Designation: ~~D4829 – 11~~ D4829 – 19

Standard Test Method for Expansion Index of Soils[1]

This standard is issued under the fixed designation D4829; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method allows for determination of expansion potential of soils when inundated with distilled water.[2] This test method measures a qualitative index property of the soil rather than a design parameter to be used for calculation of the actual amount of expansion. The expansion index, *EI,* provides an indication of swelling potential of a soil.

1.2 This test method provides a simple, yet sensitive, method for evaluation of expansion potential of soils for practical engineering applications using an index parameter.

1.3 *Units*—The values stated in SI units are to be regarded as ~~the~~ standard. The values ~~stated in inch-pound units are approximate.~~given in parentheses are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard.

1.3.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In the system, the pound (lbf) represents a unit of force (weight), while the units for mass is slugs. The slug unit is not given, unless dynamic (F = ma) calculations are involved.

1.3.2 The SI units presented for apparatus are substitutions of the inch-pound units, other similar SI units should be acceptable providing they meet the technical requirements established by the inch-pound apparatus.

1.3.3 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 of mass. However, the use of balances and scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.

1.3.4 The terms density and unit weight are often used interchangeably. Density is mass per unit volume, whereas unit weight is force per unit volume. In this standard, density is given only in SI units. After the density has been determined, the unit weight is calculated in SI or inch-pound units, or both.

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

1.4.1 For purposes of comparing a measured or calculated value(s) with specified limits, the measured or calculated value(s) shall be rounded to the nearest decimal of significant digits in the specified limit.

1.4.2 The ~~method~~procedures used to specify how data are ~~collected, calculated,~~ collected/recorded or ~~recorded~~calculated in ~~this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.~~the 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 data.

1.5 *The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.*

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[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.05 on Strength and Compressibility of Soils.

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[2] ~~Refer to~~ Anderson, J. N., and Lade, P. V., "The Expansion Index Test," *Geotechnical Testing Journal*, Vol 4, No. 2, ASTM, 1981, pp. 58–67.

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

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

1.7 *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]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2435 Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
~~D3877 Test Methods for One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures (Withdrawn 2017)[4]~~
D4546 Test Methods for One-Dimensional Swell or Collapse of Soils
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D6026 Practice for Using Significant Digits in Geotechnical Data
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
~~E145 Specification for Gravity-Convection and Forced-Ventilation Ovens~~

3. Terminology

~~3.1 For common definitions of other terms used in this Test Method, refer to Terminology D653.~~

3.1 *Definitions:*

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

3.1.2 *scarification*—scratching the surface of a compacted layer to facilitate bonding with the next layer to avoid potential separation between compacted layers.

~~3.3 *Definitions of Terms Specific to This Standard:*~~

~~3.3.1 *expansion index (EI), n*—1000 times the difference between final and initial height of the specimen divided by the initial height.~~

4. Summary of Test Method

4.1 A ~~specimen is prepared by compacting a test soil into a metal ring at a~~ sample is processed to obtain a representative sample that is then separated over a 4.75 mm (No. 4) sieve. Distilled water is added and thoroughly mixed with the soil passing the separation sieve (test specimen). A water content is determined and the soil is allowed to stand (cure) for 16 h before it is compacted into a specimen ring. The degree of saturation ~~of 50 ± 2 %. The specimen and the ring are then~~ is calculated and must be 50 ± 2 % before proceeding with testing. A new test specimen is made if the saturation doesn't meet the criteria. Several trials may occur before the necessary degree of saturation is achieved. Once achieved, the compacted specimen is placed in a ~~consolidometer. A vertical confining pressure~~ loading device. Height and deformation readings are taken prior to applying a vertical stress of 6.9 kPa (1 lbf/in.^{2}) ~~is applied to the specimen and~~on the specimen. After 10 min, the specimen is ~~then~~ inundated with distilled ~~water. The deformation of the specimen is recorded~~ water and deformation readings are taken at specific time intervals for 24 h or until the rate of ~~deformation~~expansion becomes less than 0.005 mm/h (0.0002 ~~in./h), whichever occurs first. A minimum recording time of 3 h is required.~~in./h). At the end of the test, final height and deformation readings are taken and the expansion index is calculated.

