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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions[1]

This standard is issued under the fixed designation D 5312; 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 procedures for evaluating the durability of rock for erosion control when exposed to freezing and thawing conditions.

1.2 *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:*

D 4992 Practice for Evaluation of Rock to Be Used for Erosion Control[2]

D 5121 Practice for the Preparation of Rock Slabs for Durability Testing[2]

3. Significance and Use

3.1 Rock used for erosion control may consist of several types, depending on potential use. One type may be armor stone weighing from one to three tons or breakwater stone weighing three to twenty tons placed along shorelines or in jetties to protect the shoreline from erosion due to the action of large waves. Another type may be riprap usually weighing less than one ton and placed along river banks or on the slopes of dams to prevent erosion due to run-off, wave action, or stream-flow. A third type may be gabion-fill weighing less than 50 lb and placed in baskets of wire or other suitable materials. These baskets are then tied together to form an integral structure designed to resist erosion along stream banks and around bridge piers. No matter what form it takes, 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, shorelines, and stream-banks.

3.2 This test method is designed to determine the effects of freezing and thawing 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 D 4992. This test method does not provide an absolute value but rather an indication of the resistance to freezing and thawing; therefore, the results of this test method are not to be used as the sole basis for the determination of rock durability.

4. Apparatus

4.1 *Circular Diamond Saw*, 14-in. diameter, capable of sawing rock, of the type required for Practice D 5121.

4.2 *Freeze-Thaw Chamber or Home Freezer*:

4.2.1 A timer-controlled freeze-thaw chamber specifically designed for timed cycling of 16 h of freezing at − 18± 2.5°C (0 ± 5°F) followed by a minimum of 8 h of thawing at 32 ± 2.5°C (90 ± 5°F) on a daily basis is the most desirable option. This type of apparatus can be obtained commercially and allows for the completion of one freeze-thaw cycle every day including weekends and holidays.

4.2.2 If a freeze-thaw chamber is not available, a standard chest-type home freezer capable of reaching the minimum temperatures in accordance with 4.2.1 may be used. The limitations associated with this option are related to the fact that the freeze-thaw cycling must be accomplished manually. The freezing portion of the cycle will begin when the test specimens are manually placed in the freezer at the end of the workday. The test specimens must be removed at the beginning of the workday to begin the thawing portion of the cycle. In addition, only four cycles of freezing and thawing may be accomplished during a normal work week since the 16 h of freezing may be accomplished only on the first through the fourth nights of the workweek (the fifth night of the workweek would go into the weekend). Thawing will then take place from Friday morning to Monday evening. This thawing cycle will not require the use of an oven.

4.3 *Oven*, (if option 4.2.2 is used), capable of holding the test specimen and its container and of maintaining a constant temperature of 32 ± 2.5°C required for the three thawing cycles during the workweek.

4.4 *Oven*, capable of drying the specimen to a constant mass at a temperature of 110 ± 5°C.

4.5 *Containers*, to hold the specimens partially immersed in an alcohol/water solution, These containers may be stainless steel or polyvinyl chloride (PVC) and may be obtained from a

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.17 on Rock for Erosion Control.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

restaurant supply company.

4.6 *Balance*, capable of determining the mass of the specimen to the nearest 0.1 % of the total mass.

4.7 *Camera*, capable of producing good quality, color photographs for "before" and" after" photographs.

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

5. Special Solutions

5.1 The special solution required for this test method consists of a 0.5 % isopropyl alcohol/water solution. This solution may be mixed and stored ahead of time. It will be used to replenish the solution as the test proceeds. Commercially available isopropyl alcohol as opposed to reagent grade is suitable.

6. Sampling

6.1 The number and variety of samples from a source will be dependent on the geological complexity of that source and will be left to the judgment of the individual (familiar with test specimen selection) doing the sampling; however, in no case shall the sample consist of less than five pieces per lithologic (rock) unit. Each piece will be of a size such that testing may proceed without further mechanical crushing; however, the pieces chosen shall be as large as the testing laboratory can handle but in no case shall the specimen be less than 125 mm (5 in.) on a side. In all cases, the sample will be representative of the various rock types found at the source.

7. Preparation of Test Specimens

7.1 Saw each test specimen in accordance with Practice D 5121. Cut each specimen (64 ± 6 mm (2.5± 0.25 in.) thick) normal to bedding or any potential planes of weakness which 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. Prepare a separate test specimen for each orientation of the various planes of weakness unless all such planes can be intersected with one orientation. Include planes of weakness 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 which would contain these planes of weakness.

NOTE 1—Test specimens may also be prepared by cutting a 64-mm (2.5-in.) thick slab from a 6-in. diameter diamond drill core such that any apparent zones of weakness are included.

NOTE 2—The best estimates of rock durability are those estimates that are based on the results of tests performed on the largest possible slabs of rock.

