Designation: D3967 – 08

Standard Test Method for Splitting Tensile Strength of Intact Rock Core Specimens[1]

This standard is issued under the fixed designation D3967; 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 covers testing apparatus, specimen preparation, and testing procedures for determining the splitting tensile strength of rock by diametral line compression of a disk.

NOTE 1—The tensile strength of rock determined by tests other than the straight pull test is designated as the "indirect" tensile strength and, specifically, the value obtained in Section 9 of this test is termed the "splitting" tensile strength.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are mathematical conversions and are provided for information only.

1.3 All dimension and force measurements, and stress calculations shall conform to the guidelines for significant digits and rounding established in Practice D6026.

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:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D6026 Practice for Using Significant Digits in Geotechnical Data

E4 Practices for Force Verification of Testing Machines

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 Refer to Terminology D653 for specific definitions.

4. Significance and Use

4.1 By definition the tensile strength is obtained by the direct uniaxial tensile test. But the tensile test is difficult and expensive for routine application. The splitting tensile test appears to offer a desirable alternative, because it is much simpler and inexpensive. Furthermore, engineers involved in rock mechanics design usually deal with complicated stress fields, including various combinations of compressive and tensile stress fields. Under such conditions, the tensile strength should be obtained with the presence of compressive stresses to be representative of the field conditions. The splitting tensile strength test is one of the simplest tests in which such stress fields occur. Since it is widely used in practice, a uniform test method is needed for data to be comparable. A uniform test is also needed to ensure that the disk specimens break diametrally due to tensile pulling along the loading diameter.

NOTE 2—Notwithstanding the statements on precision and bias contained in this test method; the precision of this test method 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 D3740 are generally considered capable of competent and objective testing. Reliable testing depends on many factors; Practice D3740 provides a means of evaluating some of these factors.

5. Apparatus

5.1 *Loading Device,* to apply and measure axial load on the specimen, of sufficient capacity to apply the load at a rate conforming to the requirements in 8.3. It shall be verified at suitable time intervals in accordance with Practices E4 and shall comply with the requirements prescribed therein.

5.2 *Bearing Surfaces*—The testing machine shall be equipped with two steel bearing blocks having a Rockwell hardness of not less than 58 HRC (see Note 3).

NOTE 3—False platens, with bearing faces conforming to the requirements of this standard, may be used. These shall be oil hardened to more than 58 HRC, and surface ground. With abrasive rocks these platens tend to roughen after a number of specimens have been tested, and hence need to be surfaced from time to time.

5.2.1 *Flat Bearing Blocks*—During testing the specimen can be placed in direct contact with the machine bearing plates (or false platens, if used) (see Fig. 1). The bearing faces shall not depart from a plane by more than 0.0125 mm when the platens

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[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.

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

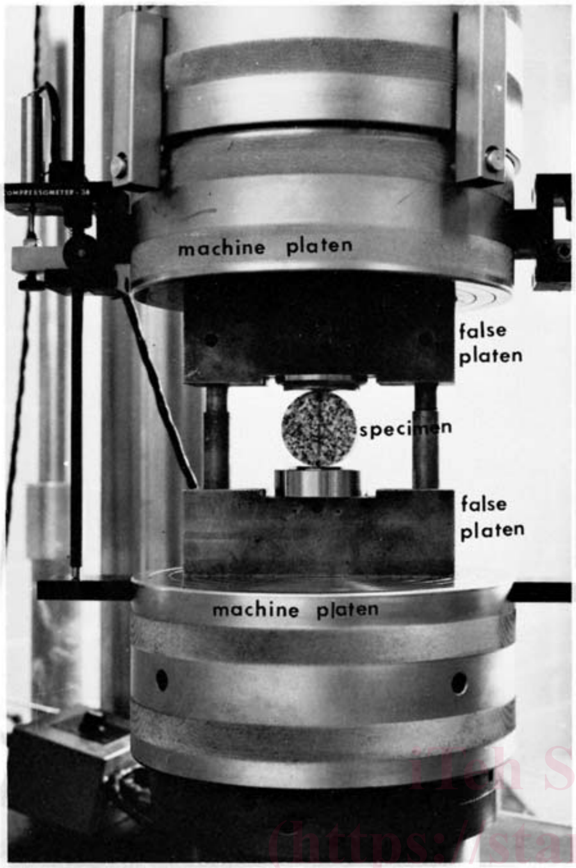

FIG. 1 One Proposed Testing Setup for Splitting Tensile Strength

are new and shall be maintained within a permissible variation of 0.025 mm. The bearing block diameter shall be at least as great as the specimen thickness.