5. Significance and Use

5.1 The expansion index, *EI*, ~~provides an indication of swelling potential of a soil.~~value is used by engineers and other professionals as an indicator of the soil's swelling potential. It may also be used to determine the suitability of a soil to satisfy requirements set by specifying agencies.

5.2 The *EI* test is not used to duplicate any particular field conditions such as soil density, water content, loading, in-place soil structure, or soil water chemistry. However, consistent test conditions are used in preparation of compacted specimens such that direct correlation of data can be made.

[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.

~~NOTE 1—Qualitative classification of potential expansion in a soil based on *EI* is provided in Table 1.~~

5.3 Based on experience with expansive soils, the recommended qualitative classification of potential expansion in a soil based on *EI* is provided in Table 1.

5.4 The measurement of the magnitude of one-dimensional wetting-induced swell or collapse (hydrocompression) under different vertical (axial) pressures, as well as the magnitude of swell pressure and the magnitude of free swell, and also the determination of data for stress-induced compression following wetting-induced swell or collapse are covered by Test Methods D4546. The ability to test intact specimens for measuring one-dimensional wetting-induced swell or collapse is also covered in Methods D4546.

NOTE 1—~~Notwithstanding the statements on precision and bias contained in this test method: The precision of this test method~~ The quality of the result produced by this standard is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies ~~which~~that meet the criteria of Practice D3740 are generally considered capable of competent ~~testing.~~ and objective testing/sampling/inspection/etc. Users of this ~~test method~~ standard are cautioned that compliance with Practice D3740 does not ~~ensure reliable testing. Reliable testing depends on several~~in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

~~5.3 The measurement of the magnitude of one-dimensional wetting-induced swell or collapse (hydrocompression) under different vertical (axial) pressures, as well as the magnitude of swell pressure and the magnitude of free swell, and also the determination of data for stress-induced compression following wetting-induced swell or collapse are covered by Test Methods D4546.~~

6. Apparatus

6.1 *Mold*—The mold shall be cylindrical in shape, made of metal, and shall have the ~~capacity and~~ dimensions indicated in Fig. 1. The mold shall have a metal, detachable collar inscribed with a mark 50.8 mm (2.00 in.) above the base. The lower section of the mold is designed to retain a removable stainless steel ~~ring 25.4 mm (1 in.) in height,~~ring. The dimensions shown in Fig. 1 ~~101.9 mm (4.01 in.) in internal diameter, and not less than 3.10 mm (0.120 in.) in wall thickness.~~are necessary to properly manufacture the mold. Laboratories are not expected to have the capability to confirm these dimensions. See Section 9 for items needing verification.

6.1.1 *Specimen Ring*—A stainless steel ring that is 25.4 ± 0.2 mm (1.0 ± 0.01 in.) in height, 101.9 ± 0.1 mm (4.010 ± 0.005 in.) in internal diameter, and not less than 3.05 mm (0.120 in.) in wall thickness. This ring is designed to fit inside the mold.

6.2 *Rammer*—A metal ~~rammer with a circular face with a diameter of 50.8 mm (2.00 in.) and a mass of 2.5 kg (5.5 lbm) shall be used.~~ rammer, either manually or mechanically operated, that shall fall freely through a distance of 305 ± 2 mm (12.0 ± 0.1 in.) from the surface of the specimen. The rammer shall be equipped with a suitable arrangement to control ~~height of drop to a free fall of 304.8 mm ± 1.3mm (12 in. ± 0.05 in.) over the top of the soil to be compacted. See~~ the drop height. The weight of the hammer shall be 24.47 ± 0.09 N (5.50 ± 0.02 lbf, or mass of 2.495 ± 0.009 kg). The striking face of the rammer shall be planar and circular with a diameter when new of 50.80 ± 0.13 mm (2.000 ± 0.005 in.) If using a manual rammer with a guide sleeve, the rammer shall meet the requirements described in Test Methods D698 for ~~further specification of a suitable rammer.~~a manual rammer. If using a mechanical rammer, the circular face rammer shall meet the requirements described in Test Methods D698.

