Designation: D6473 – 15

Standard Test Method For Specific Gravity And Absorption of Rock For Erosion Control[1]

This standard is issued under the fixed designation D6473; 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 covers the determination of specific gravity and absorption of rock for erosion control, commonly referred to as riprap or armor stone. The specific gravity may be expressed as bulk specific gravity or apparent specific gravity. Bulk specific gravity and absorption are based on a 24 ± 4-h soaking time for the rock specimens tested. This test is appropriate for breakwater stone, armor stone, riprap, and gabion sized rock materials.

1.2 The use of reclaimed concrete and other materials is beyond the scope of this test method.

1.3 *Units*—The values stated in SI units are to be regarded as the standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this standard.

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

1.4.2 The procedures used to specify how data are collected/recorded or 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 analytical methods for engineering design.

1.5 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

D653 Terminology Relating to Soil, Rock, and Contained Fluids

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

D4992 Practice for Evaluation of Rock to be Used for Erosion Control

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 *Definitions*—For definitions of common technical terms used in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *absorption*—the increase in the mass of rock due to water in the pores of the material, but not including water adhering to the outside surface of the particles. Absorption is expressed as a percentage of the dry mass.

3.2.2 *apparent specific gravity*—the ratio of the mass in air of a given volume of the impermeable portion of a permeable material (that is, the solid matter including its impermeable pores or voids) at a stated temperature to the mass of an equal volume of distilled water at the same stated temperature. The value is dimensionless.

3.2.3 *bulk specific gravity*—the ratio of the mass in air of a given volume of a permeable solid (including both permeable

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.17 on Rock for Erosion Control.

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[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.

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

and impermeable voids within the material) at a stated temperature, to the mass in air of an equal volume of distilled water at the same stated temperature. The value is dimensionless.

3.2.4 *bulk specific gravity (saturated surface-dry) (SSD)*—the ratio of the mass of a given volume of permeable solid, (including the mass of water within the saturated permeable voids) filled to the extent achieved by submerging in water for approximately 24 h at the stated temperature to the mass of an equal volume of water at the same stated temperature. The value is dimensionless.

3.2.5 *gabion-fill stone*—stone generally less than 25 kg (50 lb) and placed in baskets of wire or other suitable material. These baskets are then tied together to form an integral structure designed to resist erosion along stream banks and around bridge piers.

3.2.6 *specific gravity*—the ratio of the mass in air of a given volume of solid at a stated temperature to the mass of an equal volume of distilled water at the same stated temperature. The value is dimensionless.

4. Summary of Test Method

4.1 An air-dried specimen (block, chunk, or slab) of rock is submerged in water for 24 ± 4 h after which its mass is determined while still submerged. It is then removed from the water, dried to a surface dry condition, and its mass re-determined. Finally, it is dried in an oven to a constant mass. The initial mass and increase in mass are used to determine the specimen's specific gravity and percentage of water absorbed.

NOTE 1—Immersion durations other than the 24-h period have been used. Specimens in those tests have been immersed in increments over a four-day period. Test results indicate a higher percentage of water absorption than the 24 h test. Negligible differences in bulk specific gravity were measured after one-day soaking and four-day incremental soakings.

5. Significance and Use

5.1 Rock riprap and armor stone are composed of pieces of natural rock that are placed on construction projects, shorelines, streambeds, bridge abutments, pilings, and other structures to minimize the effects of erosion. The ability of rock to withstand deterioration from weathering affects both the effectiveness of the project and its cost. The specific gravity and absorption of rock provide useful information that can be used in evaluating possible deterioration of rock.

5.2 Bulk specific gravity and bulk specific gravity SSD may reflect the quality of rock and is important in that it may provide one indicator to the resistance of a rock to movement by water.

5.3 The absorption of water into rock may affect its durability under freezing conditions and salt crystallization conditions. In addition, the absorption test has been used as an index test in determining whether additional tests are needed to evaluate the durability of a rock.

5.4 Test specimens equal in size to the proposed design size would provide the best correlations between laboratory tests and actual field performance, however this is usually neither practical nor economically feasible.

