CRD-C 144-92

Standard Test Method for Resistance of Rock to Freezing and Thawing

1. Scope

1.1 This method covets a procedure for determining the resistance of rock to freezing and thawing. Information developed by use of this method may be applicable in the evaluation of stone for use as slope protection, as concrete aggregate, or for other purposes.

2. Referenced Documents

2.1 ASTM Standards

C 88 Teat Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate (CRD-C 137).

C 295 Guide for Petrographic Examination of Aggregates for Concrete (CRD-C 127).

D 5121-90 Practice for Preparation of Rock Slabs for Durability Testing (CRD-C 165).

3. Apparatus

3.1 **Saw.** A rock-cutting saw, preferably having a diamond blade, of suitable diameter for sawing specimens.

3.2 **Pans.** One or mom pans, each large enough to hold one sample slab, with sides at least 4 in. high made of stainless steel or other suitable noncorroding material.

Note: One freezer that has been used to perform this test will accommodate pans having inside dimensions of 16 by 19 by 4 in. (40.6 by 48.3 by 10.2 cm). If such pans are used, the maximum size of test slab will have an area of approximately 228 sq in. (1471 sq cm) on each sawed surface, assuming a slab 2 in. (5.1 cm) thick, supported 1/4 in. (6 mm) off the bottom, and covered to a depth of 3/4 in. (19 mm) with fluid.

3.3 **Specimens Supports.** Specimen supports to hold specimens above the bottom of the pan shall consist of lengths of noncorroding material approximately 1/4 in. (6 mm) in diameter.

3.4 **Freezer.** A freezer having a refrigeration capacity such that, with the maximum number of pans and specimens under test concurrently, the temperature as measured at the underside of a specimen shall be reduced to at least 5 F (-15 C) in not more than 16 hr. The number of tests that can be conducted concurrently will be limited by the capacity of the freezer. The same number of pans with water shall be in the freezer whenever tests are being made regardless of the number of specimens being tested to achieve a comparable refrigeration load.

3.5 **Thawing Oven or Room.** An oven or room that can be controlled to and maintain 100 ± 10°F (37.8 ± 5.6°C) having a capacity such that when loaded with frozen specimens they will be fully thawed in not more than 8 hr.

3.6 **Drying Oven.** A drying oven, as described in C 88 (CRD-C 137), of sufficient capacity for containing the samples in the pans.

3.7 **Balances or Scales.** Balances or scales having a capacity adequate for weighing the test material to an accuracy of at least 0.1 percent of the weight of the material being weighed.

3.8 **Photographic Equipment.** Equipment suitable for preparing photographs of the test samples before, during, and after test.

4. Test Specimens

4.1 Specimens for use in this test shall be sawed slabs 2 ± 1/4 in. (5.1 ± 0.6 cm) thick, prepared in accordance with the applicable provisions of ASTM D 5121 (CRD-C 165). Specimens shall be prepared to represent each of the principal varieties and conditions of rock present in the sample. Selection of material to use in preparation of specimens shall preferably be accomplished using the procedures described in C 295 (CRD-C 127).

4.2 Slabs should be sawed so as to include at their edges as much of the surface of the material received for testing as possible. Slabs from rock having visible bedding planes or other planar structures should usually be prepared by sawing normal to such structures. Preferably three specimens should be prepared to represent each principal variety or condition of rock Slabs should be as large as the material available for their preparation will allow, up to the capacity of the pans used for the test (see Sec. 3.2).

4.3 Slabs of different materials, the performance of which is to be compared, should preferably be of similar sizes.

4.4 Slabs prepared with sawing equipment and cutting oils shah be carefully cleaned of oil by use of suitable solvents. After having been sawed and cleaned, slabs should be inspected by the same procedures that were employed in selecting material from which the slabs were sawed, to confirm that the slabs adequately represent the types and conditions of material that were intended to be represented. In the event that a sawed slab is found to be nonrepresentative, additional material should be selected and a replacement slab prepared that is representative.

5. Solution

5.1 The test solution shall consist of tap water containing 0.5 percent ethyl alcohol by weight.

6. Procedure

6.1 After having been cleaned of cutting oil, each test specimen shall be examined and preferably photographed.

6.2 One test specimen shall be placed in a pan and covered by test solution so that the depth of the solution over the upper surface of the specimen is 3/4 ± 1/4 in. (19 ± 6 mm). The total volume of a test specimen placed in any one pan shall be such that the volume of rock does not exceed the volume of solution.

