Designation: D4543 – 08$^{\varepsilon 1}$

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.

ε[1] NOTE—Editorially corrected 5.1 in April 2017.

1. Scope*

1.1 These practices specify 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 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 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 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.

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 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 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 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] 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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***A Summary of Changes section appears at the end of 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 *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:*[2]

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)[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

D5079 Practices for Preserving and Transporting Rock Core Samples (Withdrawn 2017)[3]

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 For terminology used in this test method, refer to Terminology D653

[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.

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. This is especially true for strong rocks, greater than 7250 psi (50 MPa). 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 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 contents, from saturation to dry. In any case, the moisture content of the test specimen should be tailored to the problem at hand. 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 pieces in the direct tension test will also be affected adversely by excess moisture.

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.

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) upon which the cylindrical sides of a rock core test specimen may be rolled and a V-block end of a rock core test specimen, displacement gage assembly, or both, is placed, the tolerance of. 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 specimens to be prepared, however, a 12 in. × 12 in. (300 mm × 300 mm) area will be sufficient for most applications.

5.2 *V-block (conformance tests)*—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. 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.

5.3 *Displacement Gage Assembly:*

5.3.1 *Dial or Electronic 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 shall be round in shape. A displacement gage readable to 0.0001 in. (0.002 mm) is required for measurements on the end surfaces.

5.3.2 *Dial or Electronic 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 described in Section 9.1.

5.4 *Feeler Gage Set*—25 or 26 leaf/blade set; 3 in. long by ½ in. wide, and thicknesses beginning at 0.015 in. and ending at 0.025 in. or 25 or 26 leaf/blade set; 75-76 mm long by 12.7-15 mm wide, and thicknesses beginning at 0.04 mm and ending at 1.00 mm.

5.5 *Surface Grinder*—A manual or automatic machinist's surface grinder equipped with a grinding wheel suited for the specimen, a magnetic flat surface and a special V-block to hold the sample during the grinding process. 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 wash away cuttings.

5.6 *V-Block (Grinder)*—A metal V-block for holding the rock specimen in the surface grinder on the magnetic chuck and is configured so that the specimen can be rotated to grind both ends without interfering with the grinding process.

5.7 *Diamond Saw*—A rock saw equipped with a segmented circular diamond saw blade, with a moveable platform for holding and feeding the sample, perpendicular to the core axis, into the cutting surface of the blade. The moveable platform may be a manual or automatic feed. The apparatus is also equipped to apply appropriate cooling and cutting agents (if needed) at the cutting surface to cool the blade and wash away cuttings.

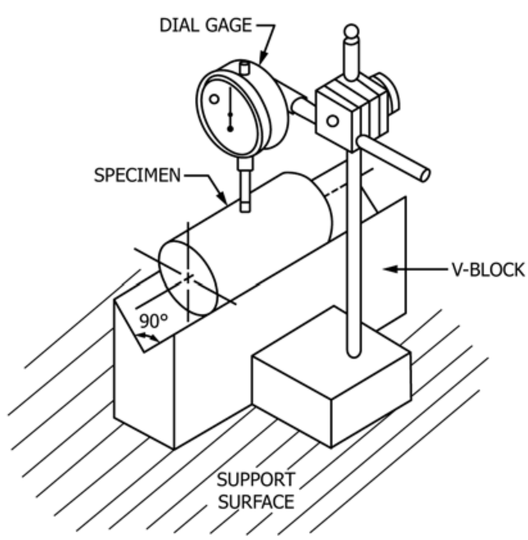


FIG. 1 Assembly for Determining the Straightness of Elements on the Cylindrical Surface (S2)

5.8 *For Drilling Block Samples:*

5.8.1 A 10-horsepower drill, with a GFI (Ground Fault Interrupt) for electrical powered drills.

5.8.2 A thin walled diamond core barrel.

5.8.3 A water swivel and adaptors for hooking up to the drill.

5.9 (Optional) Lapper.

5.10 (Optional) Machinist Shaper.

5.11 Machinist Calipers, or similar device, with vernier, digital, or dial readouts readable to 0.01 in. (0.25 mm) and large enough for the size of the specimens being measured.

5.12 Miscellaneous Tools: machinist scribe and water proof markers.

6. Samples

6.1 Samples for preparing specimens can be either drill cores obtained directly from the in situ rock 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 of the in situ material that are relevant to the intended use.

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 diameter of not less than 1-⅞ in. (47 mm).