6.3 *Balance*—~~A balance of at least 1000 g capacity meeting~~ Balances shall conform to the requirements of Guide D4753~~, Class GP2.~~ and calibrated in accordance with the interval given in Practice D3740.

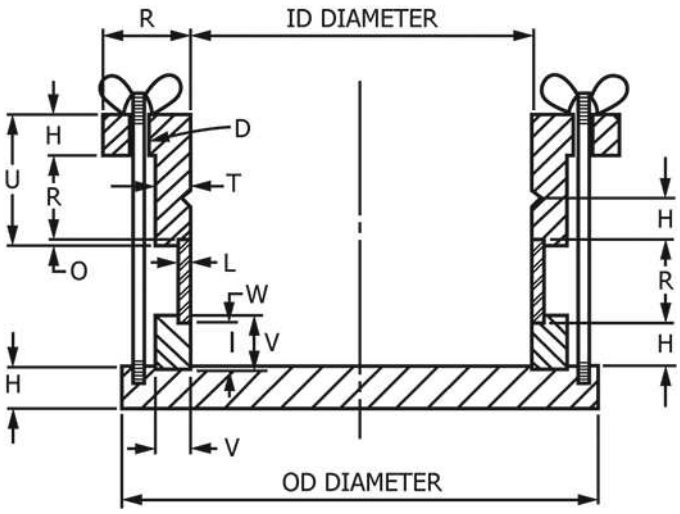
6.3.1 A balance having a minimum capacity of 1000 g with a readability without estimation of 0.1 g for use when determining masses not related to water content determination. For water content determinations, the balance shall have a minimum capacity of 100 g with a readability without estimation of 0.01 g.

6.4 *Drying Oven*—A vented, thermostatically controlled ~~drying oven (specified in Specification~~ oven ~~E145)~~ capable of maintaining a uniform temperature of 110 ± 5°C (230 ± 9°F) ~~for drying water content samples.~~throughout the drying chamber.

6.5 ~~*Straight Edge*—~~*Straightedge*—~~Steel straight edge at least~~ A stiff metal straight edge, preferably steel, of any convenient length but not less than 150 mm (6 ~~in.) in length with one beveled edge.~~in.). One edge of the straightedge shall be beveled. The straightedge must be machined straight to a tolerance of ±0.1 mm (±0.005 in.).

TABLE 1 Classification of Potential Expansion of Soils ~~Using~~ Based on *EI*

Expansion Index, *EI*	Potential Expansion
0–20	Very Low
21–50	Low
51–90	Medium
91–130	High
>130	Very High



Dimensional Equivalents[A]		
Letter	in.	mm
ID Diameter	4.010 ± 0.005	101.9 ± 0.1
OD Diameter	6.00 ± 0.01	152.4 ± 0.2
H	0.50 ± 0.01	12.7 ± 0.2
D (Hole)	7/32 ± 1/64	5.5 ± 0.4
U	1.625 ± 0.01	41.3 ± 0.2
T	0.325 - 0.375	8.25 - 9.50
O	0.125 ± 0.005	3.2 ± 0.1
R	1.00 ± 0.01	25.4 ± 0.2
W	0.563 ± 0.004	14.3 ± 0.1
V	0.688 ± 0.01	17.5 ± 0.2
L (ring wall thickness)	≥0.120	≥3.05

[A] The SI units presented are basically substitutions of the inch-pound units; other rationalized SI units should be acceptable providing they meet the technical requirements established by the inch-pound apparatus.

FIG. 1 Mold with Ring for Compaction of Specimen ~~for Expansion Index Test~~

6.6 *Separation Sieves*—A 4.75-mm (No. 4) sieve conforming to the requirements of Specification E11. This sieve is subject to rough operation and shall not be used for quantitative grain size analysis.

6.7 *Mixing Tools*—Miscellaneous tools such as mixing pans, spoons, trowels, ~~spatula, a suitable mechanical device, and so forth for thoroughly mixing the sample of soil with water.~~spatulas, a spray bottle, a suitable manual or mechanical mixer, and so forth.

6.8 *Specimen Height Measurement Device*—A device used to measure the height of the specimen with a readability to 0.025 mm (0.001 in.) or better. The device shall be constructed such that its use will not disturb/deform, indent, or penetrate the specimen.

