



Designation: D7012 – 10

Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures¹

This standard is issued under the fixed designation D7012; 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 These test methods cover the determination of the strength of intact rock core specimens in uniaxial and triaxial compression. The tests provide data in determining the strength of rock, namely: the uniaxial strength, shear strengths at different pressures and different elevated temperatures, angle of internal friction, (angle of shearing resistance), and cohesion intercept. The test methods specify the apparatus, instrumentation, and procedures for determining the stress-axial strain and the stress-lateral strain curves, as well as Young's modulus, E , and Poisson's ratio, ν . It should be observed that these methods make no provision for pore pressure measurements and specimens are undrained (platens are not vented). Thus the strength values determined are in terms of total stress, that is, are not corrected for pore pressures. These test methods do not include the procedures necessary to obtain a stress-strain curve beyond the ultimate strength.

1.2 This standard replaces and combines the following Standard Test Methods: D2664 Triaxial Compressive Strength of Undrained Rock Core Specimens Without Pore Pressure Measurements; D5407 Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements; D2938 Unconfined Compressive Strength of Intact Rock Core Specimens; and D3148 Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression. The original four standards are now referred to as Methods in this standard.

1.2.1 Method A: Triaxial Compressive Strength of Undrained Rock Core Specimens Without Pore Pressure Measurements.

1.2.2 Method B: Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements.

1.2.3 Method C: Uniaxial Compressive Strength of Intact Rock Core Specimens.

1.2.4 Method D: Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression.

1.2.5 Option A: Elevated Temperatures.

1.3 For an isotropic material in Test Methods B and D, the relation between the shear and bulk moduli and Young's modulus and Poisson's ratio are:

$$G = \frac{E}{2(1+\nu)} \quad (1)$$

$$K = \frac{E}{3(1-2\nu)} \quad (2)$$

where:

G = shear modulus,

K = bulk modulus,

E = Young's modulus, and

ν = Poisson's ratio.

1.3.1 The engineering applicability of these equations decreases with increasing anisotropy of the rock. It is desirable to conduct tests in the plane of foliation, cleavage or bedding and at right angles to it to determine the degree of anisotropy. It is noted that equations developed for isotropic materials may give only approximate calculated results if the difference in elastic moduli in two orthogonal directions is greater than 10 % for a given stress level.

NOTE 1—Elastic moduli measured by sonic methods (Test Method D2845) may often be employed as a preliminary measure of anisotropy.

1.4 Test Methods B and D for determining the elastic constants do not apply to rocks that undergo significant inelastic strains during the test, such as potash and salt. The elastic moduli for such rocks should be determined from unload-reload cycles, that are not covered by this test method.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.12 on Rock Mechanics.

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*A Summary of Changes section appears at the end of this standard

1.7 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:²

- D653** Terminology Relating to Soil, Rock, and Contained Fluids
- D2216** Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2845** Test Method for Laboratory Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock
- D3740** Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4543** Practices for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerances
- D6026** Practice for Using Significant Digits in Geotechnical Data
- E4** Practices for Force Verification of Testing Machines
- E122** Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

2.2 ASTM Adjunct:³

- Triaxial Compression Chamber Drawings (3)**

3. Terminology

- 3.1 Refer to Terminology **D653** for specific definitions.

4. Summary of Test Method

4.1 A rock core specimen is cut to length and the ends are machined flat. The specimen is placed in a loading frame and if required, placed in a loading chamber and subjected to confining pressure. In an elevated temperature test the specimen is heated to the desired test temperature. Axial load is increased continuously on the specimen, and deformation is measured as a function of load until peak load and failure are obtained.

5. Significance and Use

5.1 The parameters obtained from Methods A and B are in terms of undrained total stress (as already mentioned in **1.1**). However, there are some cases where either the rock type or the loading condition of the problem under consideration will require the effective stress or drained parameters be determined.

5.2 Uniaxial compressive strength (Method C) of rock is used in many design formulas and is sometimes used as an index property to select the appropriate excavation technique.

Deformation and strength of rock are known to be functions of confining pressure. The triaxial compression test (Method A) is commonly used to simulate the stress conditions under which most underground rock masses exist. The elastic constants (Methods B and D) are used to calculate the stress and deformation in rock structures.

5.3 The deformation and strength properties of rock cores measured in the laboratory usually do not accurately reflect large-scale *in situ* properties because the latter are strongly influenced by joints, faults, inhomogeneities, weakness planes, and other factors. Therefore, laboratory values for intact specimens must be employed with proper judgment in engineering applications.

NOTE 2—Notwithstanding the statements on precision and bias contained in this test method; the measures of precision of these test methods are dependent on the competence of the personnel performing them, and on the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice **D3740** does not in itself assure reliable testing. Reliable testing depends on many factors; Practice **D3740** provides a means for evaluating some of those factors.

6. Apparatus

6.1 Compression Apparatus:

6.1.1 Methods A to D:

6.1.1.1 *Loading Device*—The loading device shall be of sufficient capacity to apply load at a rate conforming to the requirements specified in **10.4.1**. It shall be verified at suitable time intervals in accordance with the procedures given in Practices **E4** and comply with the requirements prescribed in the method. The loading device may be equipped with a displacement transducer that can be used to advance the loading ram at a specified rate.

NOTE 3—For Methods A and B, if the load-measuring device is located outside the confining compression apparatus, calibrations to determine the seal friction need to be made to ensure the accuracy specified in Practices **E4**.

6.2 Confining System³:

6.2.1 Methods A and B:

6.2.1.1 *Confining Apparatus*⁴—The confined pressure apparatus shall consist of a chamber in which the test specimen may be subjected to a constant lateral fluid pressure and the required axial load. The apparatus shall have safety valves, suitable entry ports for filling the chamber, and associated hoses, gages, and valves as needed.

6.2.1.2 *Flexible Membrane*—This membrane encloses the rock specimen and extends over the platens to prevent penetration by the confining fluid. A sleeve of natural or synthetic rubber or plastic is satisfactory for room temperature tests; however, metal or high-temperature rubber (for example, viton) jackets are usually required for elevated temperature tests. The membrane shall be inert relative to the confining fluid and shall cover small pores in the specimen without

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.

³ Assembly and detail drawings of an apparatus that meets these requirements and which is designed to accommodate 54 mm diameter specimens and operate at a confining fluid pressure of 68.9 MPa are available from ASTM International Headquarters. Order Adjunct No. **ADJD7012**. Original adjunct produced in 1982.

⁴ Assembly and detail drawings of an apparatus that meets these requirements and which is designed to accommodate 21/8-in. (53.975-mm) diameter specimens and operate at a confining fluid pressure of 68.9 MPa are available from ASTM International Headquarters. Order Adjunct No. **ADJD7012**. Original adjunct produced in 1982.