7.2.1 The larger the internal friction angle of a specimen the more desirable 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 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 use of large drilling equipment (as is often the case in the mining industry), costs, or both, and 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, 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.[4]

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 3). 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 on the rock. Dental plaster and high strength gypsum cements are commonly used.

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

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 shall 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*—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.

8.2.1 Install the thin-wall bit and water swivel into the drill press chuck. Give the end of the thin-wall bit a tap with a rubber mallet to ensure it is snug.

8.2.2 Lower the thin-wall 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) 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 ensure 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 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.

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 Code and store the core.

8.3 *Specimen Cutting:*

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

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

8.3.3 Apply cooling fluid continuously to cool the blade and flush cuttings from the cut.

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 Remove, label and store the specimen according to the test program requirements.

NOTE 4—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.

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 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

[4] 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.

wheels are best suited for grinding rock surfaces. Use cooling fluid to cool the surfaces and wash 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 Using a machinist table grinder, the core is clamped in a V-block, or similar holding jig, suitable for table grinder and placed on the magnetic table.

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 the end with a diamond impregnated grinding wheel. Silicon carbide grinding wheels may also be used.

8.5.1.4 Use cooling fluid to cool the surfaces and wash off the cuttings.

8.5.1.5 Grind in increments of 0.002 in. (0.50 mm).

8.5.1.6 Grinding is completed as evidenced by grinding striations covering the whole end surface and the waterproof coloring is completely removed.

8.5.1.7 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.

8.5.2 *Method ES2 Lapping*—Lapping devices are available that lap both ends of the core simultaneously using slurried grit.

8.5.3 *Method ES3 Machinist Shaper:*

8.5.3.1 For large specimens, a 4 to 12 in. (100 to 300 mm) in diameter machinist shaper may be used.

8.5.3.2 The shaper is retrofitted with a segmented diamond saw blade mounted on a tool post grinder.

NOTE 5—While these other methods are suitable for some purposes and may be the only method for large diameter specimens, experience has shown that lapping devices do not usually get the results required for this standard. Also, for specimens which are susceptible to water the slurry grit may also be an issue.

9. Procedure for Verifying Shape Conformance

9.1 *Side Straightness*—Determine the deviation from straightness of the elements by either Procedure S1 or Procedure S2, as follows:

9.1.1 *Procedure S1:*

9.1.1.1 Lay the cylindrical specimen on its side, on a smooth, flat surface.

9.1.1.2 Roll the cylindrical specimen and measure the height of the maximum gap between the specimen and the flat surface with a 0.020 in. (0.50 mm) feeler gage.

9.1.1.3 If the maximum gap exceeds 0.020 in. (0.50 mm), the specimen does not meet the required tolerance for straightness of the elements.

9.1.2 *Procedure S2:*

9.1.2.1 Place the cylindrical surface of the specimen on a V-block that is laid on a flat surface as shown in Fig. 1. The length of the V-block shall be sufficient that the specimen will not project over its ends during movement.

9.1.2.2 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 that region shall not be included in the determination of Δ_0.

9.1.2.3 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).

9.2 Check the end flatness and parallelism tolerance by either Procedure FP1 or Procedure FP2, as follows:

9.2.1 *Procedure FP1*—Place the specimen in a V-block with the dial gage mounted at the end as shown in Fig. 2. Move the dial gage stand or V-block horizontally so that the dial gage measurement tip runs across a diameter of the specimen end surface. Ensure that the dial gage base maintains intimate contact with the end surface of the V-block during movement or any other guide used to control the horizontal movement. Record the dial gage readings every ⅛ in. (3 mm) across the diameter. These readings may be recorded in tabular form, or to simplify the procedure, they may be plotted directly on a graph as shown for End 1, Diameter 1, in Fig. 3. Data recording is simplified if the dial gage is set to zero when it is in contact with the center of the end face. Plot the readings and draw a smooth curve through the points to represent the surface profile along the specified diametrical plane, as shown for End 1, Diameter 1, in Fig. 3. Do not plot dial gage readings taken when the gage tip drops into a natural cavity in the rock. Rotate the specimen 90 ± 1° about its longitudinal axis and repeat the same operations and tolerance checks for the new diametrical plane. Turn the specimen end for end and repeat the same measurement procedures and tolerance checks for the other end surface. The flatness tolerance is met when each smooth curve so determined does not depart from a visual best-fit straight line by more than 0.001 in. (25 µm). The parallelism tolerance is met when the maximum angular difference between the opposing best-fit straight line on each specimen end is not more than 0.25° for spherically seated test machines and 0.13° for fixed end test machines. These measurements are also used to check perpendicularity in 9.3.1.

