Kentucky Method 64-610-0~~82~~
Revised ~~12/13/01~~03/27/08
Supersedes KM 64-610-0~~21~~
Dated ~~2/16/01~~12/13/01

# SOUNDNESS OF AGGREGATE BY USE OF SODIUM SULFATE

1. SCOPE -

1.1. This method covers the procedure to be followed in testing aggregates to determine their resistance to disintegration by a saturated solution of sodium sulfate.

1.2. Follows AASHTO T 104 with minor modifications.

2. APPARATUS & MATERIALS -

2.1. Sieves used shall conform to AASHTO M 92.

2.2. Containers

2.2.1. Containers suitable for holding sodium sulfate solution.

2.2.2. Containers for samples - 8 in. diameter sieves for each separate size fraction of aggregate. Coarse Aggregate Container – No. 8 sieve, Fine Aggregate Container – No. 60 sieve. Used out-of-tolerance sieves according to AASHTO M 92, in acceptable condition, may be used as containers.

2.3. Balance - A balance or scale having a capacity of not less than 5000 grams and sensitive to 0.1 gram.

2.4. Oven - An oven capable of maintaining a uniform temperature of 230 ± 9 $^{o}$F.

2.5. Mechanical Shaker.

2.6. Hydrometer - A hydrometer with a range of at least 1.154 to 1.171 ± 0.001.

2.7. Thermometer - A thermometer having a range of at least 60.0 - 90.0 $^{o}$F.

2.8. Sodium Sulfate - Anhydrous, reagent grade.

2.9. Temperature Regulation - Suitable means for regulating the temperature of the sodium sulfate solution shall be provided.

2.9.1. Continuous Temperature Recorder - A device to continuously record solution temperature to ±0.5 °F

3. SAMPLE PREPARATION -

3.1. Samples shall be obtained in accordance with AASHTO T 2.

3.2. In crushing ledge rock samples, adjust the crusher so that there will be a small amount of 1 ½ inch size material available to waste. This will ensure the sample is uniformly graded.

3.3. Wash fine aggregate, size 10, or size 11 samples over a No. 50 sieve and dry to a constant mass. Separate the test sample into different size fractions, as indicated in Table 1, by sieving to refusal. Any of the sizes specified in Table 1 which are present in amounts of less than 5% by mass of the sample gradation shall not be tested. Do not use aggregate sticking in the meshes of the sieves.

3.4. Coarse aggregate - The size designation will determine the size fractions to be tested as indicated in Table 4. Separate the test sample into the different size fractions as indicated in Table 4, by sieving to refusal. Any of the sizes specified in Table 4 which are present in amounts of less than the test fraction masses listed in Table 1 shall not be tested. Substitution of another size fraction will not be permitted. Do not use aggregate sticking in the meshes of the sieves. Wash each coarse fraction over a No. 4 sieve and then dry to a constant mass.

3.5. Split, weigh, and record the specified amount for each size fraction to ±1% of the mass indicated in Table 1 and place the aggregate in separate containers for the test.

3.6 Record masses of different size fractions to the nearest 0.1 gram.

Note: When an aggregate contains appreciable amounts of both fine and coarse aggregate, the sample may be separated on the No. 4 and tested in accordance with procedures for fine and coarse aggregate. Report the results separately for each fraction.

TABLE 1

| COARSE AGGREGATE | | FINE AGGREGATE, #10, or #11 | |
|---|---|---|---|
| Sieve Size | Test Fraction Mass, g | Sieve Size | Test Fraction Mass, g |
| -2 ½ in. + 2 in. | 2000 | -3/8 in. + No. 4 | 100 |
| -2 in. + 1 ½ in. | 2000 | -No. 4 + No. 8 | 100 |
| -1 ½ in. + 1 in. | 1500 | -No. 8 + No. 16 | 100 |
| -1 in. + 3/4 in. | 1000 | -No. 16 + No. 30 | 100 |
| -3/4 in. + ½ in. | 750 | -No. 30 + No. 50 | 100 |
| -½ in. + 3/8 in. | 500 | | |
| -3/8 in. + No. 4 | 500 | | |

4. PROCEDURE –

4.1. The saturated solution of sodium sulfate shall be prepared by dissolving the salt in water at a temperature of 77°F minimum. Sufficient salt shall be added to insure not only saturation but also the presence of excess crystals when the solution is ready to use in the test. The mixture shall be thoroughly stirred during the addition of the salt and the solution shall be stirred at frequent intervals until used. Prior to use, bring the solution to a temperature of 68.5 to 71.5°F, stir the solution to break up salt cake, and check the specific gravity. When used, the solution shall have a specific gravity of not less than 1.154 nor more than 1.171.

4.2. Immerse the samples in the prepared solution for at least 16 hours and not more than 18 hours at a depth of at least ½ in. below the surface of the solution. The temperature of the solution shall be maintained at 68.5 to 71.5°F, during the entire immersion period.