5.2.2 *Curved Bearing Blocks*, may be used to reduce the contact stresses. The radius of curvature of the supplementary bearing plates shall be so designed that their arc of contact with the specimen will in no case exceed 15° or that the width of contact is less than *D*/6, where *D* is the diameter of the specimen.

NOTE 4—Since the equation used in 9.1 for splitting tensile strength is derived based on a line load, the applied load shall be confined to a very narrow strip if the splitting tensile strength test is to be valid. But a line load creates extremely high contact stresses which cause premature cracking. A wider contact strip can reduce the problems significantly. Investigations show that an arc of contact smaller than 15° causes no more than 2 % of error in principal tensile stress while reducing the incidence of premature cracking greatly.

5.2.3 *Spherical Seating*—One of the bearing surfaces should be spherically seated and the other a plain rigid block. The diameter of the spherical seat shall be at least as large as that of the test specimen, but shall not exceed twice the diameter of the test specimen. The center of the sphere in the spherical seat shall coincide with the center of the loaded side of the specimen. The spherical seat shall be lubricated to assure free movement. The movable portion of the platen shall be held closely in the spherical seat, but the design shall be such that the bearing face can be rotated and tilted through small angles in any direction.

5.2.4 *Rigid Seating*—If a spherical seat is not used, the faces of the bearing blocks shall be parallel to 0.0005 mm/mm of the block diameter. This criterion shall be met when the blocks are in the loading device and separated by approximately the diameter of the test specimen.

5.3 *Bearing Strips* 0.01 *D* thick cardboard cushions, where *D* is the specimen diameter; or up to 6.4 mm (0.25 in.) thick plywood cushions are recommended to be placed between the machine bearing surfaces (or supplementary bearing plates; if used) and the specimen to reduce high stress concentration.

NOTE 5—Experience has indicated that test results using the curved supplementary bearing plates and bearing strips, as specified in 5.2.2 and 5.3, respectively, do not significantly differ from each other, but there may be some consistent difference from the results of tests in which direct contact between the specimen and the machine platen is used.

6. Sampling

6.1 The specimens shall be selected from the core to obtain the type of rock under consideration. This can be achieved by visual observations to select a range of specimens based on mineral constituents, grain sizes and shape, partings, and defects such as pores and fissures.

7. Test Specimens

7.1 *Dimensions*—The test specimen shall be a circular disk with a thickness-to-diameter ratio (*t/D*) between 0.2 and 0.75. The diameter of the specimen shall be at least 10 times greater than the largest mineral grain constituent. A diameter of 54 mm (1-15⁄16 in.) (NX core) will generally satisfy this criterion.

NOTE 6—When cores smaller than the specified minimum must be tested because of the unavailability of material, notation of the fact shall be made in the test report.

NOTE 7—If the specimen shows apparent anisotropic features such as bedding or schistosity, care shall be exercised in preparing the specimen so that the orientation of the loading diameter relative to anisotropic features can be determined precisely.

7.2 *Number of Specimens*—At least ten specimens shall be tested to obtain a meaningful average value. If the reproducibility of the test results is good (coefficient of variation less than 5 %), a smaller number of specimens is acceptable.

7.3 The circumferential surface of the specimen shall be smooth and straight to 0.50 mm (0.020 in.).

7.4 Cut the ends of the specimen parallel to each other and at right angles to the longitudinal axis. The ends of the specimen shall not deviate from perpendicular to the core axis by more than 0.5°. This requirement can be generally met by cutting the specimen with a precision diamond saw.

7.5 Determine the diameter of the specimen to the nearest 0.25 mm (0.01 in.) by taking the average of at least three measurements, one of which shall be along the loading diameter.

7.6 Determine the thickness of the specimen to the nearest 0.25 mm (0.01 in.) by taking the average of at least three measurements, one of which shall be at the center of the disk.

7.7 The moisture conditions of the specimen at the time of test can have a significant effect upon the indicated strength of the rock. The field moisture condition for the specimen shall be