



Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions¹

This standard is issued under the fixed designation D5313/D5313M; 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 procedures for evaluating the durability of rock for erosion control when exposed to wetting and drying conditions on slabs of rock. This weathering test exposes the rock to wetting and drying cycles similar to fluctuating water levels and weather conditions. The rock slabs, prepared in accordance with procedures in Practice **D5121**, are intended to be representative of erosion control rock and its weaknesses. The test is appropriate for breakwater stone, armor stone, riprap and gabion sized rock materials.

The limitations of the test are twofold. First, the size of the cut rock slab specimens may eliminate some of the internal defects present in the rock structure. The test specimens may not be representative of the quality of the larger rock samples used in construction. Careful examination of the rock source and proper sampling are essential in minimizing this limitation. Secondly, the test requires the rock slabs to be exposed to 80 wetting-drying cycles. The test is time intensive and will require approximately three months to complete the sample preparation, testing, and analysis portions of the procedure.

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 either SI units or inch-pound units [presented in brackets] are to be regarded separately as standard. 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.

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values shall conform to the guidelines for significant digits and rounding established in Practice **D6026**, unless superseded by this standard.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

- D653** Terminology Relating to Soil, Rock, and Contained Fluids
- D2216** Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- 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
- D5121** Practice for Preparation of Rock Slabs for Durability Testing
- D6026** Practice for Using Significant Digits in Geotechnical Data

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

3. Terminology

3.1 *Definitions*—See Terminology **D653** for general definitions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *rock saw, n*—a saw capable of cutting rock. The term “rock saw” shall include the blade which saws the rock, any components that control or power the sawing process or both, and framework on which the blade and any other associated components are mounted.

3.2.2 *slab, n*—a section of rock having two smooth, approximately parallel faces, produced by two saw cuts. The thickness of the slab is generally less than the other dimensions of the rock. The slab will be the specimen of a rock which will subsequently undergo durability tests. The words “slab” and “specimen” are interchangeable throughout the test method.

3.2.3 *armor stone, n*—stone generally 900 to 2700 kg [1 to 3 tons] resulting from blasting, cutting, or by other methods placed along shorelines or in jetties to protect the shoreline from erosion due to the action of large waves.

3.2.4 *breakwater stone, n*—stone generally 2700 to 18 000 kg [3 to 20 tons] resulting from blasting, cutting, or by other methods placed along shorelines or in jetties to protect the shoreline from erosion due to the action of large waves.

3.2.5 *riprap stone, n*—stone generally less than 1800 kg [2 tons] specially selected and graded, when properly placed prevents erosion through minor wave action, or strong currents and thereby preserves the shape of a surface, slope, or underlying structure.

3.2.6 *gabion-fill stone, n*—stone generally less than 22 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.

4. Summary of Test Method

4.1 Erosion control rock samples are trimmed into saw-cut slab specimens. Each slab is structurally examined macroscopically and under 20× magnification. The specimens are exposed to 80 wetting-drying cycles. Each cycle consists of full immersion in potable water for a minimum of 12 h, then drying under infrared heat lamps or in an oven for a minimum of 6 h. At the completion of the test the percent loss by mass for each specimen set is determined. A visual examination of the slabs is performed throughout and at the end of testing. The type of deterioration and changes to previously noted planes of weakness are recorded.

5. Significance and Use

5.1 Rock for erosion control consists of individual pieces of natural stone. The ability of these individual pieces of stone to resist deterioration due to weathering action affects the stability of the integral placement of rock for erosion control and hence, the stability of construction projects, structures, shorelines, and stream banks.

5.2 This test method is designed to determine the effects of wetting and drying action on the individual pieces of rock for

erosion control and the resistance of the rock to deterioration. This test method was developed to be used in conjunction with additional test methods listed in Practice **D4992**. This test method does not provide an absolute value but rather an indication of the resistance to wetting and drying; therefore, the results of this test method are not to be used as the sole basis for the determination of rock durability.

NOTE 1—The quality of the result produced by this standard is dependent upon the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **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 depend on many factors; Practice **D3740** provides a means of evaluation some of those factors.

