Designation: D4543 – 19

Standard Practices for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerances[1]

This standard is issued under the fixed designation D4543; 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 practices specify procedures for preparing rock test specimen of rock core from drill core obtained in the field or from block samples for strength and deformation testing and for determining the conformance of the test specimen dimensions with tolerances established by this practice. Cubical, rectangular, or other shapes are not covered by this practice. However, some of the information contained within this practice and in standard Test Method C170 may still be of use to preparing other test specimen shapes.

1.2 Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content and chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For rock types which are difficult to prepare, all reasonable efforts should be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial and error that this is not possible, prepare the rock specimen to the closest tolerances practicable and consider this to be the best effort (Note 1) and report it as such and if allowable or necessary for the intended test, capping the ends of the specimen as discussed in this practice is permitted.

NOTE 1—Best effort in surface preparation refers to the use of a well-maintained, suitable surface grinder, lathe or lapping machine and any required ancillary equipment are utilized by an experienced operator and in which a reasonable number of attempts has been made to meet the tolerances required in this procedure.

1.3 This practices covers some, but not all of the curatorial issues that should be implemented. For curatorial issues that should be followed before and during specimen preparation refer to Practices D5079 and to the specific test standards in 2.1 for which the specimens are being prepared.

1.4 This practice also prescribes tolerance checks on the length-to-diameter ratio, straightness of the elements on the cylindrical surface, the flatness of the end bearing surfaces, and the perpendicularity of the end surfaces with the axis of the core.

NOTE 2—This practice does not purport to cover all the issues that will or could be encountered that may control the quality of the specimen preparation required. Each laboratory may have their own issues, especially for different compression load frames or rock types. For example, stiff testing frames versus traditional load frames and loading platens with or without spherical seating. Specimens for a stiff testing load frame with no spherical seat may need to have more stringent requirements depending on the type of rock being tested. This procedure has tried to show the methods and QA that may be involved while keeping in mind those materials that are difficult to work with and for which the specimens will still be suitable to be tested. The available literature and input on this subject from D18.12 members were considered as much as possible for this standard.[2]

1.5 The requirement for specifying the moisture condition and volume of the test specimen is also stated. However, the requirements in the specific test standards in 2.1 should be followed too.

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

1.6.1 The practices/procedures used to specify how data are collected/recorded and calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope

[1] These practices are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.12 on Rock Mechanics.

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[2] Needless Stringency in Sample Preparation Standards for Laboratory Testing of Weak Rocks, P.J.N. Pells (Coffey & Partners pty Ltd, North Ryde) | M.J. Ferry (Postgraduate Scholar, University of Sydney), International Society for Rock Mechanics Source 5th ISRM Congress, 10-15 April, Melbourne, Australia Publication Date 1983.

*A Summary of Changes section appears at the end of this standard of this standard to consider significant digits used in analysis methods for engineering design.

1.7 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. Add if appropriate, "Reporting of test results in units other than inch-pound shall not be regarded as nonconformance with this standard."

1.7.1 The slug unit of mass is typically not used in commercial practice; that is, density, balances, and so on. Therefore, the standard unit for mass in this standard is either kilogram (kg) or gram (g) or both. Also, the equivalent inch-pound unit (slug) is not given/presented in parentheses.

1.7.2 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This practice implicitly combines two separate systems of units; the absolute and the gravitational systems. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit for mass. However, the use of balances or scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with 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 *These practices offer a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.10 *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:*[3]

C170 Test Method for Compressive Strength of Dimension Stone

C617 Practice for Capping Cylindrical Concrete Specimens

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

D2936 Test Method for Direct Tensile Strength of Intact Rock Core Specimens (Withdrawn 2017)[4]

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

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D5079 Practices for Preserving and Transporting Rock Core Samples (Withdrawn 2017)[4]

D6026 Practice for Using Significant Digits in Geotechnical Data

D7012 Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

D7070 Test Methods for Creep of Rock Core Under Constant Stress and Temperature

3. Terminology

3.1 *Definitions:*

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

4. Significance and Use

4.1 The dimensional, shape, and surface tolerances of rock core test specimens are important for determining rock properties of intact specimens. This is especially true for strong rocks, greater than 7250 psi (50 MPa) and for rock specimens that will be tested in stiff testing load frames without a spherical seat where non-uniform loading could occur. Dimensional and surface tolerance checks are required in the test methods listed in Section 2.1. To simplify test procedures in laboratories, the parts of those procedures that are common to the test methods in Section 2.1 are given in this standard.

4.2 This procedure is applicable to all the standards listed in Section 2.1; however, specimens for Test Method D2936 do not need to be machined or to meet the specified tolerances for flatness and parallelism.

4.3 The moisture condition of the specimen at the time of the sample preparation can have a significant effect upon the strength and deformation characteristics of the rock. Good practice generally dictates that laboratory tests be made upon a specimens' representative of field conditions. Thus, it follows that the field moisture condition of the specimen should be preserved until the time of the test. In some instances, however, there may be reasons for testing specimens at other moisture

[3] 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.

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

contents, from saturation to dry. In any case, the moisture content of the test specimen should be tailored to the problem at hand.