8. Procedure

8.1 Examine each slab both macroscopically and microscopically using a minimum of 20× magnification. Note the presence of bedding planes, microfractures, and other planes of weakness and their condition. Describe each slab in accordance with Practice D 5121.

8.2 Label each test specimen with a suitable marker. Photograph each test specimen using color film and in such a way that the test specimen covers most of the photograph (wet or partially wet test specimens usually show more detail). Include a scale in all photographs.

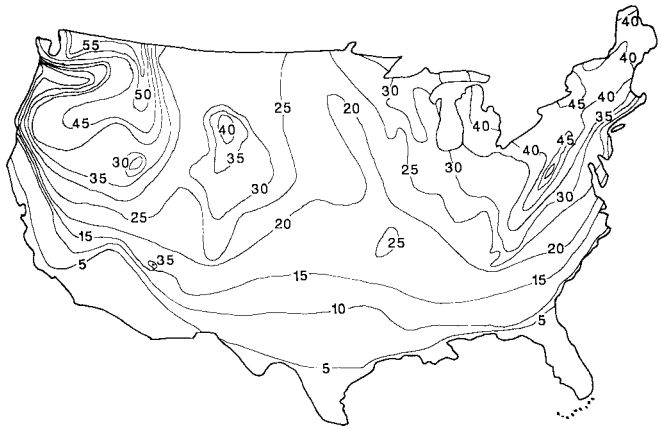

FIG. 1 Isoline Map of the Freeze-Thaw Severity Index

8.3 Dry each slab in an oven to a constant mass (±0.1 % of total mass) at 110 ± 5°C (230 ± 9°F) and record. The time interval between weighings shall be a minimum of 4 h.

8.4 Place each test specimen, sawed side down, in a container on a piece of scrap carpeting (synthetic fiber preferred). Add enough of the alcohol/water solution to the container such that the solution covers the test specimen and let stand for a minimum of 12 h.

8.5 Decant enough liquid such that the scrap carpeting is just immersed.

8.6 Place the container and test specimen in the freeze-thaw chamber or freezer and subject the specimen to a freezing temperature of − 18°C (0°F) for a minimum of 12 h (there is no upper limit for storage during freezing). Upon completing the required time for freezing, subject the container and specimen to complete thawing at a temperature of 32°C (90°F) for a minimum of 8 h but no more than 12 h. The required thawing may be accomplished either in the freeze-thaw chamber or in an oven; however, the test specimen must be left in its container during the entire thawing process. Replenish the alcohol/water solution to maintain coverage of the scrap carpeting.

8.7 Repeat the process of freezing and thawing for a total number of cycles equivalent to the index number rounded to the nearest five cycles of the geographic area of intended use as determined by Fig. 1.[3]

NOTE 3—Fig. 1 is an index map based on National Oceanic and Atmospheric Agency (NOAA) climatic data and was developed to determine the geographic distribution of the severity of freeze-thaw cycles. The figure not only takes into account the annual number of freeze-thaw cycles, but also the amount of moisture associated with each cycle and the temperature extremes of the freeze-thaw cycle. The index number, therefore, is not a prediction of the annual number of freeze-thaw cycles, but rather, is an indicator of the severity of the freeze-thaw process by geographic area. Since the freeze-thaw severity varies from one geographic location to another, it is not possible to provide a reliable indication of the serviceability of rock for erosion control for a given

[3] Lienhart, D. A., "The Geographic Distribution of Intensity and Frequency of Freeze-Thaw Cycles," *Bulletin of the Association of Engineering Geologists*, Vol XXV, No. 4, 1988, pp. 465–471.

locality unless the test procedure is customized for that locality. The freeze-thaw severity index allows for this type of customization.

8.8 Examine the test specimen every few days for any changes in the test specimen's condition and photograph as needed.

9. Calculation

9.1 *Quantitative Examination*—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. Qualitative Examination

10.1 Every five cycles, visually examine the slab 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, and other types of deterioration). Note and describe any changes to previously noted planes of weakness.

10.2 Take color photographs of each slab at the completion of testing. Provide close-ups of any unusual features. Include a scale with all photographs.

11. Report

11.1 Report the following information:

11.1.1 Identification number,

11.1.2 Sample source location,

11.1.3 Location of intended use,

11.1.4 Rock type,

11.1.5 The results of the quantitative examination required in 9.1 and reported to the nearest 0.1 %,

11.1.6 A written description of the qualitative examination and the findings of this exam, and

11.1.7 "Before" and "after" color photographs.

11.2 The following items are optional for the report:

11.2.1 Geological formation name, and

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

12. Precision and Bias

12.1 *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 test specimens that have uniform physical properties. Since test 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 test 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.

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

13. Keywords

13.1 armor stone; breakwater stone; climatic setting; erosion control; freeze-thaw; gabion-fill; laboratory testing; riprap; rock; rock material properties.