6.9 *Loading Device*—A consolidometer or equivalent loading device as described in Test Methods D2435 ~~for supporting and submerging the specimen, for applying a vertical load, and for measuring the change in height of the specimen. The consolidometer ring must be as specified in 6.1~~.

6.10 *Porous Disks*—The disks shall be smooth ground and fine enough (Note ~~3~~2) to ~~minimize~~ reduce or prevent intrusion of soil into the disks. The ~~disk shall~~ disks shall have a close fit to the specimen ring to avoid extrusion or punching. Refer to the apparatus section of Test Methods D2435 for further details on the porous disks. The disks shall reduce false displacements caused by seating of the specimen against the surface of the disk. Such displacements are significant, especially if displacements and applied vertical pressures are small.

NOTE 2—A suitable pore size is 10 µm. Experience has shown that suitable disk dimensions are 12.7 mm ± 0.13 mm (0.50 in. ± 0.005 in.) in height and 101.5 mm ± 0.13 mm (3.995 in. ± 0.005 in.) in diameter.

~~6.9.1 Porous disks shall be air dry.~~

~~6.9.2 Porous disks shall have a close fit to the consolidometer ring to avoid extrusion or punching. Suitable disk dimensions are 12.7 mm ± 0.13 mm (0.50 in. ± 0.005 in.) in height and 101.5 mm ± 0.13 mm (3.995 in. ± 0.005 in.) in diameter or as described in 6.3 of Test Methods D2435.~~

6.11 *Deformation Indicator*—A mechanical or digital dial indicator, displacement transducer, or equivalent with a readability of 0.025 mm (0.001 in.) or better.

6.12 *Miscellaneous Items*—Distilled water, knife, pan, bowl, spray bottle, and tare cans are useful.

7. Sample Preparation Sampling

7.1 This test method does not address, in any detail, procurement of the sample. It is assumed the sample is obtained using appropriate methods and is representative of the soil under evaluation. Preserve the sample at its original moisture condition and at no time shall the sample be allowed to undergo undesirable temperature changes such as freezing or heating.

7.2 The soil should not be excessively wet or dry, unless received in the dry state, during processing. If the sample is excessively wet, allow the sample to air dry (Note 3) until the surface of the soil looks slightly wet but there are no signs of free water exiting the soil. Then, thoroughly mix the sample. Using miniature stockpiling or quartering, obtain a representative sample that will yield 1 kg (2.2 lbm) or more of soil passing the 4.75 mm (No. 4) sieve. Determine and record the mass of the representative sample, M_r, to the nearest 1 g.

NOTE 3—Air drying causes irreversible changes to some clay particles that cause permanent flocculations and decreases the fine fraction.[4]

7.3 *Preparation for Sieving*—If the soil sample is damp when received from the field, dry it until it becomes friable using a trowel. Air representative sample contains particles larger than the 4.75 mm (No. 4) sieve, separate the soil using the separation sieve. Determine and record the mass of the soil retained, *drying* M_{cfi} or oven drying at temperatures below 60°C (140°F) may be used. Thoroughly break up the aggregations in a manner such that the natural size of individual particles is not reduced. on the 4.75 mm (No. 4) separation sieve to the nearest 1 g. Determine and record the percent retained on the separation sieve of the representative sample to the nearest 1 %.

NOTE 4—If particles larger than 6.35 mm (0.25 in.) are potentially expansive, such as particles of claystone, shale, or weathered volcanic rock, they may be broken down so as to pass the 4.75-mm (No. 4) sieve if this is consistent with use of the soil.

7.3.1 If the particles retained on the separation sieve are aggregations and not individual particles, thoroughly break up the aggregations in a manner such that the natural size of individual particles is not reduced. If particles larger than 4.75 mm are potentially expansive, such as claystone, shale, or weathered volcanic rock, they may be broken down to pass the 4.75 mm (No. 4) sieve if these particles are being evaluated and are consistent with the intended use of the soil. Determine and record the mass of soil retained, M_{cfa}, on the 4.75 mm (No. 4) sieve after breaking apart any aggregations or larger particles of interest to the nearest 1 g. Record on the data sheet if particles were broken down and included that otherwise would not have been. Determine and record the percent retained on the separation sieve after particle reduction of the representative sample to the nearest 1 %.

