonant frequency in the flexural mode of vibration and the dynamic shear modulus is determined using the resonant frequency in the torsional mode of vibration. Poisson's ratio is computed from the dynamic Young's modulus and the dynamic shear modulus.

1.2 Although not specifically described herein, this method can also be performed at high temperatures with suitable equipment modifications and appropriate modifications to the calculations to compensate for thermal expansion.

1.3 The values are stated in SI units and are to be regarded as the standard.

1.4 *This standard may involve hazardous materials, operations, and equipment. 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

C 71 Terminology Relating to Refractories²

C 215 Test Method for Fundamental Transverse, Longitudinal, and Torsional Frequencies of Concrete Specimens³

C 885 Test Method for Young's Modulus of Refractory Shapes by Sonic Resonance²

C 1259 Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio for Advanced Ceramics by Impulse Excitation of Vibration²

3. Summary of Test Method

3.1 The fundamental resonant frequencies are determined by measuring the resonant frequency of specimens struck once mechanically with an impacting tool. Frequencies are measured with a transducer held lightly against the specimen using a signal analyzer circuit. Impulse and transducer locations are selected to induce and measure one of two different modes of vibration. The appropriate resonant frequencies, dimensions, and mass of each specimen may be used to calculate dynamic Young's modulus, dynamic shear modulus, and dynamic Poisson's ratio.

4. Significance and Use

4.1 This test method is non-destructive and is commonly used for material characterization and development, design data generation, and quality control purposes. The test assumes that the properties of the specimen are perfectly isotropic, which may not be true for some refractory materials. The test also assumes that the specimen is homogeneous and elastic. Specimens that are micro-cracked are difficult to test since they do not yield consistent results. Specimens with low densities have a damping effect and are easily damaged locally at the impact point. Insulating bricks can generally be tested with this technique, but fibrous insulating materials are generally too weak and soft to test.

4.2 For quality control use, the test method may be used for measuring only resonant frequencies of any standard size specimen. An elastic modulus calculation may not be needed or even feasible if the shape is non-standard, such as a slide gate plate containing a hole. Since specimens will vary in both size and mass, acceptable frequencies for each shape and material must be established from statistical data.

¹ This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.01 on Strength. Current edition approved Nov. 10, 2002. Published July 2003.

² Annual Book of ASTM Standards, Vol. 15.01.

³ Annual Book of ASTM Standards, Vol. 04.02.