4.3. After the immersion period, remove the containers from the solution and let drain for approximately 15 minutes. Then place the containers in the oven for at least 5 hours at a temperature of 230° ± 9 °F or for such additional time as required to ensure thorough drying.

4.4. After drying, cool the sample to 68 to 77°F, then re-immerse into the solution as described in 4.2.

4.5. Repeat the process of alternate immersion and drying for 5 cycles. The test shall be performed continuously without interruption for the 5 complete cycles. However, if the test must be interrupted, leave the samples in the oven at -230° ± 9 °F until test can be resumed.

4.6. After completion of the fifth cycle and after the sample has cooled, rinse the sample in hot running tap water to remove any traces of salt. Rinse by circulating hot water, through the samples in their containers, by introducing hot water near the bottom and allowing the water to pass through the samples and overflow. Rinsing shall be complete when a sample of the rinse water remains clear when checked with a 5 percent barium chloride solution (5g $BaC1_2$ to 100 ml $H_2O$) Further rinsing is required if the rinse water sample becomes cloudy upon addition of the barium chloride solution. Dry each size fraction to a constant mass at a temperature of 230 ° ± 9°F.

Note: Some sources of water may naturally display cloudiness upon addition of the barium chloride solution. In these instances, the wash water shall be judged free of sodium sulfate when the degree of cloudiness is no greater than when testing the source water alone.

4.7. After drying, sieve over the size sieve specified in Table 2 by hand sieving with agitation sufficient only to assure all undersize material passes the designated sieve. No extra manipulation shall be employed to break up particles or cause them to pass the sieves. Weigh the particles retained on each sieve to the nearest 0.1 gram and record the mass.

TABLE 2

| Size Fraction | Sieve Used to Determine Loss |
|---|---|
| -2 ½ in. + 1 ½ in. | 1 1/4 in. |
| -1 ½ in. + 3/4 in. | 5/8 in. |
| -3/4 in. + 3/8 in. | 5/16 in. |
| -3/8 in. + No. 4 | No. 5 |
| Fine Aggregates | Same sieves used in set up |

5. CALCULATIONS -

5.1. Coarse Aggregate (Original Sample)

5.1.1. Add the initial masses of the different size fractions as recorded in 3.6.

5.1.2. Add the masses of the different size fractions after testing as determined in 4.7.

5.1.3. Subtract the sum obtained in 5.1.2 from the sum obtained in 5.1.1. To obtain the percent loss, divide this difference by the sum in 5.1.1 and multiply by 100.

5.2. Coarse Aggregate Verification Samples when required, (see 6.2.2) and Fine Aggregate Samples are to be calculated by weighted average based on the grading of the sample as received (see Table 3 for example).

~~5.2.1. For fine aggregate, assume sizes finer than the No. 50 sieve have 0 percent Loss and sizes coarser than the 3/8 in. sieve to have the same loss as the next smaller size.~~

5.2.1. For fine aggregates (with less than 10 % coarser than the 3/8 in. sieve), assume sizes finer than the No. 50 sieve to have 0 % loss and sizes coarser than the 3/8 in. sieve to have the same loss as the next smaller size for which test data are available.

5.2.2. For coarse aggregate, assume sizes finer than No. 4 sieve to have the same loss as the next larger tested size and sizes coarser than those required in Table 4 for the size designation to have the same loss as the next smaller tested size.

5.2.3. For an aggregate containing appreciable amounts of both fine and coarse material (base aggregates, etc.) the verification shall be tested as two separate samples, fine and coarse. Compute the weighted average separately for the minus No. 4 and plus No. 4 fractions. Report the results separately with the plus No. 4 compared to the original failure.

5.2.4. If any fraction in Table 4 contains less than 5 percent of the sample assume that fraction to have the same loss as the next larger or next smaller size, whichever is present.

5.2.5. For large rock or ledge rock which requires crushing the weighted average shall be the arithmetic mean of the loss on the fractions tested.

5.3. In addition a qualitative examination may be performed, in which individual particles are examined for splitting, crumbling, cracking, flaking, etc. This

information, in conjunction with the quantitative analysis, will be used to determine aggregate soundness.

6. REPORT:

6.1. Report the percent loss determined in Section 5 to the nearest whole percent.

6.2. Reporting of results when failures are encountered –

6.2.1. Fine Aggregate: When test results are obtained that do not fall within specification limits, the failure must be verified. Additional soundness testing shall be performed on the unused field sample. The verification soundness shall be tested in the same manner as the original test sample. The original failure and the verification will be calculated by weighted average based on the grading of the field sample. When the original and the verification test are reasonably close, they are to be averaged to obtain a single reportable test result. When the two tests vary considerably, further investigation will be necessary. Investigation may include checking test equipment, reviewing practices of reducing field sample to test sample, checking calculations and/or obtaining an additional field sample for testing.