7.3.2 The soil retained on the separation sieve can be discarded after determining its mass.

7.2 *Sieving*—Sieve an adequate quantity of the representative soil using the 4.75-mm (No. 4) sieve. Record the percentage of coarse material retained on the 4.75-mm (No. 4) sieve and discard.

7.4 *Sample*—Select a representative sample Determine and record the mass of the soil with a mass passing the 4.75 mm (No. 4) sieve, M_p, of approximately 1 kg (2 lbm) or more prepared using the guidelines in to the nearest 1 g. The amount of soil must be 1 kg (2.2 lbm) or more. 7.1 and 7.2.

8. Test Specimen Preparation

8.1 Place the soil passing the separation sieve in a pan or bowl. Based on the mass of the soil, its water content, and the estimated water content needed to achieve a degree of saturation of 50 ± 2 % in the compacted condition, calculate the amount of distilled water to add.

8.2 *Water Content*—Thoroughly mix the selected representative sample with sufficient Use a spray bottle filled with distilled water to bring the soil to a water content that has a corresponding degree of saturation of 50 ± 2 % in the compacted condition. evenly distribute the calculated amount of distilled water needed. Then mix thoroughly to achieve a uniform water content. After mixing, take a representative sample of the material for determination of the water content and seal the remainder of the soil in a close-fitting airtight container for a period of at least 16 h. Weigh the moisture sample immediately, and dry in an oven at 110 ± 5°C (230 ± 9°F) for at least 12 h, or in accordance with 100 g or more of soil for a water content determination. Follow the procedure given in Test Methods D2216, to a constant mass. The water content sample shall have a mass of at least 100 g conforming with Test Methods with the exception for the minimum mass of the specimen as stated above. Determine and record the necessary masses for the water content to the nearest 0.01 g. Immediately after taking soil for the water content determination, place the remaining soil in a tightly sealed container and allow it to stand (cure) for D2216. The water content of the trimmings shall be determined in accordance with Test Methods a period of at least 16 h. D2216 using a resolution of 0.1 % or better.

8.2.1 Determine and record the water content, w, to the nearest 0.1% in accordance with Test Method D2216.

8.3 *Specimen Compaction*—Prepare a specimen by Determine and record the mass of the specimen ring, *compacting* M_r, the cured soil in the 101.9-mm (4.01-in.) diameter to the nearest 1 g. Assemble the mold and the specimen ring and prepare to compact the specimen. Compact the specimen in the mold in two equal layers to give a total compacted depth of approximately 50.8 mm (2 in.). Compact each layer by using 15 uniformly distributed blows of the rammer dropping free from a height of 305 mm ± 2.5

[4] The last approved version of this historical standard is referenced on www.astm.org. Sridharan, A., Jose, B.T., and Abraham, B.M., Technical Note on "Determination of Clay Size Fraction of Marine Clays," *Geotechnical Testing Journal*, GTJODJ, Vol. 14, No. 1, March 1991, pp. 103-107.

~~mm (12 in. ± 0.1 in.) above the top of the soil when a sleeve type rammer is used, or from 305 mm ± 2.5 mm (12 in. ± 0.1 in.) above the approximate elevation of each finally compacted layer when a stationary mounted type of rammer is used.~~ from the specified drop height. Scarify the first compacted layer before adding material for the second layer using a knife or other suitable ~~object.~~ object to avoid potential separation between compacted layers. During compaction rest the mold on a uniform rigid foundation, such as provided by a cube of concrete with a mass not less than 90 kg (200 ~~lb).~~lbm).

8.4 ~~*Specimen Trimming*—~~Following compaction, remove the upper and lower portions of the mold from the inner ring and carefully trim the specimen flush with the top and bottom of the ring with a ~~straight edge.~~straightedge. Where removal of coarse sand grains or crumbling resulting from trimming causes voids on the surface of the specimen, carefully fill the voids with remolded soil obtained from the trimmings. If desired, use the trimmings to make a water content, w_t determination. If performed, record masses to nearest 0.01 g and the water content determination to the nearest 0.1 % (Note 5). Determine and record the mass of the compacted specimen plus ring, M_{sr}, to the nearest 1 g.