9.2.2 *Procedure FP2*—Set the specimen upright on a flat surface. Place a dial gage measurement tip in contact with the top of the specimen. Move the dial gage measurement tip across the top of the specimen along at least three different

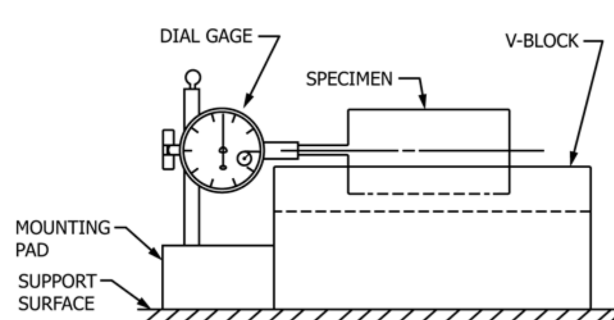


FIG. 2 Assembly for Determining the Flatness and Perpendicularity of End Surfaces to the Specimen Axis (FP1)

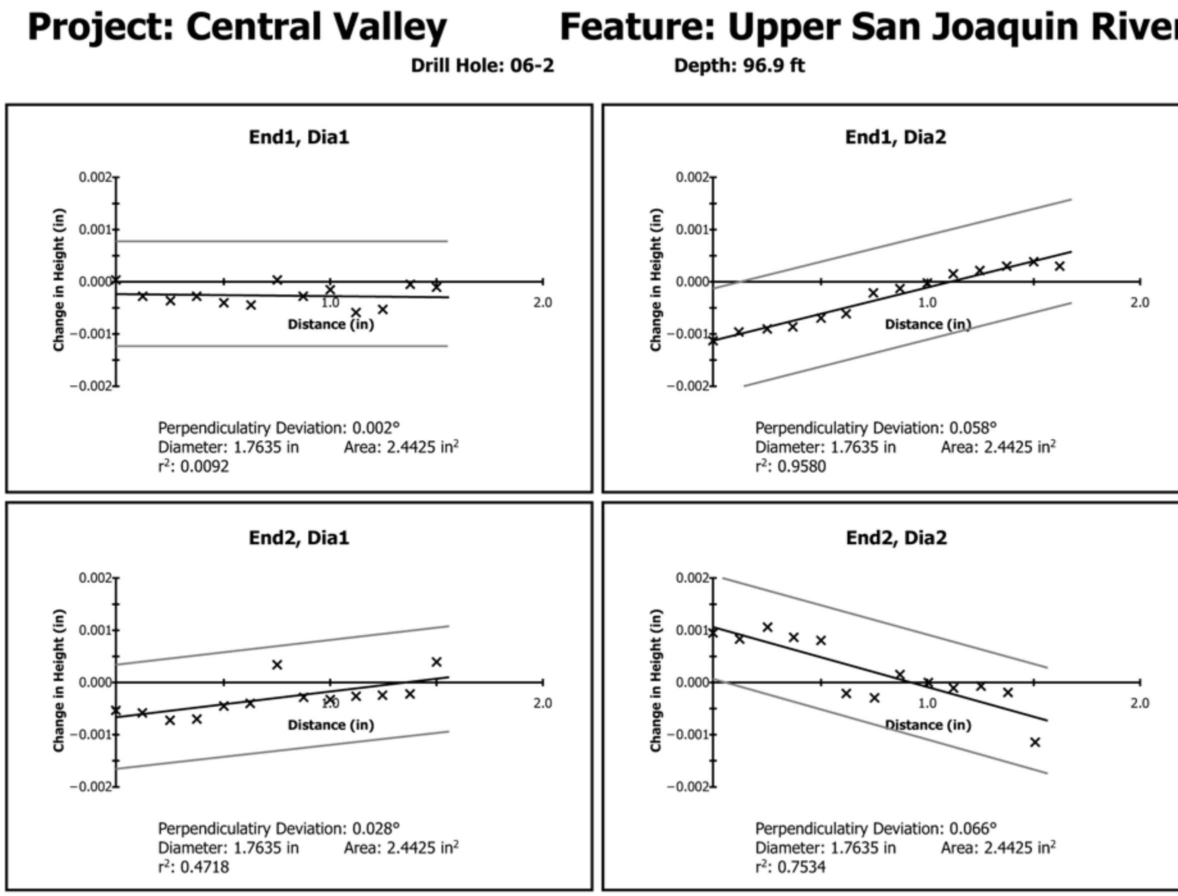


FIG. 3 Suggested Table and Graphing Format for Presenting Shape and Dimensional Tolerance Data; Methods S1, FP1 and P1 were used.