6.2.2. Coarse Aggregate: When test results are obtained that do not fall within specification limits, the failure must be verified. A gradation and verification soundness shall be performed on the unused field sample. The verification soundness shall be tested in the same manner as the original test sample, except the verification will be set up based on the grading of the field sample (all screens with 5% or more retained will be used for soundness) and calculated by weighted average. The verification soundness will also be re-calculated as outlined in 5.1 for the same screen(s) as used in the original sample setup. If this re-calculated result varies considerably from the original test sample result, further investigation will be necessary. Investigation may include checking test equipment, reviewing practices of reducing field sample to test sample, checking calculations and/or obtaining an additional field sample to test. If the aforementioned comparison is satisfactory, the weighted average result will be the reported test result.

APPROVED _____
DIRECTOR
DIVISION OF MATERIALS

DATE 03/27/08

~~APPROVED _____~~
~~Director~~
~~Division of Materials~~

~~DATE 1/16/02~~

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TABLE 3

| SIEVE SIZE | SAMPLE GRADATION PERCENT RETAINED | MASS OF TEST FRACTIONS BEFORE TEST | PERCENT WT. LOSS AFTER TEST | WEIGHTED PERCENTAGE LOSS |
|---|---|---|---|---|
| 1 ½" | 0 | | | |
| 1" | 3 | | | |
| ¾" | 22 | 1000 | 3.2 | 0.8* |
| ½" | 45 | 750 | 2.7 | 1.2 |
| 3/8" | 20 | 500 | 5.8 | 1.2 |
| No. 4 | 7 | 500 | 6.4 | 0.6** |
| No. 8 | 2 | | | |
| PAN | 1 | | | |
| TOTAL | | | | 3.8 = 4 % loss |

Weighted percentage loss is calculated by multiplying the percent retained from the sample gradation by the corresponding screen's percent of weight loss after test. The individual screen's percentage losses are then combined to report total soundness loss.

*Since the 1" sieve had less than 5 % retained from the sample gradation, it is accounted for by adding its retained percentage (3 %) to the retained percentage of the ¾" (22 %). The combined percentages (25 %) are then multiplied by the percentage of weight loss after test for the ¾" sieve (.032). This will derive the weighted percentage loss of 0.8 for the ¾" sieve.

**Both the No. 8 sieve and the pan have less than 5 % retained and are accounted for by adding their retained percentages to the retained percentage of the No. 4 sieve and multiplying this total

(10 %) by the percentage of weight loss after test for the No. 4 sieve (.064).

TABLE 4
SIEVE FRACTIONS TO BE TESTED BY
COARSE AGGREGATE SIZE DESIGNATION

| Size Designation | -2 1/2 in. + 2 in. | -2 in. + 1 ½ in. | -1 1/2 in. + 1 in. | -1 in. + 3/4 in. | -3/4 in. + ½ in. | -½ in. + 3/8 in. | -3/8 in. + No. 4 |
|---|---|---|---|---|---|---|---|
| 1 | X | X | | | | | |
| 2 | X | X | | | | | |
| 23 | X | X | X | | | | |
| 3 | | X | X | | | | |
| 357 | | X | X | X | X | | |
| 4 | | | X | X | | | |
| 467 | | | X | X | X | X | |
| 5 | | | | X | X | | |
| 57 | | | | X | X | X | X |
| 610 | | | | X | X | X | X |
| 67 | | | | | X | X | X |
| 68 | | | | | X | X | X |
| 710 | | | | | X | X | X |
| 78 | | | | | | X | X |
| 8 | | | | | | | X |
| 9-M | | | | | | | X |
| DGA | | | | | X | X | X |
| Gravel Base | | | | X | X | X | X |
| CSB | | | | X | X | X | X |
| Ledge Rock | | | X | X | X | X | |
| 10 | Tested as fine aggregate | | | | | | |
| 11 | Tested as fine aggregate | | | | | | |

## TABLE 4
## SIEVE FRACTIONS TO BE TESTED BY COARSE AGGREGATE SIZE DESIGNATION

| Size Designation | 2 1/2 in. + 2 in. | 2 in. + 1 ½ in. | 1 1/2 in. + 1 in. | 1 in. + 3/4 in. | 3/4 in. + ½ in. | ½ in. + 3/8 in. | 3/8 in. + No. 4 |
|---|---|---|---|---|---|---|---|
| 1 | X | X | | | | | |
| 2 | X | X | | | | | |
| 23 | X | X | X | | | | |
| 3 | | X | X | | | | |
| 357 | | X | X | X | X | | |
| 4 | | | X | X | | | |
| 467 | | | X | X | X | X | |
| 5 | | | | X | X | | |
| 57 | | | | X | X | X | X |
| 610 | | | | X | X | X | X |
| 67 | | | | | X | X | X |
| 68 | | | | | X | X | X |
| 710 | | | | | X | X | X |
| 78 | | | | | | X | X |
| 8 | | | | | | | X |
| 9-M | | | | | | | X |
| DGA | | | | | X | X | X |
| Gravel Base | | | | X | X | X | X |
| CSB | | | | X | X | X | X |
| Ledge Rock | | | X | X | X | X | |
| 10 | Tested as fine aggregate | | | KM 64-610-02 | | | |
| 11 | Tested as fine aggregate | | | Page 8 | | | |