METHODS OF SAMPLING AND TESTING
MT 205-04
METHOD OF TEST FOR SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATES
(Modified AASHTO T 85)

1 Scope:

1.1 This method covers the determination of specific gravity and absorption of coarse aggregate. The specific gravity may be expressed as bulk specific gravity, bulk specific gravity (saturated-surface-dry (SSD)), or apparent specific gravity. The bulk specific gravity (SSD) and absorption are based on aggregate after 15 h soaking in water. This method is not intended to be used with lightweight aggregates.

1.2 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Referenced Documents:

2.1 ***AASHTO:***

M 43 Sizes of Aggregate for Road and Bridge Construction
M 92 Wire Cloth Sieves for Testing Purposes
R 1 Metric Practice

MT Materials Manual:

MT 201 Sampling Roadway Materials
MT 202 Sieve Analysis of Fine and Coarse Aggregates
MT 204 Specific Gravity and Absorption of Fine Aggregate
MT 206 Terms Relating to Density and Specific Gravity of Solids, Liquids and Gases
MT 607 Reducing Field Samples of Aggregate to Testing Size

[1]This method agrees with ASTM C 127-88 except for differences in soaking time, accuracy of weighing, balance requirements, and water tank requirements.

2.2 ***ASTM Standards:***

C 125 Terminology Relating to Concrete and Concrete Aggregates
C 670 Practice of Preparing Precision Statements for Test Methods for Construction Materials

3 Summary of Method:

3.1 A sample of aggregate is immersed in water for approximately 15 h to essentially fill the pores. It is then removed from the water, the water dried from the surface of the particles, and weighed. Subsequently the sample is weighed while submerged in water. Finally the sample is oven-dried and weighed a third time. Using the weights thus obtained and formulas in the method, it is possible to calculate three types of specific gravity and absorption.

4 Terminology:

4.1 *Absorption* **-** The increase in the weight of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry weight. The aggregate is considered "dry" when it has been maintained at a temperature of 110 ± 5°C for sufficient time to remove all uncombined water.

4 Terminology: (continued)

4.2 *Specific Gravity* - The ratio of the mass (or weight in air) of a unit volume of a material to the mass of the same volume of water at stated temperatures. Values are dimensionless.

4.3 *Apparent Specific Gravity* - The ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

4.4 *Bulk Specific Gravity* - The ratio of the weight in air of a unit volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

4.5 *Bulk Specific Gravity (SSD)* - The ratio of the weight in air of a unit volume of aggregate, including the weight of water within the voids filled to the extent achieved by submerging in water for approximately 15 h (but not including the voids between particles) at a stated temperature, compared to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

Note 1 - The terminology for specific gravity is based on terms in MT-206 and that for absorption is based on that term in ASTM C 125.

5 Apparatus:

5.1 *Balance* - A balance having a capacity of 1 kilogram or more and sensitive to 0.1 gram or less.

5.2 *Sample Container* - A wire basket of 3.35 mm (No. 6) or finer mesh, or a bucket of approximately equal breadth and height, with a capacity of 4 to 7 L for 37.5-mm (1½-in.) nominal maximum size aggregate or smaller, and a larger container as needed for testing larger maximum size aggregate. The container shall be constructed so as to prevent trapping air when the container is submerged.

5.3 *Water Tank* - A watertight tank into which the sample and container are placed for complete immersion while suspended below the balance, equipped with an overflow outlet for maintaining a constant water level.

5.4 *Sieves* - A 4.75 mm (No. 4) sieve or other sizes as needed (see Sections 6.2, 6.3, and 6.4), conforming to M 92.

5.5 *Suspended Apparatus* - Wire suspending the container shall be of the smallest practical size to minimize any possible effects of a variable immersed length.

6 Sampling:

6.1 Sample the aggregate in accordance with MT-201.

6.2 Thoroughly mix the sample of aggregate and reduce it to the approximate quantity needed using the applicable procedures in MT 607. Reject all material passing a 4.75 mm (No. 4) sieve by dry sieving and thoroughly washing to remove dust or other coatings from the surface. If the coarse aggregate contains a substantial quantity of material finer than the 4.75 mm sieve (such as for Size No. 8 and 9 aggregates in M 43), use the 2.36 mm (No. 8) sieve in place of the 4.75 mm sieve. Alternatively, separate the material finer than the 4.75 mm sieve and test the finer material according to MT-204.

