

OHD L-58
METHOD OF TEST FOR LOSS OF
SOUNDNESS OF ROCK TO FREEZING AND THAWING

1. SCOPE

1.1 This method covers a procedure for determining the loss of soundness of rock due to freezing and thawing. Information developed by use of this method may be applicable in the evaluation of rip rap stone for use as slope protection, gabions, or for other purposes. This procedure was adapted from the United States Army Corps of Engineers test CRD-C 144-92¹.

2. Referenced Documents

- 2.1 United States Army Corps of Engineers
CRD-C 144-92 Standard Test Method for Resistance of Rock to Freezing and Thawing
- 2.2 ASTM Standards
D 5121 Practice for Preparation of Rock Slabs for Durability Testing

3. Apparatus

- 3.1 Saw: A rock-cutting saw, preferably having a diamond blade, of suitable diameter for sawing adequate specimens.
- 3.2 Pans: One or more pans, each large enough to hold one sample slab, with sides a minimum of 4 inches in height, and made of stainless steel or other non-corroding material.

NOTE: One freezer that has been used, to perform this test will accommodate pans having inside dimensions of 19 by 11 by 6 inches.

- 3.3 Specimen Supports: Specimen supports to hold specimens above the bottom of the pan shall consist of lengths of non-corroding material, and approximately ¼ inch in height or diameter.
- 3.4 Freezer: A freezer having a refrigeration capacity as such, 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 in not more than 16 hours. The number of the tests that can be conducted concurrently will be limited only by the capacity of the freezer.
- 3.5 Thawing Oven: An oven that can be controlled to maintain 100° ± 10°F and having a capacity which will be capable of fully thawing all specimens in not more than 7 hours when loaded with frozen specimens.

- 3.6 Drying Oven: A ventilated oven that can reach and maintain $230^{\circ} \pm 9^{\circ}\text{F}$.
- 3.7 Balance or Scales: Balances or scales having a capacity adequate for weighing the test material to an accuracy of at least 0.1% 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 into slabs $2 \pm \frac{1}{4}$ in. thick and prepared in accordance with the applicable provisions of Section 8 of ASTM D5121. Specimens shall be prepared to represent each of the principle varieties and conditions of any and all qualifying rock.
- 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 rocks having visible bedding planes or other planer structures should be prepared by sawing normal to such structures. 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.
- 4.3 Slabs of different materials, the performance of which are to be compared, should be of similar sizes.
- 4.4 Slabs prepared with sawing equipment and cutting oils shall 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. Confirm that the slabs adequately represent the types and conditions of materials that were intended to be represented. In the event that a sawed slab is found to be non-representative, additional material should be selected and a replacement slab prepared that is representative.

5. Solution

- 5.1 The test solution shall consist of water containing 0.5% ethyl alcohol by weight.

6. Procedure

- 6.1 After having been cleaned of cutting oil each test specimen shall be dried in an oven at $230^{\circ} \pm 9^{\circ}\text{F}$ to a constant mass. Record the initial dry mass (W_i) of the specimen.
- 6.2 Place one test specimen in a pan with a minimum of three supports under the specimen and then photograph the dry specimen.
- 6.3 The specimen shall then be covered by test solution so that the depth of the solution over the upper surface of the specimen is $\frac{3}{4} \pm \frac{1}{4}$ in.

- 6.4 The pan containing the immersed specimen should be stored at $70^{\circ} \pm 10^{\circ}\text{F}$ for a minimum of 48 hours. It shall then be placed in the freezer for 16 ± 1 hour. Then removed and placed in a $100^{\circ} \pm 10^{\circ}\text{F}$ oven for 8 ± 1 hour. When fully thawed, the specimen shall be inspected to observe the effects of the exposure. Any observed changes should be recorded, and if regarded as a sufficient significance, the specimen should be photographed.
- 6.5 Continue with additional cycles of freezing and thawing, followed by inspection and photographing when appropriate, until a total of 20 cycles has been obtained. The solution shall be maintained at the specified depth by adding additional solution as needed.
- 6.6 The exposure of a specimen may be terminated prior to completion of 20 cycles if the largest remaining fragment of the slab has a mass less than half of the initial dry mass of the specimen.
- 6.7 After the freezing and thawing cycles have been completed, the solution shall be carefully poured off through a 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. All the loose material and the remaining fragments of the specimen shall then be dried to a constant mass in the drying oven. The loose material and remaining fragments will be photographed in the pan after drying. Each fragment having a mass of more than 25% of the initial dry mass of the specimen shall have its mass determined, and the sum of the masses of such fragments (W_f) 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, W_i (obtained in Section 6.1)
 - (3) Significant changes observed during testing.
 - (4) Final dry mass of all fragments remaining at conclusion of test that have a mass more than 25% of the initial dry mass, W_f (obtained in Section 6.7)
 - (5) Calculate Loss of Soundness, LS, expressed as a percentage as follows:

$$LS = 100 - [(W_f / W_i) \times 100]$$

- (6) Record the number of cycles run at completion or early termination.
- (7) Attach photographs as appropriate.

¹ This test method was adapted from the United States Army Corps of Engineers test CRD-C 144-92 which was modified for the capabilities and requirements of the Oklahoma Department of Transportation's Materials and Research Division Laboratory. The following is a list of the major changes made:

1. The number of duplicate specimens was reduced from three to one for each principle variety of stone.
2. The time tolerance of the freezing and thawing cycles was modified from +/- ½ hour to +/- 1 hour.
3. The initial mass of each specimen is determined at the beginning of testing instead of after all freeze/thaw cycles have been completed.
4. The Loss of Soundness calculation was added to aid in the calculation of results to meet the Departments specification requirements.