

KTMR-21 SOUNDNESS OF AGGREGATES BY FREEZING AND THAWING

a. SCOPE

This test method covers the procedures for the determination of aggregate resistance to disintegration by freezing and thawing.

b. REFERENCED DOCUMENTS

- b.1.** AASHTO M 92; Wire-Cloth Sieves for Testing Purposes
- b.2.** AASHTO M 231; Balances Used in the Testing of Materials
- b.3.** AASHTO T 103; Soundness of Aggregates by Freezing and Thawing

c. APPARATUS

- c.1.** The freezing tank shall be capable of maintaining a heat conducting fluid bath, e.g., propylene glycol, at -20 to 0°F (-29 to -18°C).
- c.2.** The sample containers shall be of non-corroding metal, cylindrical in shape, and approximately 4.5 inches (114 mm) in diameter by 22 inches (559 mm) in length.
 - c.2.a.** The rack shall be capable of containing eight sample containers at one time.
- c.3.** The sieves shall conform to the requirements of AASHTO M 92.
- c.4.** The balance shall be of sufficient capacity, be readable to 0.1% of the sample mass, or better, and conform to the requirements of AASHTO M 231.
- c.5.** The drying oven shall provide a free circulation of air through the oven and shall be capable of maintaining a temperature of 230 ± 9°F (110 ± 5°C).
- c.6.** A thawing tank shall be of suitable size to hold the samples, containers, and racks, allowing total submersion of the samples. The water shall be maintained at 70-80°F (21-27°C) during the thaw period.

d. SAMPLE PREPARATION

- d.1.** Official Quality Aggregate (Soundness)
 - d.1.a.** Crushed Stone
 - d.1.a.1.** Preliminary preparation shall include the removal of all material retained on the 1 in (25.0 mm) sieve and passing the No. 8 (2.36 mm) sieve, mud or clay lumps, and sticks. Shale or shale-like materials, coal, asphalt coated pieces, rotten stone, soft or friable particles and other foreign

material shall **not** be removed prior to testing. The material shall then be soaked for a period of 24 ± 4 hours.

d.1.a.2. Final preparation shall include bringing the saturated sample to a surface dry condition at room temperature; screening over 1 in, 3/4 in, 3/8 in, No. 4, and No. 8 (25.0, 19.0, 9.5, 4.75, 2.36 mm) sieves; selecting a grading from **Table 1**; and preparing a 5,000 gram test sample meeting the selected grading.

TABLE 1

Grading Designation ^a	Mass Retained (grams) Individual Square Mesh Sieves				
	1 in (25.0 mm)	3/4 in (19.0 mm)	3/8 in (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)
I	0	2250	1750	500	500
II	...	0	3500	1000	500
III	0	4000	1000

Note a: The largest particle appearing in the 5000g test sample shall be the largest particle that represents 10% or more of the “as received” sample.

d.1.b. Sand and Gravel

d.1.b.1. Preliminary preparation shall include the removal of all material retained on the 1 in (25.0 mm) sieve and passing the No. 8 (2.36 mm) sieve, mud or clay lumps, and sticks. Shale or shale-like materials, coal, asphalt coated pieces, rotten stone, soft or friable particles and other foreign material shall **not** be removed prior to testing. The material shall then be soaked for a period of 24 ± 4 hours.

d.1.b.2. Final preparation shall include bringing the saturated sample to a surface dry condition at room temperature; performing a sieve analysis to determine the gradation of the minus 1 in (25.0 mm) to plus No. 8 (2.36 mm) portion of the "as received" material; and preparing a 5,000 g test sample of the saturated surface dry material, matching the determined gradation to within ± 5%.

d.1.c. Lightweight Aggregate (expanded slate, shale, or clay)

d.1.c.1. Preliminary preparation shall include the removal of all material retained on the 1 in (25.0 mm) sieve and passing the No. 8 (2.36 mm) sieve, mud or clay lumps, and sticks. Coal, asphalt coated pieces, rotten stone, soft or friable particles and other foreign material shall **not** be removed prior to testing. The material shall then be oven dried to a constant mass at a temperature of 230 ± 9°F (110 ± 5°C).

d.1.c.2. Final preparation shall consist of screening the oven dried material over 1 in, 3/4 in, 1/2 in, 3/8 in, No. 4, and No. 8 (25.0, 19.0, 12.5, 9.5, 4.75, 2.36 mm) sieves, selecting a grading from Table 1, and preparing a 5,000 gram test sample meeting the selected grading.

e. PROCEDURE

- e.1.** The prepared sample shall be placed in an open top container, covered with a No. 16 (1.18 mm) mesh cloth and submerged in tap water maintained at a temperature from 70-80°F (21-27°C).
 - e.1.a.** For Crushed Stone and Sand and Gravel Aggregate, soak for 1 - 2 hours.
 - e.1.b.** For Lightweight Aggregates, soak for a period of 24 ± 4 hours.
- e.2.** Remove sample from the water, drain, and while in a saturated and drained condition place in the freezing equipment that maintains a temperature between -20 and 0°F (-29 and -18°C). The sample remains in the freezing equipment until frozen, but in no case shall this period of time be less than two hours.
 - e.2.a.** Remove sample from the freezer and place in a tap water bath maintained at 70-80°F (21-27°C) for a period of 40 minutes. During any interruptions (nights, weekends, and holidays) the samples remain in the water bath.
- e.3.** One freezing period and one thawing period shall be considered one cycle. After the sample has been subjected to 25 cycles of freezing and thawing, determine its final mass as described below.
 - e.3.a.** For Crushed Stone and Sand and Gravel Aggregate, dry samples to a saturated surface dry condition at room temperature. Screen samples over the 1 in, 3/4 in, 3/8 in, No. 4, and No. 8 (25.0, 19.0, 9.5, 4.75, and 2.36 mm) sieves and record the cumulative mass retained on each sieve.
 - e.3.b.** For Lightweight Aggregate, oven dry samples to a constant mass at a temperature of 230 ± 9°F (110 ± 5°C). Screen sample over the 1 in, 3/4 in, 3/8 in, No. 4, and No. 8 (25.0, 19.0, 9.5, 4.75, and 2.36 mm) sieves and record the cumulative mass retained on each sieve.

f. CALCULATIONS

- f.1.** Calculate the cumulative percent retained on each sieve based on the total sample mass at the beginning of the test.
- f.2.**
$$SOUNDNESS = \frac{A}{B}$$

Where: SOUNDNESS = freeze-thaw loss-ratio

A = the sum of the cumulative retained percentages of the sample at the end of the test

B = the sum of the cumulative retained percentages of the sample at the beginning of the test