6. Apparatus

6.1 *Rock Saw*—A laboratory diamond saw used to cut geological and concrete specimens, or a diamond saw used for lapidary purposes, shall be acceptable. A minimum blade diameter of 36 cm [14 in.] will be needed to obtain the required slab sizes (a larger one is preferable). The blade shall be a circular diamond blade.

6.1.1 The rock saw apparatus shall have a fixed or removable vise to hold the samples during the cutting process. An automatic feed (either gravity, hydraulic, or screwfeed operated) that controls the cutting action is preferred; however, a manual feed is also acceptable. The saw shall have a platform to prevent the cut slab from falling and shattering.

6.2 *Containers*—Of sufficient size to hold the specimens fully immersed in potable water. It is advised that these containers be non-reactive, resistant to breakage, and resistant to deformation and degradation when exposed to temperatures encountered in this test method.

6.3 *Drying Oven*—Thermostatically controlled oven, capable of maintaining a uniform temperature of $110 \pm 5^\circ\text{C}$ [$230 \pm 9^\circ\text{F}$] throughout the drying chamber. These requirements typically require the use of a forced-draft type oven. Preferably the oven should be vented outside the building.

6.4 *Drying Apparatus*—Infrared heat lamps (150 W) or a thermostatically controlled oven capable of maintaining a uniform temperature of $65 \pm 5^\circ\text{C}$ [$150 \pm 9^\circ\text{F}$] throughout the drying chamber.

6.5 *Stereomicroscope*—A microscope or other suitable magnifying device capable of at least 20× magnification for examination of the specimen prior to and after testing.

6.6 *Balance*—A balance capable of determining the mass of the specimen to the nearest 0.1 % of the total mass meeting the requirements of Specification **D4753**.

6.7 *Camera*—A digital or film camera capable of producing good quality, color photographs for “before” and “after” photographs.

7. Sampling, Test Specimens, and Test Units

7.1 A source of rock to be sampled shall be guided by the principles in Practice **D4992**.

7.2 Rock sources may be from mine, quarry, outcrop, or field boulders. Visual observation of color, texture, mineralogy, or some other feature, will be the key to proper representative sampling.

7.2.1 A rock source that is macroscopically uniform shall be represented by a minimum of five pieces of the material obtained from separate locations within the source area. This group is considered as a specimen set.

7.2.2 A rock source that is macroscopically non-uniform shall be represented by a minimum of eight pieces of the material obtained from separate locations within the source area. This group is considered as a specimen set.

7.2.3 Sample the rock types in their approximate proportion to the types that occur at the source.

7.3 Planes of weakness will be included in each sample such that a determination may be made as to the durability of the various planes of weakness and their effect on the overall durability of a rock mass that would contain these planes of weakness.

7.4 Each rock sample shall be of sufficient size to provide the finished size specimens described in Section 8.

7.5 In all cases, the rock pieces selected for the sample shall be chosen to be representative of the majority of the rock at the source. Rock pieces, as determined by their macroscopic properties, which comprise less than 5 percent of the source material, may be ignored unless their presence in a sample will significantly affect the test results and subsequent proposed use of the rock.

7.6 Each piece will be of a size such that testing may proceed without further mechanical crushing; however, the chosen pieces shall be as large as the laboratory can handle but in no case shall the sample be less than 125 mm [5 in.] on a side.

8. Preparation of Test Specimens

8.1 Prepare a separate slab for each orientation of the various planes of weakness unless all such planes can be intersected with one orientation.

8.2 Saw each sample, as obtained in accordance with 7.2.1 and 7.2.2, in accordance with Practice D5121. Each specimen will be cut to 65 ± 5 mm [2.5 ± 0.25 in.] thick and cut normal to bedding or any potential planes of weakness that may be observed in the samples. In no case will the size of the slab be less than 125 mm [5 in.] on a side, excluding the thickness.

NOTE 2—Test specimens may also be prepared by cutting a 65 mm [2.5 in.] thick slab from a 150-mm [6-in.] diameter diamond drill core such that any apparent zones of weakness are included.

NOTE 3—The best estimates of rock durability are the result of tests performed on the largest possible slabs of rock. The maximum slab size shall be limited only by the capacity of the laboratory and its equipment.