6.3 The pans containing the immersed specimens shall be stored at 73 ± 3°F (22.8 ± 1.7°C) for at least 48 hr. They shall then be placed in the freezer for 16 ± 1/2 hr. then removed and placed in a 100 ± 10°F (37.8 ± 5.6°C) room or oven for 8 ± 1/2 hr. When fully thawed, the specimens shall be inspected to observe the effects of the exposure. Any observed changes should be recorded, and if regarded as of sufficient significance, the specimens should be photographed.

6.4 Additional cycles of freezing and thawing, followed by inspection and photographing, as may be appropriate, shall be continued until a total of 20 cycles has been obtained. The solution shall be maintained at the specified depth by adding additional solution as needed. After every 5 cycles, the solution shall be carefully poured off through a 75-µm (No. 200) sieve so as not to displace any of the fragments of the samples, and any material caught on the sieve shall be returned to the pan. New solution shall then be added. When the l6-hr/8-hr cycle is interrupted, as for holidays and weekends, the five specimens shall remain in the frozen condition until the sequence is resumed.

6.5 The exposure of a specimen may be terminated prior to completion of 20 cycles if the largest remaining fragment of the slab amounts to less than half of the original specimen.

6.6 After the freezing-and-thawing cycling has been completed, the solution shall be carefully poured off using the procedure described in 6.4 above, and the contents of the pan, both that remaining in the pan and the material caught on the 75-µm (No. 200) sieve, shall be dried in the drying oven until the loss in weight between successive weighings at intervals of not less than 4 hr does not exceed 0.1 percent of the later weight. The dry mass shall be recorded. The dry mass of the pan and contents, less the mass of the pan, will be taken as the initial dry mass of the specimen. The contents of the pan should be photographed. Each fragment having a mass more than 25 percent of the initial dry mass of the specimen shall have its mass determined, and the sum of the masses of such fragments shall be recorded.

7. Calculation and Report

7.1 The report shall include the following:

7.1.1 Source of material.

7.1.2 Tabulation of data on each test specimen as follows:

(1) Designation of type and condition of rock represented,

(2) Initial dry mass (obtained as described in Sec. 6.6),

(3) Changes observed at each inspection, and

(4) Number and mass of all fragments remaining at conclusion of test that have a mass more than 25 percent of the initial dry mass, and mass of each of these expressed as percentage of initial dry mass of specimen.

7.1.3 Photographs as appropriate.

8. Results

8.1 Results of this and other tests on riprap will be reported to the using agency without any interpretation of results by the laboratory.

9. Interpretation

9.1 The results of this test should generally be employed as a basis for comparing the relative resistance of different types of material, from one or more sources, being considered for the same use. The results of this

test as performed on a single material will not ordinarily provide a basis for concluding that the material is "satisfactory" or "unsatisfactory" for a proposed use unless the specimens either are essentially completely unaffected or essentially completely disintegrated by the action of the test. The interpretation of the results will also depend on the nature of the material tested, the degree to which the specimens represent the material, and the intended use.

9.2 **Rock of Uniform Structure and Texture.** Rock of uniform structure and texture intended for use either as a source of protection stone or crushed stone for concrete aggregate will generally be affected by surface scaling, crumbling, flaking, or disaggregation. The total amount of material separated from the largest remaining fragment, i.e., the weight loss, will normally be a suitable basis for quantitative comparison of such materials.

9.3 **Rock with Planar Structures.** Rock with observable bedding planes, joints, seams, stringers, or other planar structures will generally be affected, if at all, by separation into discrete portions along such planes. Such separation may be of little importance when the rock is being considered as crushed stone aggregate to be confined in concrete. Such separation may be of much greater importance in rock proposed for use as protection stone. In the latter instance, however, it will be necessary to estimate the separation distance of the planes such as those at which test specimens have separated in the material from which the specimens were made. If these planes are so closely spaced that the stone, after separating thereon, is in sizes too small to serve its intended purpose, the rock may be unsuitable for such use. If these planes are more widely spaced, or only infrequently closely spaced, the rock may be suitable for such use, even though planes of potential separation are present.