

**INDIANA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS MANAGEMENT**

**SOUNDNESS OF AGGREGATES BY FREEZING AND
THAWING IN A BRINE SOLUTION
ITM No. 209-08T**

1.0 SCOPE.

- 1.1** This method of test covers the determination of the resistance of fine or coarse aggregates to disintegration by rapidly repeated cycles of freezing and thawing in the presence of a solution of water and sodium chloride. This test method provides information used in determining the soundness of fine or coarse aggregates subjected to weathering, particularly when adequate information is not available from service records of the behavior of the aggregates.
- 1.2** Coarse aggregate ledge, production, and point-of-use samples and all fine aggregate production and point-of-use samples are tested using this procedure.
- 1.3** The values stated in either acceptable English or SI metric units are to be regarded separately as standard, as appropriate for a specification with which this ITM is used. Within the text, SI metric units are shown in parenthesis. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other, without combining values in any way.
- 1.4** This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0 REFERENCES.

2.1 AASHTO Standards.

- M 92 Wire-Cloth Sieves for Testing Purposes
M 231 Weighing Devices Used in the Testing of Materials

3.0 TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101.

4.0 SIGNIFICANCE AND USE. This ITM is used to verify the minimum specification requirements for brine freeze-and-thaw soundness for aggregates.

5.0 APPARATUS.

- 5.1** Freezing-and-thawing apparatus, consisting of a suitable environmental chamber, refrigeration and heating equipment, and controls. The apparatus shall produce continuous, automatic, and reproducible cycles at a low temperature freezing range not higher than -15°F (-26°C) at any point in the environmental freezing chamber and a high temperature thawing range between 70°F (21°C) and 75°F (24°C) at any point in the environmental thaw water zone of the environmental chamber. In the event that the equipment does not operate automatically, provisions shall be made for either continual manual operation on a 24 h a day basis or for the storage of all specimens in a frozen condition when the equipment is not in operation. In the event that a capacity load of test specimens is not available, provisions shall be made to occupy empty spaces.
- 5.2** Sample containers, plastic, rubber, or other materials suitable for the procedure to be followed to insure water tightness
- 5.3** Sieves, in accordance with AASHTO M 92
- 5.4** Balance, in accordance with AASHTO M 231 for the class of general purpose balance required for the sample weight (mass) being tested
- 5.5** Oven, appropriate size capable of providing a free circulation of air through the oven, and maintaining a temperature of $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$)

6.0 REAGENTS. Sodium chloride solution with three percent of sodium chloride by weight

7.0 FREEZING-AND-THAWING CYCLE. The nominal freezing-and-thawing cycle shall consist of alternately lowering the sample temperature from between 70°F (21°C) and 75°F (24°C) to below -15°F (-26°C) and raising the temperature from below -15°F (-26°C) to between 70°F (21°C) and 75°F (24°C). At the end of the cooling period, the sample temperature shall be below -15°F (-26°C) and shall have been below this temperature for at least 15 minutes. At the end of the heating period the sample temperature shall be between 70°F (21°C) and 75°F (24°C) and shall have been maintained in this range at least 15 minutes.

8.0 SAMPLES.

- 8.1** Fine aggregate shall consist of material passing a 3/8 in. (9.5 mm) sieve. The sample shall yield not less than 100 g of each of the following sizes, which shall be available in amounts of 5 percent or more, expressed in terms of the following sieves:

Passing Sieve	Retained on Sieve
No. 30 (600 μ m)	No. 50 (300 μ m)
No. 16 (1.18 mm)	No. 30 (600 μ m)
No. 8 (2.36 mm)	No. 16 (1.18 mm)
No. 4 (4.75 mm)	No. 8 (2.36 mm)
3/8 in. (9.5 mm)	No. 4 (4.75 mm)

Table 1

- 8.2** Coarse aggregate shall consist of material retained on the No. 4 (4.75 mm) sieve and all sieves above the No. 4 sieve. The sample shall yield not less than the following amounts of the different sieve sizes, which shall be available in amounts of 5 percent or more.

Size	
No. 4 - 3/8 in. (4.75 to 9.5 mm)	300 g
3/8 - 3/4 in. (9.5 to 19.0 mm) consisting of:	1000 g
3/8 - 1/2 in. (9.5 to 12.5 mm) material	33 percent
1/2 - 3/4 in. (12.5 to 19.0 mm) material	67 percent
3/4 - 1 1/2 in. (19.0 to 37.5 mm) consisting of:	1500 g
3/4 - 1 in. (19.0 to 25.0 mm) material	33 percent
1 - 1/2 in. (25.0 to 37.5 mm) material	67 percent
1 1/2 - 2 1/2 in. (37.5 to 63 mm) consisting of:	3000 g
1 1/2 - 2 in. (37.5 to 50 mm) material	50 percent
2 - 2 1/2 in. (50 to 63 mm) material	50 percent
Larger sizes by 1 in. (25.0 mm) spread in sieve size each fraction	3000 g