9. Procedure

9.1 Examine each slab macroscopically and under a minimum of 20× magnification. Note the presence of bedding planes, microfractures, and other planes of weakness and their condition. Describe each slab as indicated in Practice D5121.

9.2 Label each specimen with a suitable waterproof marker. Photograph each test specimen digitally or using color film in

such a way that the slab fills most of the photograph. Wet or partially wet specimens usually show more detail than dry specimens. Include a scale in all photographs.

9.3 Dry each trimmed slab in an oven to a constant mass (± 0.1 % of the total mass) at $110 \pm 5^\circ\text{C}$ [$230 \pm 9^\circ\text{F}$] and record the mass. Rock that contains gypsum (calcium sulfate dihydrate), shall be dried at the 60°C [140°F] temperature recommended in Test Method D2216.

9.4 Begin the wetting sequence by placing each specimen, sawed surface down, in a container on a thin layer, 6 mm [$1/4$ in.], of plus No. 8 size sand. Add enough potable water to the container such that the specimen is fully immersed and let stand at room temperature for a minimum of 12 h.

9.5 Begin the drying sequence by decanting or siphoning the water and placing the container in an oven at a temperature of $65 \pm 5^\circ\text{C}$ [$150 \pm 9^\circ\text{F}$]. As an alternative, the sample may be dried under an infrared heat lamp such that the rock surface is 40 to 50 cm [16 to 20 in.] from the lamp. Thoroughly dry the specimen for a minimum of 6 h.

9.6 The completion of the wetting and drying sequences constitutes one wetting-drying cycle.

9.7 At the completion of the drying sequence allow the samples to cool to ambient room temperature.

9.8 Repeat the process of wetting and drying in accordance with 9.4 and 9.5 for a total of 80 cycles.

9.9 Preferably, the test shall be performed continuously until the specified number of cycles is obtained. However, if the test must be interrupted, leave the samples at the ambient room temperature attained in 9.7 until the testing can be resumed.

9.10 Photograph and perform a qualitative examination on each slab as specified in Section 11.

9.11 Upon completion of the 80 cycles, dry the largest remaining piece of each slab in an oven to a constant mass and record the mass as in accordance with 9.3.

10. Quantitative Examination

10.1 For each slab perform the following calculation:

$$\% \text{ loss} = (A - B)/A \times 100 \quad (1)$$

where:

A = oven dried mass of the specimen prior to testing, and
 B = oven dried mass of the largest remaining piece of each slab after testing.

10.2 Calculate the percent loss determined to the nearest 0.1 percent for each specimen.

10.3 Calculate the mean of the percent loss for the specimen set.

11. Qualitative Examination

11.1 Visually examine the slabs every four cycles, and at the completion of testing for any changes that have taken place over the duration of the test and describe the changes. Identify the type of deterioration (spalling, splitting, disintegration, slaking, and other types of deterioration). Observe and record any changes to previously noted planes of weakness.

11.2 Take color photographs of each slab every four cycles, and at the completion of testing. Provide close-ups of any unusual features. Include a scale in all photographs.

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

12.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as given below, is covered in 1.3.

12.2 Record as a minimum the following general information (data):

12.2.1 Sample/specimen identifying information, such as Project No., Sample No., Sample source location, Depth, etc.

12.3 Record as a minimum the following test specimen data:

12.3.1 The name and initials of testing personnel.

12.3.2 The initial oven-dried specimen mass.

12.3.3 The start and finish time and date for each wetting-drying cycle.

12.3.4 The initial qualitative examination observations and those made every fourth wetting-drying cycle.

12.3.5 “Before,” “during,” and “after” color photographs.

12.3.6 The final oven-dried specimen mass.

12.4 Report as a minimum the following information:

12.4.1 Sample identification number.

12.4.2 Sample source location.

12.4.3 Location of intended use.

12.4.4 Rock type.

12.4.5 The mean percent loss of the quantitative examination in accordance with 10.3 to the nearest 0.1 percent.

12.4.6 A written description of the qualitative examination for each specimen in accordance with 11.1, and the findings of this examination.

