Designation: D 4543 – 07

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 D 4543; 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 practice specifies procedures for laboratory rock core test specimen preparation of rock core from drill core and 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 with in this practice and in standard Test Method C 170 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 and/or weak structural features. For these and other rock types which are difficult to prepare, all reasonable efforts shall 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 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 surface grinder, lathe or lapping machine by an experienced operator 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 D 5079 and to the specific test standards in section 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.

1.5 The requirement for specifying the moisture condition of the test specimen is also stated. However, the requirements in the specific test standards in section 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 D 6026, 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 of this standard to consider significant digits used in analysis methods for engineering design.

1.7 *Units*—The dimensional values stated in either inch-pound units or SI units are to be regarded as standard, such as 4 to 12 in. or 100 to 300 mm. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the

[1] These practices are 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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*A Summary of Changes section appears at the end of this standard.

two systems may result in non-conformance with the standard. (Note, when mass measurements are added to determine densities or unit weights, add the following.)

1.7.1 Only the SI units are used for mass determinations, calculations and reported results. However, the use of balances or scales recording pounds of mass (lbm) 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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This practice offers 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.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 170 Test Method for Compressive Strength of Dimension Stone
C 617 Practice for Capping Cylindrical Concrete Specimens
D 653 Terminology Relating to Soil, Rock, and Contained Fluids
D 2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation
D 2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
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 Construction
D 5079 Practices for Preserving and Transporting Rock Core Samples
D 6026 Practice for Using Significant Digits in Geotechnical Data
D 7012 Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
D 7070 Test Method for Creep of Rock Core Under Constant Stress and Temperature

3. Terminology

3.1 For terminology used in this test method, refer to Terminology D 653

4. Significance and Use

4.1 The dimensional, shape, and surface tolerances of rock core specimens are important for determining rock properties of intact specimens. Dimensional and surface tolerance checks are required in Test Methods D 7012 and D 7070. To simplify test procedures in laboratories, the parts of those procedures that are common to the test methods are given in this standard.

NOTE 2—The quality of the result produced by this standard 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 D 3740 are generally considered capable of competent and objective testing and sampling. 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

5. Apparatus

5.1 *Flat Surface*—The tolerances of a flat test surface on which a rock specimen is rolled, a V-block placed, or the end of a rock core is placed shall not depart from a plane by more than 0.0005 in. (13 µm).

5.2 *V-block*—The V-block 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.

5.3 *Dial Gage*—The sensitivity of the dial gage shall be at least 0.001 in. (25 µm) for measurement of cylindrical surfaces. The measurement contact tip of the dial gage shall be round in shape. A dial gage readable to 0.0001 in. (2.5 µm) is required for measurements on the end surfaces.

5.4 *Feeler Gage*—The feeler gage 3 in. (76 mm) "leaves" must include sizes beginning at 0.0015 in. (38 µm).

5.5 *Surface Grinder*—A manual or automatic machinist's surface grinder equipped with a magnetic flat surface and a V-block.

5.6 *Diamond Saw*—A manual or automatic rock saw equipped with a segmented circular diamond saw blade, and appropriate cooling and cutting agents.

6. Specimens

6.1 Test specimens shall be right circular cylinders within the tolerances specified herein.

6.2 The specimen shall have a length-to-diameter ratio (L/D) of 2.0 to 2.5 and a diameter of not less than 1-⅞ in. (47 mm).

NOTE 3—It is desirable that the diameter of rock test specimens be at least ten times the diameter of the largest mineral grain. For weak rock types which behave more like soil (for example, weakly cemented sandstone), the specimen diameter should be at least six times the maximum particle diameter. It is considered that the specified minimum specimen diameter of approximately 1-⅞ in. (47 mm) will satisfy this criterion in the majority of cases. When cores of diameter smaller than the specified minimum must be tested because of the unavailability of larger diameter core or prohibitive large drilling equipment siting costs, as is often the case in the mining industry, suitable notation of this fact shall be made in the report.

6.3 The sides of the specimen shall be generally smooth and free of abrupt irregularities, with all the elements straight to within 0.020 in. (0.50 mm) over the full length of the specimen, as determined by 7.1.

[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.

6.4 The ends of the specimen shall be cut parallel to each other and at right angles to the longitudinal axis. The end surfaces shall be surface ground or lapped flat to a tolerance not to exceed 0.001 in. (25 μm), as determined by 7.2.[3]

6.5 Sections 6.6 and 6.7 describe laboratory core drilling and cutting specimens from blocks of rock samples. Practice D 2113 describes rock core drilling and sampling of rock for site investigations. Water is normally a suitable fluid for rock cutting and grinding operations. However, some rock materials are sensitive to water and thus alternate suitable cooling and flushing fluids should be used. In sections 6.8 and 6.9 an air-cooled grinding unit with a dust collector is recommended for weak rocks and rocks that may react to fluids.

