



Standard Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using a Radial Jacking Test¹

This standard is issued under the fixed designation D 4506; 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 is used to determine the in situ modulus of deformation of rock mass by subjecting a test chamber of circular cross section to uniformly distributed radial loading; the consequent rock displacements are measured, from which elastic or deformation moduli may be calculated. The anisotropic deformability of the rock can also be measured and information on time-dependent deformation may be obtained.

1.2 This test method is based upon the procedures developed by the U.S. Bureau of Reclamation featuring long extensometers (1)². An alternative procedure is also available and is based on a reference bar (2).

1.3 Application of the test results is beyond the scope of this test method, but may be an integral part of some testing programs.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *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:

D 653 Terminology Relating to Soil, Rock, and Contained Fluids³

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of soil and Rock as Used in Engineering Design and Construction³

D 4403 Practice for Extensometers Used in Rock³

3. Terminology

3.1 **Definitions:** See Terminology D 653 for general definitions.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 **deformation**—the change in the diameter of the excavation in rock (test chamber).

4. Summary of Test Method

4.1 A circular test chamber is excavated and a uniformly distributed pressure is applied to the chamber surfaces by means of flat jacks positioned on a reaction frame. Rock deformation is measured by extensometers placed in boreholes perpendicular to the chamber surfaces. Pressure is measured with a standard hydraulic transducer. During the test, the pressure is cycled incrementally and deformation is read at each increment. The modulus is then calculated. To determine time-dependent behavior, the pressure is held constant and deformation is observed over time.

5. Significance and Use

5.1 Using this test method, a volume of rock large enough to take into account the influence of discontinuities on the properties of the rock mass is loaded. The test should be used when values are required which represent the true rock mass properties more closely than can be obtained through less expensive uniaxial jacking tests or other procedures.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 **Chamber Excavation Equipment**—This includes drilling and “smooth wall” blasting equipment or mechanical excavation equipment capable of producing typically a 9-ft (3-m) diameter tunnel with a length about three times that dimension.

6.2 **Concreting Equipment**—Concreting materials and equipment for lining the tunnel, together with strips of weak jointing materials for segmenting the lining.

6.3 **Reaction Frame**—The reaction frame shall be comprised of steel rings of sufficient strength and rigidity to resist the force applied by flat jacks, as depicted in Fig. 1. For load application by flat jacks, the frame must be provided with

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² The **boldface** numbers in parentheses refer to the list of references appended to this standard.

³ *Annual Book of ASTM Standards*, Vol 04.08.