diameters. Note the maximum and minimum dial gage readings. Do not include dial gage readings taken when the measurement tip drops into a natural cavity in the rock. Scribe lines on the specimen at the measurement locations. Turn the specimen end-for-end and repeat. The flatness tolerance is met when the smooth curve so determined does not depart from a visual best-fit straight line by more than 0.001 in. (25 µm). The parallelism tolerance is met when the maximum angular difference between the opposing best-fit straight line on each specimen end is not more than 0.25° for spherically seated test machines and 0.13° for fixed end test machines.

9.3 The ends of the specimen shall not depart from perpendicularity to the axis of the specimen by more than 0.25°, which is a slope of 1 part in 230.[4,5] Check this tolerance using either Procedure P1 or Procedure P2, as follows:

9.3.1 *Procedure P1*—Use the measurements taken in 9.2.1. Calculate the difference between the maximum and the minimum readings on the dial gage along Diameter 1. This difference is denoted as Δ_1. Calculate the corresponding difference for Diameter 2, which is 90° from Diameter 1. Denote the difference for Diameter 2 as Δ_2. Calculate the corresponding differences for the other end of the specimen, Δ_1' and Δ_2'. The perpendicularity tolerance will be considered to have been met when:

$$\frac{\Delta_i}{d} \text{ and } \frac{\Delta_i'}{d} \leq \frac{1}{230} = 0.0043 \quad (1)$$

where:

i = 1 or 2,
$'$ = opposite flat end of core specimen,
d = diameter of specimen (see Section 10.2), and
Δ_i = difference in displacement measurements normal to the specimen end surface.

9.3.2 *Procedure P2*—Set the specimen upright on a smooth flat surface. Place the base of a true square on the test surface and in contact with the bottom of the specimen. Rotate the specimen, keeping contact with the square, until the maximum gap between the square and the top of the specimen is found. Determine the width of the gap using a feeler gage. The perpendicularity tolerance is met if the gap, Δ, divided by the specimen length, L, is less than 1 part in 230, that is,

$$\frac{\Delta}{L} \leq \frac{1}{230} = 0.0043 \quad (2)$$

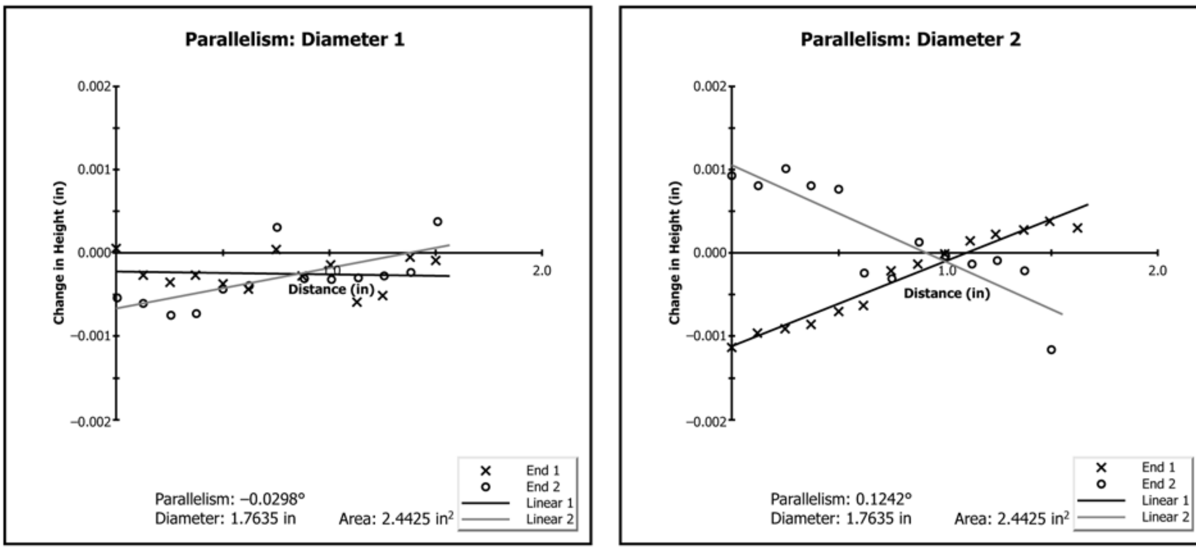
where:

L = length, and
Δ = length difference.