6.6 *Core Drilling Block Samples*—At least a 10 horsepower drill, with a GFI for electrical powered drills is recommended. A thin walled core barrel with a water swivel and adaptors for hooking up the drill are recommended. Surface set diamond thin-wall bits are suited for soft rock. Impregnated diamond thin-wall bits are better suited for hard rock. Install the thin-wall bit into the drill press chuck. Give the end of the thin-wall bit a tap with a rubber mallet to ensure it is snug. Lower the thin-wall bit to the drill table and mark the bit core barrel for reference for sufficient drilling depth. Connect the cooling fluid hose to the swivel and tie it out of the way. Place a sheet of ½ in. (12.7 mm) plywood on the drill table, then clamp the rock block securely to the table with clamping devices such as chain vise locks. Block with wood wedges as necessary to ensure the rock is secure and has a relatively flat drilling surface. Turn on the cooling fluid with sufficient flow to cool the bit and to flush the cuttings. With the bit raised off the sample, turn on the drill using a slow speed. Lower the bit slowly onto the sample using a slow rotation speed until a groove is started. Use enough down force to prevent chatter but do not allow the motor to slow so much as to buzz. A loss of drill cooling fluid and the reference position mark indicates the end of the run. After breaking through, back the bit out of the hole and turn off the drill. If the core is not completely drilled through, remove the block and tap the bottom gently, then remove the core. Code and store the core.

6.7 *Specimen Cutting*—Use a segmented diamond saw for cutting core. Apply cooling fluid continuously to cool the blade and flush cuttings from the cut. Automatic feed diamond saws are recommended for cutting large rock specimens. Clamp the specimen in the jig. Turn on the saw and manually or automatically cut the specimen perpendicular to its axis (see 6.2 and 6.4) slowly avoiding blade chatter. Once the specimen is cut, back off the blade and turn off the saw. Remove, code and store the specimen. When cutting weak or friable rock such as potash, shale, etc., it is recommended the core be first encapsulated in polyolefin heat shrink tubing before cutting.

6.8 *Cylindrical Surface Grinding*—The quality of the circumferential surfaces of core specimens is usually acceptable for most rock types, and no further surface finishing is required. If the drilled surface contains abrupt irregularities however, further finishing is recommended. This can be accomplished by surface grinding in a lathe in much the same way as dog bone specimens are prepared for direct tensile tests. The lathe chuck and center spindle are fitted with brass centers having knurled end bearing surfaces. The specimen is held between the brass centers by end pressure. A tool post grinder equipped with a diamond impregnated wheel is used to grind the cylindrical surfaces. Diamond impregnated grinding wheels are best suited for grinding rock surfaces. Use cooling fluid to cool the surfaces and wash away cuttings.

6.9 *End Surface Grinding/Lapping*—There are several ways to prepare the end surfaces of a specimen. Using a machinist table grinder, the core is clamped in a V-block and the V-block is placed on the magnetic table. The specimen ends are typically colored with a waterproof marker. Grind the end with a diamond impregnated grinding wheel. Silica carbide grinding wheels may also be used. Use cooling fluid to cool the surfaces and wash off the cuttings. Grind in increments of 0.002 in. (0.50 mm). Grinding is completed as evidenced by grinding striations covering the whole end surface and the waterproof coloring is completely removed. Reverse the core and grind the other end. Alternatively the core may be secured in the chuck of a lathe, and the end surfaces finished using a tool post diamond grinding wheel. Lapping devices are available that lap both ends of the core simultaneously using slurried grit. For large specimens, 4 to 12 in. (100 to 300 mm) a machinist shaper may be used. The shaper is retrofitted with a segmented diamond saw blade mounted on a tool post grinder. Cooling fluid is used to cool the surfaces and wash away the cuttings.

7. Procedure

7.1 Determine the deviation from straightness of the elements by either Procedure A or Procedure B, as follows:

7.1.1 *Procedure A*—Roll the cylindrical specimen on a smooth, flat surface and measure the height of the maximum gap between the specimen and the flat surface with a feeler gage. If the maximum gap exceeds 0.020 in. (0.50 mm), the specimen does not meet the required tolerance for straightness of the elements.

7.1.2 *Procedure B*—Place the cylindrical surface of the specimen on a V-block that is laid on a flat surface. The length of the V-block shall be sufficient that the specimen will not project over its ends during movement. Place a dial gage in contact with the top of the specimen cylindrical surface, as shown in Fig. 1, and observe the dial reading as the specimen is moved from one end of the V-block to the other along a straight line, without rotation. Record the maximum and minimum readings of the dial gage and calculate the difference, Δ_0. If the dial gage traverses a natural cavity in the rock, readings in this region shall not be included in the determination of Δ_0. Repeat the same operations by rotating the specimen for every 120 ± 1°, and obtain the differences Δ_{120} and Δ_{240}. The maximum value of these three differences shall be less than 0.020 in (0.50 mm).

7.2 Check the end flatness and parallelism tolerance by either Procedure A or Procedure B, as follows:

7.2.1 *Procedure A*—Place the specimen in a V-block with the dial gage mounted at the end as shown in Fig. 2. Move the mounting pad horizontally so that the dial gage measurement

[3] Hoskins, J. R., and Horino, F. G., "Effects of End Conditions on Determining Compressive Strength of Rock Samples," *Report of Investigations U.S. Bureau of Mines 7171*, 1968.