NOTE 4—Compaction energies are different between this standard and D698. Using the specified compaction energy, the compaction water content should be selected such that the as-compacted degree of saturation is 50 ± 2 %.

NOTE 5—This water content determination should be close (~0.5 to 1 percentage points) to the water content determination taken the day before.

8.5 ~~*Specimen Height*—Determine the~~ Using the specimen height measuring device, determine and record the initial height of the specimen, H_{ti}, ~~with a resolution of 0.03~~ to the nearest 0.025 mm (0.001 in.) ~~similar to the procedure in Section 7 of Test Methods~~by either taking the average of at least ~~D3877 or assume equal to~~ four evenly spaced measurements over the top (and bottom) surface of the specimen (preferred) or using the height of the ~~specimen ring.~~ ring as the initial height.

8.6 *Degree of ~~Saturation~~—Saturation Confirmation*—~~Calculate the~~Using Eq 1-4 ~~water content~~ in ~~accordance~~Section 11~~with Test Methods~~, determine ~~D2216~~and ~~the dry unit weight in accordance with Section 11 of Test~~record the degree of saturation, ~~*Methods*~~*S*, ~~D698. Determine the~~ to the nearest 1 %. The degree of saturation ~~using the equation provided below. If the degree of saturation~~ must be 50 ± 2 %. If it is not within ~~50 ± 2 %, prepare another specimen. Adjust~~ these limits, remove the specimen from the ring and discard. Prepare another specimen by adjusting the water content of the new specimen based on the calculated degree of saturation ~~and prepare the specimen in accordance with 8.1-8.4 to achieve a degree of saturation 50 ± 2 %.~~ of the previous trial. Increase the water content if the degree of saturation is less than ~~50%~~50 % and decrease the water content if the degree of saturation is higher than 50 %.

$$S = \frac{wG_s\gamma_d}{G_s\gamma_w - \gamma_d} \quad (1)$$

It may take several trials to achieve the required degree of saturation.

~~where:~~

~~S = degree of saturation, %~~
~~w = water content, %,~~
~~G_s = specific gravity, use 2.7 unless the specific gravity is known to be less than 2.6 or more than 2.8,~~
~~γ_w = unit weight of water, 9.79 kN/m^3 (62.3 lbf/ft^3) at 20°C (68°F), and~~
~~γ_d = dry unit weight of compacted soil specimen, kN/m^3 (lbf/ft^3).~~

~~Use the resolution provided in 8.1 for w. Use a resolution of 0.1 kN/m^3 (0.1 lbf/ft^3) or better for γ_d.~~

~~NOTE 5—This standard test method assumes a specific gravity of 2.7, which is typical of soil minerals commonly used for compaction. In addition, using an assumed specific gravity value of 2.7 will result in a maximum error of 4 % in the calculated degree of saturation, provided the actual specific gravity is between 2.6 and 2.8. These small errors in saturation with mineral type will cause systematic and small changes in the *EI* that are considered equally important to variations caused when determining the specific gravity using Test Methods D854.~~

9. Verification of Apparatus

9.1 Perform the verification of the following items before initial use, after repairs, or other occurrences that might affect the test results. Thereafter, the items shall be verified after 1,000 tests or annually, whichever occurs first, unless otherwise indicated below. For other items used in this standard, refer to Practice D3740 for their specified intervals.

9.1.1 *Rammer*—Verify the free fall distance, rammer weight or mass, and rammer face in accordance with 6.2. The rammer shall be replaced when the striking face becomes worn or bellied to the extent that the diameter exceeds 50.80 ± 0.25 mm (2.000 ± 0.01 in.).

9.1.2 *Ring Dimensions*—Verify the height, diameter, and thickness of the ring in accordance with 6.1.1.

9.1.3 *Mold Collar*—The location of the inscribed mark on the collar shall be verified before initial use or after repair in accordance with 6.1.

9.1.4 *Mold*—The internal diameter (ID) of the mold shall be verified in accordance with the value given in Fig. 1.

10. Procedure

10.1 Determine and record the mass of the air-dried porous disk that will be placed on top of the specimen and the mass of the unbalanced mass of the loading machine to the nearest 1 g.