[5] Podnieks, E. R., Chamberlain, P. G., and Thill, R. E.,“ Environmental Effects on Rock Properties,” *Basic and Applied Rock Mechanics, Proceedings of Tenth Symposium on Rock Mechanics*, AIME, 1972, pp. 215–241.

Project: Central Valley **Feature: Upper San Joaquin River**

Drill Hole: 06-2 **Depth: 96.9 ft**



Project: Central Valley **Feature: Upper San Joaquin River Basin - RM-274**

Drill Hole: 06-2 **Depth: 96.9 ft**

End1, Dia1 - Travel (in)	End1, Dia1 - Displacement (in)	End1, Dia2 - Travel (in)	End1, Dia2 - Displacement (in)	End2, Dia1 - Travel (in)	End2, Dia1 - Displacement (in)	End2, Dia2 - Travel (in)	End2, Dia2 - Displacement (in)
0.000	0.0000	0.000	−0.0011	0.000	−0.0005	0.000	0.0009
0.125	−0.0003	0.125	−0.0010	0.125	−0.0006	0.125	0.0008
0.250	−0.0004	0.250	−0.0009	0.250	−0.0007	0.250	0.0010
0.375	−0.0003	0.375	−0.0009	0.375	−0.0007	0.375	0.0008
0.500	−0.0004	0.500	−0.0007	0.500	−0.0004	0.500	0.0008
0.625	−0.0004	0.625	−0.0006	0.625	−0.0004	0.625	−0.0002
0.750	0.0000	0.750	−0.0002	0.750	0.0003	0.750	−0.0003
0.875	−0.0003	0.875	−0.0001	0.875	−0.0003	0.875	0.0001
1.000	−0.0001	1.000	0.0000	1.000	−0.0003	1.000	0.0000
1.125	−0.0006	1.125	0.0001	1.125	−0.0003	1.125	−0.0001
1.250	−0.0005	1.250	0.0002	1.250	−0.0003	1.250	−0.0001
1.375	−0.0001	1.375	0.0003	1.375	−0.0002	1.375	−0.0002
1.500	−0.0001	1.500	0.0004	1.500	0.0004	1.500	−0.0012
		1.625	0.0003				

FIG. 3 Suggested Table and Graphing Format for Presenting Shape and Dimensional Tolerance Data; Methods S1, FP1 and P1 were used. *(continued)*

Repeat for other end of specimen unless the specimen ends were checked for parallelism in 9.2.2.

9.4 The measurements described in 9.1.2, 9.2.1, and 9.2.2 are taken with a mechanical dial gage. An optical or electronic device with an equivalent or better readout sensitivity and accuracy may be used in place of the dial gage, if desired.

9.5 The measurements taken on the ends of the specimen in 9.2.1 and 9.2.2 may also be made with the specimen clamped upright in a V-block. The measuring tip of the dial gage would then contact the upper end surface of the specimen. Either the V-block and specimen may be moved as a unit under a stationary dial gage, or the dial gage may be moved while the V-block and specimen remain stationary. The readings to be taken with such a vertical configuration are the same as those specified for the horizontal configuration in 9.2.1 and 9.2.2.

9.6 If the specimen does not pass the perpendicularity or flatness (or both) conformance criteria then the specimen should be evaluated to determine if a best effort was achieved or not for the rock type involved. Based upon the evaluation and professional judgment a determination is made whether the specimen should be discarded, tested as is, use of capping compound, or start over with at Section 8.4 (See Note 2).

10. Procedure for Determining Specimen Dimensional and Moisture Properties

10.1 *General*—The dimensions determined in this section yield three significant digits; therefore, calculated values of such items as stress, strain, density or unit weight can have only three significant digits. However, there might be cases requiring four significant digits. In that case, the dimension measurements would require four significant digits.

10.2 *Diameter and cross sectional area*—Determine the diameter of the test specimen perpendicular to the core axis, using a machinist caliper or similar device, to the nearest 0.01 in. (0.25 mm) by averaging two diameters measured at right angles to each other at about mid-height of the specimen.