6 Sampling: (continued)

6.3 The minimum weight of test sample to be used is given below. In many instances it may be desirable to test a coarse aggregate in several separate size fractions; and if the sample contains more than 15% retained on the 37.5 mm (1½-in.) sieve, test the material larger than 37.5 mm in one or more size fractions separately from the smaller size fractions. When an aggregate is tested in separate size fractions, the minimum weight of test sample for each fraction shall be the difference between the weights prescribed for the maximum and minimum sizes of the fraction.

Nominal Maximum Size, mm (in.)	Minimum Weight of Test Sample, kg (lb.)
12.5 (½) or less	2 (4.4)
19.0 (¼)	3 (6.6)
25.0 (1)	4 (8.8)
37.5 (1½)	5 (11)
50 (2)	8 (18)
63 (2½)	12 (26)
75 (3)	18 (40)
90 (3½)	25 (55)
100 (4)	40 (88)
112 (4½)	50 (110)
125 (5)	75 (165)
150 (6)	125 (276)

6.4 If the sample is tested in two or more size fractions, determine the grading of the sample in accordance with MT-202, including the sieves used for separating the size fractions for the determinations in this method. In calculating the percentage of material in each size fraction, ignore the quantity of material finer than the 4.75 mm (No. 4) sieve or 2.36 mm (No. 8) sieve when that sieve is used in accordance with Section 6.2.

7 Procedure:

7.1 Dry the test sample to constant weight at a temperature of 110 ± 5°C (230 ± 9°F), cool in air at room temperature for 1 to 3 h for test samples of 37.5 mm (1½-in.) nominal maximum size, or longer for larger sizes until the aggregate has cooled to a temperature that is comfortable to handle (approximately 50°C). Subsequently immerse the aggregate in water at room temperature for a period of 15 to 19 hours.

Note 2 -When testing coarse aggregate of large nominal maximum size requiring large test samples, it may be more convenient to perform the test on two or more sub-samples, and the values obtained combined for the computation described in Section 8.

7.2 Where the absorption and specific gravity values are to be used in proportioning concrete mixtures in which the aggregates will be in their naturally moist condition, the requirement for initial drying to constant weight may be eliminated, and, if the surfaces of the particles in the sample have been kept continuously wet until test, the 15-h soaking may also be eliminated.

Note 3 - Values for absorption and bulk specific gravity (SSD) may be significantly higher for aggregate not oven dried before soaking than for the same aggregate treated in accordance with Section 7.1. This is especially true of particles larger than 75 mm (3 in.) since the water may not be able to penetrate the pores to the center of the particle in the prescribed soaking period.

7.3 Remove the test sample from the water and roll it in a large absorbent cloth until all visible films of water are removed. Wipe the larger particles individually. A moving stream of air may be used to assist in the drying operation. Take care to avoid evaporation of water from aggregate pores during the operation of surface-drying. Weigh the test sample in the saturated surface-dry

7 Procedure: (continued)

condition. Record this and all subsequent weight to the nearest 1.0 g or 0.1% of the sample weight, whichever is greater.

7.4 After weighing, immediately place the saturated-surface-dry test sample in the sample container and determine its weight in water at 23 ± 1.7°C (73.4 ± 3°F), having a density of 997 ± 2 kg/m³. Take care to remove all entrapped air before weighing by shaking the container while immersed.

Note 4 -The container should be immersed to a depth sufficient to cover it and the test sample during weighing. Wire suspending the container should be of the smallest practical size to minimize any possible effects of a variable immersed length.

7.5 Dry the test sample to constant weight at a temperature of 110 ± 5°C (230 ± 9°F), cool in air at room temperature 1 to 3 h, or until the aggregate has cooled to a temperature that is comfortable to handle (approximately 50°C), and weigh. Use this weight for A in the calculations in section 8.

8 Calculations:

8.1 *Specific Gravity:*

8.1.1 *Bulk Specific Gravity*--Calculate the bulk specific gravity, 23/23°C (73.4/73.4°F), as follows:

Bulk sp gr = $A/(B - C)$

where:

A = weight of oven-dry test sample in air, g,

B = weight of saturated-surface-dry test sample in air, g, and

C = weight of saturated test sample in water, g.

