



Standard Test Method for Determining the In Situ Modulus of Deformation of Rock Using the Diametrically Loaded 76-mm (3-in.) Borehole Jack¹

This standard is issued under the fixed designation D 4971; 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 estimation of in situ modulus of a rock mass at various depths and orientations. Information on time-dependent deformation may also be obtained.

1.2 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026.

1.2.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.3 The values stated in SI units are regarded as standard. The inch-pound units in parentheses are for information only.

1.4 *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 Fluids²

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction²

D 6026 Practice for Using Significant Digits in Geotechnical Data³

D 6032 Test Method for Determining Rock Quality Designation [RQD] of Rock Core³

3. Terminology

3.1 See Terminology D653 for general definitions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *deformation*—change in shape or size, (see Terminology D 653). In this test method deformation is the change in the diameter of the borehole.

3.2.2 *modulus of deformation*—ratio of stress to strain for a material under given loading conditions; numerically equal to the slope of the tangent or the secant of the stress-strain curve. The use of the term modulus of elasticity is recommended for materials that deform in accordance with Hooke's law, and the term modulus of deformation is recommended for materials that deform otherwise, (see Terminology D 653). In this test method, the modulus of deformation is calculated from the applied fluid pressure, the relative change in hole diameter, a function of Poisson's ratio, and a constant.

3.2.3 *jack efficiency*—ratio of the jack plate pressure to the applied hydraulic pressure.

4. Summary of Test Method

4.1 The 76 mm (3.0 in.) jacks, (see Fig. 1 and Fig. 2), induce unidirectional pressure to the walls of a borehole by means of two opposed curved steel platens each covering a 90° sector, over a length of 20.3 cm (8 in.).

4.2 Raw data from a test consist of hydraulic-line pressure, Q_h , versus readout from linear variable differential transformers (LVDT's) measuring platen movement. Knowing the displacement calibration of the LVDT's, the raw data can be transformed to a test record of hydraulic pressure versus hole diameter, D . For each increment of pressure, ΔQ_h , and hole deformation, ΔD , theoretical data analysis **(1)**,⁴ assuming rigid jack plates and full 90° contact, give the theoretical rock mass modulus, E ($E_{\text{theoretical}}$) as a function $E = f(\Delta Q_h \cdot \Delta D \cdot T^*)$, where T^* is a coefficient dependent upon Poisson's ratio. If E is measured on a linear segment of the loading curve, common

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² *Annual Book of ASTM Standards*, Vol 04.08.

³ *Annual Book of ASTM Standards*, Vol 04.09.

⁴ The boldface numbers in parentheses refer to a list of references at the end of the standard.

