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.

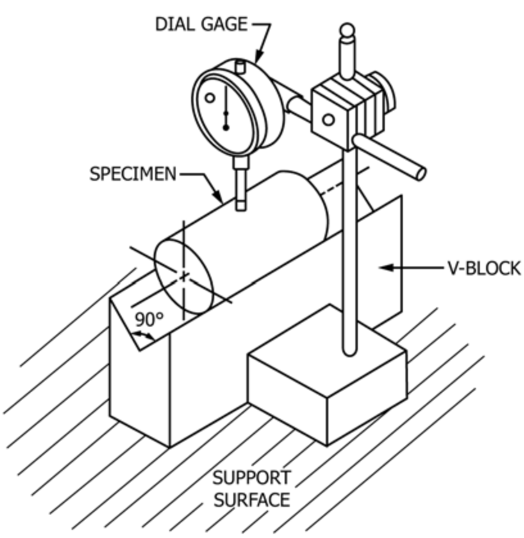

FIG. 1 Basic Dial Gage Setup for Determining the Straightness of Elements Along the Cylindrical Surface (S2)

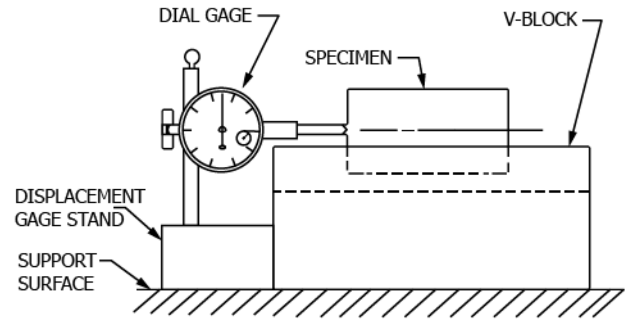

FIG. 2 Assembly for Determining the Flatness and Perpendicularity of End Surfaces to the Specimen Axis (FP1)

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

FIG. 3 One example of Holding Jig for Surface Grinder that can be Rotated and Grind Both Ends of up to Four Specimens (The adjacent short core is used as a spacer to fill unused specimen slot and yellow on top of specimen is placed prior to grinding for showing where grinding is occurring as the surface grinding progresses. Once lapping of the visible specimen end is completed the top half of the jig is unbolted and the section rotated so the opposing end of the specimen is now facing up and can be lapped as well.)

the sections provided here. Any other specialty or expensive type equipment or methods or combination thereof that can shape the rock core specimen into a specimen and meet the specification is acceptable.

NOTE 6—Surface grinders with greater mass is preferred because they have a greater resistance against vibration and will therefore produce a more uniform surface. Grinding wheels should be true and balanced. Some surface grinders have wheel hubs/flanges that did not have balancing systems however this could be added later using aluminum leaves.

5.6 *V-Block, or Other Similar Holding Device (Grinder Accessory)*—A metal V-block of sufficient size for holding the rock specimen in the surface grinder, with or without a magnetic chuck and is configured so that the specimen can be rotated to grind both ends and without losing any alignment with the grinder tolerances that would affect the grinding results on the specimen. See showing one example of V-block designed for up to four specimens on a magnetic chuck.

5.7 *Lapidary/Trim Saw*—A power saw of adequate size and horse power equipped with a circular diamond saw blade suitable for the material to be cut, with a movable platform for holding and feeding the core specimen, perpendicular to the core axis and feeding the specimen into the cutting surface of the blade. The movable platform may be a manual or automatic feed device. A GFI (Ground Fault Interrupt) for electrical powered saws is advised. The apparatus should be equipped to safely apply appropriate cooling agents (if needed) to the cutter to cool the blade and remove any cuttings and, if required, retained in a settling tank setup for disposal.

5.8 *For Drilling Block Samples:*

5.8.1 At least a 10-horsepower (750 kgf-m per second) drill, with a GFI (Ground Fault Interrupt) for electrical powered drills is recommended.

5.8.2 Drill can be hand held but some type of rigid platform is preferred, and side straightness may not be met and could then involve extra effort such as machining of sides of the sample or specimen.

5.8.3 Drill bit can be advanced manually or automatically.

5.8.4 A thin walled diamond core barrel is typically used. However, if needed, most drilling supply companies can build a short, double or triple tube core barrel that may be useful for certain rock types too.

5.8.5 A swivel and adaptors for hooking up to the drill to supply a fluid to cool the cutting surface and remove any cuttings.

