Designation: D2936 – 20

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

This standard is issued under the fixed designation D2936; 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 the determination of the direct tensile strength of the rock substance or discontinuities normal to the longitudinal axis of intact, isotropic cylindrical rock specimens at room temperature.

1.2 Non-isotropic or even transversely isotropic specimens are not covered by this standard.

1.3 Cylindrical rock specimens can be drill core from the field or rock blocks transported to the laboratory and drill core specimen obtained there.

1.4 Specimen shapes other than cylindrical specimens, such as dog bone-shaped, are not covered by this standard.

1.5 Test specimens may be tested under constant load or deformation rate.

1.6 The values stated in SI units are to be regarded as standard. The values provided in parenthesis are for information only.

1.7 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026 unless superseded by this standard.

1.8 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Exploration

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D2845 Test Method for Laboratory Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock (Withdrawn 2017)[3]

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

D5079 Practices for Preserving and Transporting Rock Core Samples (Withdrawn 2017)[3]

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

E2586 Practice for Calculating and Using Basic Statistics

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

[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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[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] The last approved version of this historical standard is referenced on www.astm.org.

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

3.2.1 *transverse isotropy, n*—implies that, at any point in the rock, there is an axis of symmetry of rotation and that the rock has isotropic properties in a plane normal to this axis.

4. Summary of Test Method

4.1 A sample of rock cores or block samples, to be cored in the laboratory, are obtained in the field and as needed to be handled in accordance with Practice D5079 or as directed by the client. The test intervals in the rock core sample are selected, and the number of rock specimens selected, and then those core segments are cut to the specified length and any relevant pretesting documentation recorded. Specimens can be selected and prepared to test the tensile strength of the rock substance or bonding of specific rock discontinuities.

4.2 Both ends of the specimen are cemented to metal caps, which provide a means through which the specimen can be held in the test apparatus, and a direct tensile load can be applied to specimen. The specimen is loaded at a constant rate in tension, according to the project requirements, until it fails.

NOTE 1—To reduce costs and to get data that is not as biased toward the weakest link failure, some laboratory studies have taken the tensile test specimen after it was broken and if the previous test had a clean break, they re-bond the two halves of the specimen together and run the test again.

5. Significance and Use

5.1 Rock is much weaker in tension than in compression. Thus, in determining the failure condition for a rock structure, many investigators employ the tensile strength of the component rock as the failure strength for the structure. Direct tensile stressing of rock is the most basic test for determining the tensile strength of rock. However, direct tensile tests will typically break at the weakest link along the longitudinal axis of the specimen, whether it is the rock substance or any discontinuity that is weaker than the adjacent rock substance. Unless the purpose of the direct tension tests is to get the strength across discontinuities the test results are on the conservative side and are more representative of the tensile strength at the rock substance scale. See Note 2 for additional significance and use information.

NOTE 2—The quality of the result produced by these practices is dependent upon 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 and sampling. Users of these practices are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Interferences

6.1 Gripping a cylindrical specimen (non-dog bone) specimen can cause stress concentrations at the ends near the grips. A valid direct tensile test should result in a failure at the midpoint of the specimen. With stress concentrations at the ends of the specimen, failure can initiate near the grips resulting in an invalid test. In work by Fairhurst (1961)[4], the stress concentrations were reduced by directly cementing end caps of the same diameter to the specimen ends which results in a similar stress distribution as in a uniaxial compression test.

6.2 If the specimen is more anisotropic than isotropic, then this test procedure or data manipulations may need to be adjusted or handled differently.[5] At the minimum, the data should be flagged as anisotropic or isotropic for the user or client, so it is used appropriately.

7. Apparatus

7.1 *Loading Device,* to apply and measure axial load and deformation, on the specimen, of sufficient capacity and at a rate conforming to the requirements of 9.3. The device shall be verified at suitable time intervals in accordance with the procedures given in Practices E4 and shall comply with the requirements prescribed therein.

7.2 *Caps*—Cylindrical metal caps that, when cemented to the specimen ends, provide a means through which the direct tensile load can be applied through some linkage to the loading device. The diameter of the metal caps shall not be less than that of the test specimen, nor shall it exceed the test specimen diameter by more than 4 %. Caps shall have a thickness of at least 30 mm (1¼ in.). Caps shall be provided with a suitable linkage system for load transfer from the loading device to the test specimen.

7.3 *Linkage System*—The connection between the cap and the loading device. Any linkage is allowed but shall be so designed that the load will be transmitted through the axis of the test specimen without the application of bending or torsional stresses. The length of the linkages at each end shall be at least two times the diameter of the metal end caps. One such system is shown in Fig. 1.

NOTE 3—Roller of link chain of suitable capacity has been found to perform quite well in this application. Because roller chain flexes in one plane only, the upper and lower segments should be positioned at right angles to each other to effectively reduce bending in the specimen. Ball-and-socket, cable, or similar arrangements have been found to be generally unsuitable as their tendency for bending and twisting makes the assembly unable to transmit a purely direct tensile stress to the test specimen. Metal rods just below the lower end cap in Fig. 1 are to prevent the lower half of the specimen from falling and damaging the end cap or specimen for any post-failure observations or photographs.

7.4 *Cement*—Any suitable material that will bond or adhere to the two dissimilar materials together with enough strength that the test specimen will not fail right at the contact between either end of the specimen and the cap during testing.

8. Sampling and Test Specimens

8.1 *Samples:*

8.1.1 Rock samples in the form of rock cores or rock blocks that rock cores are obtained from may be used. Practice D2113 should be followed as needed or specified by the client. Samples may be from oriented core holes or block samples that were obtained such that test specimens can be prepared that

[4] Fairhurst C (1961) Laboratory measurements of some physical properties of rock, Proceedings of the fourth symposium on rock mechanics. Pennsylvania, USA

[5] International Journal of Rock Mechanics and Mining Sciences Volume 34, Issue 5, July 1997, Pages 837-849 Direct tensile behavior of a transversely isotropic rock, Jyh Jong Liao, Ming-TzungYang, Huei-YannHsieh