Compression Specimen Tolerance Summary Table Checked By: ___________
Method used: ASTM D-4543-04

Project: Central Valley
Feature: Upper San Joaquin River Basin - RM-274

Specimen Information:

Index No.	67U-19
Drill Hole:	06-2
Depth:	96.9 ft
Weight:	453.19 g
Bulk S.G.*	2.671
Length:	4.2486 in
Diameter:	1.7635 in
Area:	2.44 in^2
L/D Ratio:	2.41

Tested By: Reo
Date Tested: 4/12/2007

Side Tolerance (Straightness): 0.0015 in — Passed

Perpendicularity Deviation:

End 1, Dia 1: –0.0023°	Passed
End 1, Dia 2: 0.0580°	Passed
End 2, Dia 1: 0.0276°	Passed
End 2, Dia 2: –0.0662°	Passed

Max. Deviation from Flatness: 0.0006 in — Passed

Parallelism Deviation:

Dia 1: –0.0298°	Passed
Dia 2: 0.1242°	Passed

Tolerance Limits**

Side Tolerance (Straightness):	Not to exceed 0.020 in
Perpendicularity Deviation:	Not to exceed 0.250°
Deviation from Flatness:	Not to exceed 0.001 in
Parallelism Deviation:	Not to exceed 0.13° for fixed head

*Note: Specific gravity is calculated with a pure water density of 20°C
**Note: All tolerance limits are from ASTM D-4543-04 standard.

Test Data saved as: C:\Rock Surface\Tests\Upper San Joaquin River Basin - RM-274, DH-06-2, 96.9 {4-12-2007 1'48'44 PM}.rsf

FIG. 3 Suggested Table and Graphing Format for Presenting Shape and Dimensional Tolerance Data; Methods S1, FP1 and P1 were used. *(continued)*

10.3 *Cross Sectional Area*—Use the average diameter for calculating the circular cross-sectional area perpendicular to the core axis, to three significant digits.

10.4 *Length*—Determine the length of the test specimen using a machinist caliper, or similar device, to the nearest 0.01 in. (0.25 mm) at the centers of the end faces.

10.5 *Volume*—Determine the volume of the specimen to three significant digits using the area and length values from Sections 10.3 and 10.4.

10.6 Record the moisture condition of the sample at the time of the receipt and at the completion of the specimen preparation procedure. At the minimum the moisture condition shall be reported qualitatively as as-received, saturated, laboratory air-dry, or oven dry. However, it is recommended that the moisture conditions be more precisely determined when possible and reported as either water content or degree of saturation using Test Method D2216 and reported as required in 11.1.6.

11. Report

11.1 Report the following along with other data required for the particular test method in 2.1 in which the specimen will be used:

11.1.1 Source of test specimen, including project name and location. Often the location is specified in terms of the drill hole number and depth of specimen from collar of hole. Include curatorial record number if any, and curatorial history if pertinent to the specimen preparation or intended test method that will use the specimen.

11.1.2 Date, which practice method was performed, and personnel involved.

11.1.3 Physical description of test specimen including: rock type such as sandstone, limestone, granite, etc.; location and orientation of inherent rock structural features and any discontinuities; and large inclusions or inhomogeneities, if any. A sketch of the test specimen is recommended for other than homogeneous rock types.

11.1.4 Specimen diameter and length, L/D, volume and conformance or best effort conformance with dimensional requirements (7.2, 7.3, and 7.4).

11.1.5 Data to substantiate the following three tolerances:

11.1.5.1 Straightness surfaces by either Procedure S1 (9.1.1) or Procedure S2 (9.1.2).

11.1.5.2 Flatness and parallelism by either Procedure FP1 (9.2.1) or Procedure FP2 (9.2.2).

11.1.5.3 Perpendicularity by either Procedure P1 (9.3.1) or Procedure P2 (9.3.2).

11.1.6 The moisture condition of the sample at the time it was received and after the specimen preparation is completed, such as as-received, saturated, laboratory air-dry, or oven dry. It is recommended that the moisture conditions be more precisely determined when possible and reported as either water content or degree of saturation.

11.1.7 List the equipment used to prepare the specimens and for conformance measurements.

12. Keywords

12.1 conformance; core; diameter; dimensional tolerances; dimensions; length; rock; specimen preparation (for testing); specimen shape; specimen size

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D4543 – 07) that may impact the use of this standard. (Approved Jan. 1, 2008.)

(1) Added D2936 to Referenced Documents.
(2) Significantly revised Sections 4 – 9.
(3) Replaced Fig. 3.
(4) Completely revised Section 10.
(5) Other minor editorial changes throughout.