12.4.7 “Before” and “After” color photographs.

12.5 The following items are optional for the report:

12.5.1 Geological formation name.

12.5.2 Geological setting of the source with pertinent information on planes of weakness noted in the field.

13. Precision and Bias

13.1 *Precision*—Due to the nature of the rock materials tested by this test method, it is, at this time, either not feasible or too costly to produce multiple specimens that have uniform physical properties. Since specimens that would yield the same test results cannot be tested, Subcommittee D18.17 cannot determine the variation between tests since any variation observed is just as likely to be due to specimen variation as to operator or laboratory testing variation. Subcommittee D18.17 welcomes proposals to resolve this problem that would allow for the development of a valid precision statement.

13.2 *Bias*—There is no accepted reference value for this test method; therefore, bias cannot be determined.

14. Keywords

14.1 armor stone; breakwater stone; climatic setting; erosion control; gabion-fill; laboratory testing; riprap; rock; rock material properties; wetting-drying

APPENDIX
(Nonmandatory Information)
X1. DURABILITY OF ROCK FOR EROSION CONTROL UNDER WETTING AND DRYING CONDITIONS WORKSHEET

ASTM D5313 Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions					
Project:			Lab Number:		
Test Start Date:		Test End Date:		Tested By:	
(A) Initial Specimen Mass, g:			(B) Final Specimen Mass, g:		
Initial Qualitative Description:					
Cycle 1	Wet Start Date/Time	Dry Start Date/Time	Cycle 2	Wet Start Date/Time	Dry Start Date/Time
By			By		
Cycle 3	Wet Start Date/Time	Dry Start Date/Time	Cycle 4	Wet Start Date/Time	Dry Start Date/Time
By			By		
Qualitative Description:					
Cycle 5	Wet Start Date/Time	Dry Start Date/Time	Cycle 6	Wet Start Date/Time	Dry Start Date/Time
By			By		
Cycle 7	Wet Start Date/Time	Dry Start Date/Time	Cycle 8	Wet Start Date/Time	Dry Start Date/Time
By			By		
Qualitative Description:					
Cycle 73	Wet Start Date/Time	Dry Start Date/Time	Cycle 74	Wet Start Date/Time	Dry Start Date/Time
By			By		
Cycle 75	Wet Start Date/Time	Dry Start Date/Time	Cycle 76	Wet Start Date/Time	Dry Start Date/Time
By			By		
Qualitative Description:					
Cycle 77	Wet Start Date/Time	Dry Start Date/Time	Cycle 78	Wet Start Date/Time	Dry Start Date/Time
By			By		
Cycle 79	Wet Start Date/Time	Dry Start Date/Time	Cycle 80	Wet Start Date/Time	Dry Start Date/Time
By			By		
Final Qualitative Description:					
Calculations		% Loss = (A – B) / A × 100			
By					

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this test method since the last issue, D5313–12, that may impact the use of this test method. (Approved July 1, 2012.)

(1) The Scope (Section 1) was expanded to indicate the test method’s intent and limitations. Clarification and reference to Practice D6026 was expanded and a statement was added indicating that the values stated in either SI units or inch-pound units [presented in brackets] are to be regarded separately as standard.

(2) The Terminology (Section 3) was expanded to include terms specific to the standard.

(3) A Summary of Test Method (Section 4) was added to present a clear and concise summary of the test method.

(4) The Significance and Use (Section 5) was updated to improve readability.

(5) The Apparatus (Section 6) was clarified to reflect the wording in Practice D5121 and to eliminate superlative wording.

(6) The Sampling, Test Specimens, and Test Units (Section 8) was expanded and broken down into simple sections for clarification and to improve readability.

(7) The Procedure (Section 10) was updated to clarify the sequencing of, and to remove ambiguity from, the test.

(8) Rationalized SI and inch-pound units were added throughout the standard.

(9) The Report: Test Data Sheet(s)/Form(s) (Section 12) was expanded to specify the manner in which the data is recorded and reported.

(10) Appendix X1 was added to provide the user with a worksheet for data recording. This worksheet is strictly an example that the user may vary to suit their particular requirements.

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