5.9 *(Optional) Lapper.*

5.10 *(Optional) Machinist Shaper.*

5.11 *Cooling or Cutting Agents*—This is typically portable water or house air but may be some other liquid or gas for special circumstances. Whatever cooling or cutting agent is used it must be suitable for the specimen preparation process such that it leaves a specimen's strength properties unaffected. For example, sedimentary rocks originally deposited in a saline environment may be affected if subjected to fresh water.

5.12 *Machinist Calipers,* or similar device, with vernier, digital, or dial readouts readable to 0.001 in. (0.025 mm) and large enough for the size of the specimens being measured.

5.13 *Scale or Balance,* of adequate size and capacity to measure the mass of the specimen after preparation is completed to the nearest 1 gram. All balances must meet the requirements of Guide D4753 and this section. A Class GP1 balance of 0.01 g readability is required for specimens having a mass of up to 200 g (excluding mass of specimen container) and a Class GP2 balance of 0.1 g readability is required for specimens having a mass over 200 g. If desired, a Class GP1 balance may be used for specimens exceeding 200 g providing the specimen size is within the capacity of the balance. However, the balance used may be controlled by the number of significant digits needed (see 1.10).

5.14 *Miscellaneous Tools,* machinist scribe, rubber mallet, safety glasses, hearing protection, containers or plastic bags for curatorial control and indelible markers.

6. Samples

6.1 Samples for preparing specimens can be either drill cores obtained directly from the in situ rock (D2113) or obtained from block samples cored in the field or in the laboratory.

6.2 Samples should be selected or obtained (or both) to meet the objectives of the specific standard listed in 2.1 and the test program and any requirements related to anisotropic properties, moisture, and alike, of the in situ material that are relevant to the intended use.

6.3 Block samples must be provided which are clearly marked and if needed have appropriate measurements taken during sample acquisition to identify the orientation and or location of any geologic characteristics that might be important for coring samples from the block sample.

7. Specimens

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

7.2 The specimen shall have a length-to-diameter ratio (L/D) of 2.0 to 2.5 and a minimum diameter 1-⅞ in. (47 mm) or as directed by the client.

NOTE 7—The larger the internal friction angle of a specimen the more important it will be to have larger L/D ratios so that the specimen can potentially develop a true shear plane that does not pass through either end of the specimen or is not altered by the specimen size.

NOTE 8—It is important to determine what type of test specimen and test apparatus will be used before starting the specimen preparation process or the required end product may not be obtained.

NOTE 9—It is desirable that the diameter of rock test specimens be at least ten times the diameter of the largest discrete mineral grain, particle or crystalline. For weak rock types which behave more like soil (for example, poorly 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 with smaller diameters than the specified minimum must be tested because larger diameter cores are unavailable or impractical use of large drilling equipment (as is often the case in the mining industry), costs, or both, are prohibitive, a suitable notation of this fact shall be made in the report.

7.3 The cylindrical surfaces of the specimen shall be generally smooth and free of abrupt irregularities that are not part of the rock natural fabric, that is, voids or vugs, with all the elements straight to within 0.020 in. (0.50 mm) over the full length of the specimen, as determined by 9.1, procedure S1 or S2.

7.4 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 9.2 and to make the two ends more parallel to each other.[5]

7.5 The use of capping materials or end surface treatments other than the grinding, lathe, and lapping specified herein is not permitted, except as noted in 7.6.

7.6 There are some rock types with physical characteristics or low strengths which preclude preparing specimens to the flatness tolerance specified in 7.4, even with the best effort (Note 9). In these instances, first cut the core specimen to length, then apply end caps to the end surfaces of the specimen.

7.7 The specifications for the capping compound, capping plates, and alignment devices and the procedure for capping weak rock core specimens shall be the same as those established for compression testing of concrete in Practice C617; however, melted sulfur capping compounds are not permitted because of the possible detrimental effects of the high temperature from such capping compounds on the rock. Dental plaster and high strength gypsum cements are commonly used but other materials may be acceptable or better suited for the rock types being prepared.

7.8 The ends of the specimen shall not depart from perpendicularity to the axis of the specimen by more than 0.25° as determined in Section 9.