8.1.2 *Bulk Specific Gravity (Saturated-Surface-Dry)* - Calculate the bulk specific gravity, 23/23°C (73.4/73.4°F), on the basis of weight of saturated-surface-dry aggregate as follows:

Bulk sp gr (saturated-surface-dry) = $B/(B - C)$

8.1.3 *Apparent Specific Gravity* - Calculate the apparent specific gravity, 23/23°C (73.4/73.4°F), as follows:

Apparent sp gr = $A/(A - C)$

8.2 *Average Specific Gravity Values* - When the sample is tested in separate size fractions, the average value for bulk specific gravity, bulk specific gravity (SSD), or apparent specific gravity can be computed as the weighted average of the values as computed in accordance with Section 8.1 using the following equation:

$$G = \frac{1}{\frac{P_1}{100G_1} + \frac{P_2}{100G_2} \ldots + \frac{P_n}{100G_n}}$$

where:

G = average specific gravity. All forms of expression of specific gravity can be averaged in this manner.

8 Calculations: (continued)

G_1, G_2...G_n = appropriate specific gravity values for each size fraction depending on the type of specific gravity being averaged.

P_1,P_2...P_n = weight percentages of each size fraction present in the original sample.

Note 5 - Some users of this method may wish to express the results in terms of density. Density may be determined by multiplying the bulk specific gravity, bulk specific gravity (SSD), or apparent specific gravity by the weight of water (997.5 kg/m³ or 62.27 lb ft³ at 23°C). Some authorities recommend using the density of water at 4°C (1.000 kg/m³ or 1.000 Mg/m³ 3 or 62.43 lb/ft²) as being sufficiently accurate. Results should be expressed to three significant figures. The density terminology corresponding to bulk specific gravity, bulk specific gravity (SSD), and apparent specific gravity has not been standardized.

8.3 *Absorption* - Calculate the percentage of absorption, as follows:

Absorption, % = [(B - A)/A] X 100

8.4 *Average Absorption Value* - When the sample is tested in separate size fractions, the average absorption value is the average of the values as computed in Section 8.3, weighted in proportion to the weight percentages of the size fractions in the original sample as follows:

$A = (P_1A_1/100) + (P_2A_2/100) +. . . (P_nA_n/100)$

where:

A = average absorption, %.

A_1, A_2 ... A_n = absorption percentages for each size fraction, and

P_1, P_2 ... P_n = weight percentages of each size fraction present in the original sample.

9 Report:

9.1 Report specific gravity results to the nearest 0.01, and indicate the type of specific gravity, whether bulk (saturated-surface-dry), or apparent.

9.2 Report absorption result to the nearest 0.1%.

9.3 If the specific gravity and absorption values were determined without first drying the aggregate, as permitted in Section 7.2, it shall be noted in the report.

10 Precision and Bias:

10.1 The estimates of precision of this test method listed in Table 1 are based on results from the AASHTO Materials Reference Laboratory Reference Sample Program, with testing conducted by this test method and ASTM C 127. The significant difference between the methods is that ASTM C 127 requires a saturation period of 24 ± 4 h, while MT-205 requires a saturation period of 15 h minimum. This difference has been found to have significant effect on the precision indices. The data are based on the analyses of more than 100 paired test results from 40 to 100 laboratories.

TABLE 1 Precision

	Standard Deviation (IS)[A]	Acceptable Range of Two Results (D2S)[A]
Single operator precision:		
Bulk specific gravity (dry)	0.009	0.025
Bulk specific gravity (SSD)	0.007	0.020
Apparent specific gravity	0.007	0.020
Absorption[B],%	0.088	0.25
Multilaboratory precision:		
Bulk specific gravity (SSD)	0.011	0.32
Apparent specific gravity	0.011	0.032
Absorption[B], %	0.145	0.41

[A] These numbers represent, respectively, the (IS) and (D2S) limits as described in ASTM C 670. The precision estimates were obtained from the analysis of combined AASHTO Materials Reference Laboratory reference sample data from laboratories using 15-h minimum saturation times and other laboratories using 24 ± 4-h saturation time. Testing was performed on normal weight aggregates, and started with aggregates in the oven-dry condition.

[B] Precision estimates are based on aggregates with absorptions of less than 2%.