NOTE 3—Discussions on moisture content are common in many rock testing standards but professional judgement will be needed to both handle and report this issue. For example, when obtaining the samples or preparing the specimens, water or some other cooling agent may be required or used. Therefore, the moisture in the specimen or samples may not be what it was in situ; this applies to both water chemistry and quantity of fluids. This issue should be addressed, and a plan put in place for each step from the sampling to the testing phase in a manner that records/reports what steps were advised to successfully prepare testable samples. Usually a compromise between preserving in-situ conditions, costs, conditions outside the control of the laboratory and obtaining testable specimens is required. For example, loss of moisture that leads to the samples or specimens falling apart may be of greater concern than testing with in situ water or at the in situ water content or both.

4.4 Excess moisture will affect the adhesion of resistance strain gages, if used, and the accuracy of their performance. Adhesives used to bond the rock to steel end caps and fixtures for attaching specimens to actuators and crosshead of the load frame in the direct tension test (D2936) will also be affected adversely by excess moisture.

NOTE 4—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.

5. Apparatus

5.1 *Support Surface*—A flat test surface which shall not depart from a plane by more than 0.0005 in. (0.013 mm) or meets ISO 9001 Certification. It shall have a large enough area such that the cylindrical surface of a rock core test specimen may be rolled and a V-block end of a rock core test specimen, or displacement gage assembly can be placed (Figs. 1 and 2) to perform the required tolerances measurements. Machinist grade, certified, granite blocks are commonly used for support surfaces because they do not dent or rust. However, other materials may be used if they meet the criteria of the procedure. The area of the support surface will depend on the size of specimen to be prepared; however, a 12 in. × 12 in. (300 mm × 300 mm) area will be sufficient for most applications.

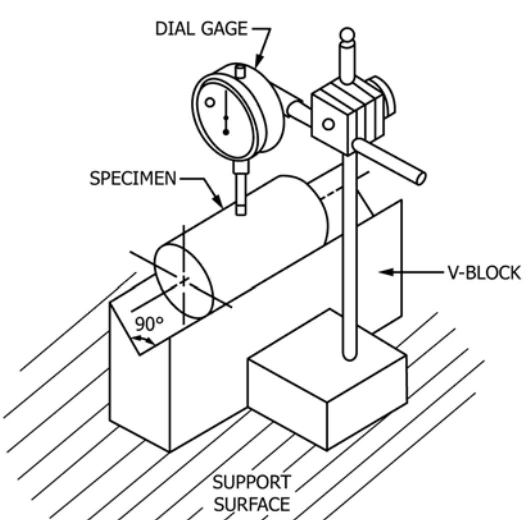

FIG. 1 Basic Dial Gage Setup for Determining the Straightness of Elements Along the Cylindrical Surface (S2)

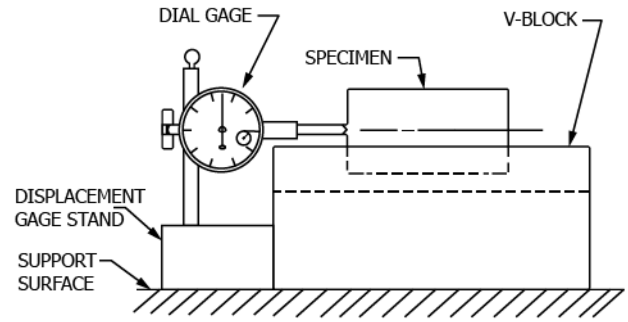

FIG. 2 Assembly for Determining the Flatness and Perpendicularity of End Surfaces to the Specimen Axis (FP1)

5.2 *V-block (conformance tests)*—The V-block (Figs. 1 and 3) shall be machinist quality with all bearing faces surfaces ground flat, smooth to within 0.0005 in. (13 µm) and with a 90° included angle. The V-block shall have some means of securing the specimen firmly in the V-block. The dimensions of the V-block must be such that it does not physically interfere with the displacement gage readings and suited for the size of specimen to be handled.

5.3 *Displacement Gage Assembly (Figs. 1 and 2):*

5.3.1 *Dial or Electronic (Contact or Non-contact) Displacement Gage*—The sensitivity of the displacement gage shall be at least 0.001 in. (0.02 mm) for measurement of cylindrical surfaces. The measurement contact tip of the displacement gage should be round. A displacement gage readable to 0.0001 in. (0.002 mm) is advised for measurements on the end surfaces.

5.3.2 *Dial or Electronic (Contact or Optic) Displacement Gage Stand*—A stand with a base and vertically mounted rod with an adjustable gage holder to support the gage on the flat surface at the proper height for the specimen and to take measurements normal to the flat surface. The side of the base can be machined flat so that it may be used as a straight edge for taking measurements as shown in Fig. 1 and Fig. 2 and described in 9.1 and 9.2. See Note 11 for more useful information.

5.4 *Feeler Gage Set*—25 or 26 leaf/blade set; 3 in. (76 mm) long by ½ in. (13 mm) wide, and thicknesses beginning at 0.0015 in. (0.04 mm) and ending at 0.025 in. (0.64 mm).

5.5 *Surface Grinder*—Any manual or automatic machinist's grade surface grinder equipped with a grinding wheel suited for the type and size of specimen, a magnetic flat surface and a V-block (5.6) to hold one or more specimens during the grinding process is suitable. The apparatus is also equipped to apply appropriate cooling and cutting agents (if needed) at the cutting surface to cool the grinding wheel surface and remove any cuttings.

NOTE 5—A commonly available apparatus and method is presented in