5.5 The results of these tests are not to be used as the sole basis for determination of rock durability, but should be used in conjunction with the results of other tests.

5.6 These test methods have been used to evaluate different types of rocks. There have been rare occasions when test results have provided data that have not agreed with the durability of rock under actual field conditions. For example, some rocks with low absorption values have fragmented in actual usage and some with high absorption values have proven to be durable.

NOTE 2—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 meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depends on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Balance*—A balance or scale conforming to the requirements of Specification D4753 and readable (with no estimation) and accurate to the nearest 5 g or to 0.1 % or better of the mass of the test specimen. The balance shall be equipped with suitable apparatus for suspending the sample container in water from the center of the platform or pan of the balance.

6.2 *Specimen Container*—A wire basket capable of holding the submerged rock specimen being tested. The container shall be constructed so as to prevent trapping air when the container is submerged.

6.3 *Water Tank*—A watertight tank capable of holding the fully immersed rock and specimen container while suspended below the balance.

6.4 An example apparatus is shown in Fig. 1.

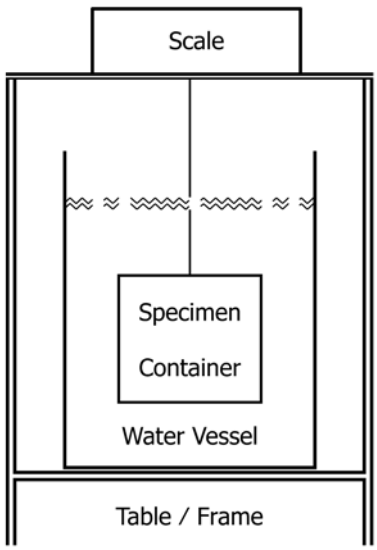

FIG. 1 Example Apparatus

6.5 *Drying Oven*—Vented, thermostatically-controlled, preferably of the forced-draft type and capable of maintaining a uniform temperature of 110 ± 5°C (230 ± 9°F) throughout the drying chamber.

7. Sampling

7.1 Practice D4992 provides guidance on sampling a source of rock. A source that is macroscopically uniform in color, texture, mineralogy, or some other visual property shall be represented by a sample consisting of a minimum of five specimens of rock. A macroscopically non-uniform source shall be represented by a sample consisting of a minimum of eight specimens of rock for testing. Rock types that comprise less than 5 % of the total source, as determined from their macroscopic properties may be ignored, unless their presence will greatly affect the test results and subsequent proposed use of the rock. Sample the rock types in their approximate proportion to the types that occur at the source.

8. Specimens

8.1 Specimens shall be clean and without soil particles or other adherent materials. Specimens shall have all loose parts and adherent material removed by brushing with a stiff brush (including the use of water, as necessary) and shall be allowed to air dry.

8.2 Each specimen shall be a minimum of 1 kg (2.2 lb) in mass. The maximum mass shall be limited only by the capacity of the scale and size of the water-filled tank.

NOTE 3—Tests to determine the absorption and specific gravity have been performed on aggregate-sized particles in accordance with Test Method C127. Larger-sized particles may include more variability in rock properties than small particles and can give a better indication of the bulk properties than small ones.

9. Procedure

9.1 Conduct the testing procedure at ambient laboratory temperatures.

9.2 Completely submerge the air-dried specimens in water at 20 to 30°C (68 to 86°F) for a period of 24 ± 4 h. Place the soaked test specimen, one at a time, in the suspended specimen container ensuring it is completely immersed in water. The specimen container shall be immersed to the same level (depth) as when determining the tare value to reduce error caused by the mass of the equipment above and below the water level. Take care to remove all entrapped air before determining its mass in water by shaking the immersed container. Determine and record the mass of each specimen as the buoyant mass, C. Record this, and all subsequent masses, to the nearest 5 g or 0.1 %, whichever is more precise.

NOTE 4—Care should be taken to ensure that any material detached from its parent specimen during the immersion process shall remain with its parent specimen throughout the balance of testing. The detached material shall be treated and its mass determined, as with the parent specimen.