7.9 The parallelism tolerance is the maximum angular difference between the opposing best-fit straight line on each

[5] 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.

specimen end. It shall not be more than 0.25° for spherically seated test machines and 0.13° for fixed end test machines as determined in Section 9.[5]

8. Procedure for Preparing Test Specimens

8.1 Specimens can be prepared from either drill cores obtained directly from the in situ rock or obtained from block samples cored in the field or in the laboratory. If block samples are being used, then Section 8.2 which describes laboratory coring of specimens from block samples should be followed before proceeding to Section 8.3. Practice D2113 describes rock core drilling and sampling of rock for site investigations. Water is normally a suitable fluid for rock coring, cutting and grinding operations. However, some rock materials are sensitive to water, the chemistry of the water, or both. For example, using fresh water on saline sedimentary rocks may cause the sample or specimen to fall apart. Therefore, alternate suitable cooling and flushing fluids should be used. In Sections 5.8 and 5.9 an air-cooled grinding unit with a dust collector is recommended for weak rocks and rocks that may react to fluids.

8.2 *Core Drilling Block Samples*—Use a drill as recommended in 5.7 to obtain rock core samples from the block sample(s). In general, surface set diamond thin-wall bits are suited for soft rock and impregnated diamond thin-wall bits are better suited for hard rock. However, experience and trial and error may be required to obtain suitable samples.

8.2.1 Install the core bit and water swivel into the drill press chuck. Give the end of drill bit a tap with a rubber mallet to make sure it is snug.

8.2.2 Lower the core bit to the drill table and mark the core barrel for reference for sufficient drilling depth.

8.2.3 Connect the cooling fluid hose to the swivel and tie it out of the way.

8.2.4 Place a sheet of ½ in. (12.7 mm) or thicker plywood on the drill table. Place and orient if required, the rock block on the plywood and then clamp the rock block securely to the table with clamping devices such as chain vise locks. Block with wood wedges as necessary to make sure the rock is secure and has a relatively flat surface for drill bit to start cutting on.

8.2.5 Turn on the cooling fluid with sufficient flow to cool the bit and to flush the cuttings.

8.2.6 With the bit raised off the sample, turn on the drill using a slow speed.

8.2.7 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 electric motors to slow so much as to buzz, which could lead to damaging the motor. A loss of drill cooling fluid and reaching the reference position mark indicates the end of the run.

8.2.8 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.

8.2.9 Properly document the core sample and store the core.

8.3 *Specimen Cutting:*

8.3.1 Automatic feed diamond saws are recommended for cutting rock specimens.

8.3.2 Clamp the core sample in the jig used for holding or feeding the specimen during the cutting process for each end of the core sample.

8.3.3 Apply cooling fluid continuously to cool the blade and flush cuttings during the cutting process.

8.3.4 Turn on the saw and use either the manual or automatic feed capabilities of the saw to cut the specimen perpendicular to its axis (see 7.2 and 7.4) at a rate that avoids blade chatter.

8.3.5 Once the specimen is cut, back off the blade and turn off the saw.

8.3.6 Unclamp the specimen and if needed reposition the sample so that the opposite end of the intended specimen can be cut.

8.3.7 Repeat steps 8.3.2 through 8.3.6.

8.3.8 Remove, label and store the specimen after this first stage of specimen preparation according to the test program requirements.

NOTE 10—When cutting weak, soluble, or friable rock such as potash, shale, for example, it is recommended the core be protected as best as possible before cutting to protect the sample from damage from fluids or vibrations Heat shrink tubing has been successfully used by even the International Ocean Discovery Program (IODP) for marine sediments but the user needs to determined prior to use if the heat will affect the specimen in any deleterious manner.

8.4 *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 circumferential surface contains abrupt or wavy 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 (D2936). 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 flush away cuttings.

8.5 *End Surface Flatness and Parallelism*—There are several ways to prepare the end surfaces of a specimen.

8.5.1 *Method ES1—Surface Grinding:*

8.5.1.1 T core specimen is clamped in a V-block, or similar holding jig, suitable for placement on a machinist table grinder. The V-block is held in place by a magnetic table or other suitable means of holding the V-block under the cutting wheel.

8.5.1.2 The specimen ends are typically colored with a waterproof marker, prior to the start of grinding, in order to monitor where material is being removed.

8.5.1.3 Grind each end one at a time with a diamond impregnated grinding wheel. Silicon carbide grinding wheels or other grinding wheels may also be used if suitable for the type of specimens being prepared.

8.5.1.4 Use a cooling fluid to cool the specimen and grinding wheel surfaces and flush away the cuttings.

8.5.1.5 Grinding increments of 0.002 in. (0.50 mm) is recommended unless experience shows otherwise.