Table 2

- 8.3** If the sample contains less than 5 percent of the sizes specified in 8.1 or 8.2, that size shall not be tested. For the purpose of calculating the test results, the sample shall be considered to have the same loss in testing as the average of the next smaller and the next larger size. If one of these sizes is absent, the sample shall be considered to have the same loss as the next larger or next smaller size, whichever is present. When the 3/8 to 3/4 in. (9.5 to 19.0 mm), 3/4 to 1 1/2 in. (19.0 to 37.5 mm) or 1 1/2 to 2 1/2 in. (37.5 to 63 mm) test samples specified in 8.2 cannot be prepared due to absence of one of the two sizes of aggregate shown for each, the size available shall be used to prepare the sample tested.
- 8.4** When an aggregate to be tested contains appreciable amounts of both fine and coarse material having a grading with more than 10 percent coarser than the 3/8 in. (9.5 mm) sieve and more than 10 percent finer than the No. 4 (4.75 mm) sieve, separate samples of the minus No. 4 (4.75 mm) fraction and the plus No. 4 (4.75 mm) fraction shall be tested in accordance with the procedures for fine aggregate and coarse aggregate, respectively. The results shall be reported separately for the fine aggregate fraction and the coarse aggregate fraction, with the percentages of the coarse and fine size fractions in the initial grading stated.

9.0 PREPARATION OF TEST SPECIMEN.

- 9.1** The sample of fine aggregate shall be washed on a No. 100 (150 μ m) sieve, dried to constant weight (mass) at a temperature of $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$), and separated into the different sizes by sieving, as follows.
- 9.2** A rough separation of the graded sample shall be made by means of a nest of the sieves specified in 8.1. From the fractions obtained in this manner, samples of sufficient size shall be selected to yield 100 g after sieving (In general, one 100 g sample will be sufficient). Fine aggregate sticking in the meshes of the sieves shall not be used in preparing the samples. Samples consisting of 100 g shall be weighed from each of the separated fractions after final sieving and placed in separate containers for the test.
- 9.3** The sample of coarse aggregate shall be thoroughly washed and dried to constant weight (mass) at a temperature of $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$) and shall be separated into the different sizes shown in 8.2 by sieving. The proper weight (mass) of sample for each fraction shall be determined and placed in separate containers for the test. For aggregate coarser than the 3/4 in. (19.0 mm) sieve, the number of particles shall be counted.
- 9.4** **Ledge Rock.** For testing ledge rock, the sample shall be prepared by breaking the material into fragments reasonably uniform in size and shape and having a weight (mass) of approximately 100 g each. The test sample shall have a weight (mass) of 5000 g + 2 percent. The sample shall be thoroughly washed and dried prior to the test as described in 9.3.

10.0 PROCEDURE.

- 10.1** Each of the fractions specified in 8.1 and 8.2 shall be completely immersed in separate leak proof sample containers containing a 3 percent solution of sodium chloride (NaCl) for a period of 24 h prior to the start of the freezing cycle and shall be frozen and thawed in this completely immersed condition.
- 10.2** Alternate freezing and thawing shall be repeated until 25 cycles are obtained.
- 10.3** After the completion of the final cycle, each sample shall be dried to constant weight (mass) at $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$), weighed and, except in the case of ledge rock, sieved over the sieve indicated for the appropriate size of aggregate in Table 3. The material retained on the sieve shall be weighed and the weight (mass) recorded.
- 10.3.1** Samples of fine aggregate shall be sieved over the original retaining sieve to determine the loss. The material retained on each sieve shall be weighed and the weight (mass) recorded.
- 10.3.2** For ledge rock, the loss in weight (mass) shall be determined by subtracting from the original weight (mass) of the sample the final weight (mass) of all fragments which have not broken into three or more pieces.

Size of Aggregate	Sieve Used to Determine Loss
2 1/2 to 1 1/2 in. (63 to 37.5 mm)	1 1/4 in. (31.5 mm)
1 1/2 to 3/4 in. (37.5 to 19.0 mm)	5/8 in. (16.0 mm)
3/4 to 3/8 in. (19.0 to 9.5 mm)	5/16 in. (3.0 mm)

Table 3

11.0 REPORT.

- 11.1** The report shall include the following data:
- 11.1.1** Weight (Mass) of each fraction of each sample before testing.
- 11.1.2** Except in the case of ledge rock, the actual loss of each fraction of the sample expressed as a percentage of the original weight (mass) of the fraction.
- 11.1.3** Weighted average calculated from the percentage of loss for each fraction, based on the average grading of the material from that portion of the material of which the sample is representative. In these calculations, sizes finer than the No. 50 (300 μm) sieve shall be assumed to have 0 percent loss.

- 11.1.4** For an aggregate containing appreciable amounts of both fine and coarse material tested as two separate samples as required in 8.4, the weighted average losses shall be calculated separately for the minus No. 4 (4.75 mm) and plus No. 4 (4.75 mm) fractions based on recomputed gradings considering the fine fraction as 100 percent and the coarse fraction as 100 percent. The results shall be reported separately with the percentage of the minus No. 4 (4.75 mm) and plus No. 4 (4.75 mm) material in the initial grading stated.
- 11.1.5** For ledge rock, the loss as determined in 10.2.2 shall be reported as a percentage of the original weight (mass).
- 11.1.6** If considered beneficial or when requested, the type of failure of the discrete particles in the sample shall be reported.