9.3 Remove each specimen from the water and roll it in a large absorbent cloth until all visible films of water are removed. A moving stream of air (but not a heated air stream, such as from a drier) may be used to assist the drying. Take care to avoid evaporation of water from the pores during the surface drying operation. Determine and record the mass of each specimen as the saturated-surface dry mass, B.

9.4 Dry each specimen for a minimum of 24 h or to a constant mass within ±0.1 % at a temperature of 110 ± 5°C (230 ± 9°F), then cool them in air at room temperature for 1 to 3 h. Constant mass will be considered to have been achieved when weight loss is less than 0.1 % of specimen weight in four hours of drying. Determine and record the mass of each specimen as the oven-dry mass, A.

NOTE 5—The use of tap water instead of distilled water is permitted. The tap water shall not contain a high amount of dissolved minerals and shall stand for several hours to dissipate any dissolved air. Laboratory test results run on specimens tested in distilled water were sufficiently close to those tested in tap water so as not to significantly affect the result.

10. Calculation

10.1 Calculate the bulk specific gravity, bulk specific gravity (SSD), apparent specific gravity, and absorption for each specimen at ambient laboratory temperature as follows:

$$\text{bulk specific gravity} = A/(B - C) \quad (1)$$

$$\text{bulk specific gravity (SSD)} = B/(B - C) \quad (2)$$

$$\text{apparent specific gravity} = A/(A - C) \quad (3)$$

$$\text{absorption, \%} = [(B - A)/A] \times 100 \quad (4)$$

where:

A = mass of oven-dry test specimen in air, g,
B = mass of saturated-surface dry test specimen in air, g, and
C = buoyant mass of submerged test specimen in water, g.

10.1.1 Calculate the results for each specific gravity test to the nearest 0.01. Calculate the averages of all specific gravity tests by summing the results of all test specimens and dividing by the number of specimens tested and report to the nearest 0.01.

10.1.2 Calculate the results for each absorption test to the nearest 0.1 %. Calculate the averages for all absorption tests by summing the results of all specimens and dividing by the number of specimens and report to the nearest 0.1 %.

11. Report: Test Data Sheet(s)/Form(s)

11.1 Record the following information:

11.1.1 Prepare a separate report on rock from each source. Report the source of the samples, its location, the dates sampled and tested, and the geological formation if known,

11.1.2 Description and type of materials,

11.1.3 Name of the individuals performing the test,

11.1.4 Indicate the type of specific gravity, whether bulk, bulk (SSD), or apparent. The specific gravity results for each specimen tested and the average of each type of test to the nearest 0.01, and

11.1.5 Absorption result for each specimen tested and the average of all the specimens tested to the nearest 0.1 %.

12. Precision and Bias

12.1 The precision of these test methods has not been determined. Limited data are being evaluated to determine the precision of these test methods. Subcommittee D18.17 is seeking pertinent data from users of these test methods.

12.2 The procedure defined in these test methods has no bias because the values of riprap particle size can be defined only in terms of a test method.

12.3 Variation in the results of these test methods is a consequence of the variation in the materials sampled and tested and variation in the application of the test methods.

13. Keywords

13.1 absorption; riprap; rock material properties; specific gravity

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (2010) that may impact the use of this standard. (July 1, 2015)

(1) Revised 1.1 to include what materials are deemed appropriate for use in this practice.
(2) Revised 1.3, 1.4, 3.1, 11 and 12, along with Note 2 to meet D18.91 editorial requirements.
(3) Deleted the reference to ASTM E145 in Sections 2.1 and 6.4 as it has been removed from the standard.
(4) Added 3.2.4 to include gabion-fill as it is not referenced in D653.
(5) Revised Section 4.1 for ease of use and clarification.
(6) Added Figure 1 to illustrate the positioning of the specimen container relative to the water vessel during testing.
(7) Created new Section 8 (Specimens) with information removed from Section 7 (Sampling), as it did not pertain to sampling. This is consistent with Sections 7 and 8 in D5779. Subsequent sections were renumbered to reflect this revision.
(8) Revised Sections 9.2 and 9.4 for ease of use and clarification.