METHODS OF SAMPLING AND TESTING
MT 204-04
METHOD OF TEST FOR SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE
(Modified AASHTO T 84)

1 Scope:

1.1 This method covers the determination of bulk and apparent specific gravity, 23/23°C 73.4/73.4°F), and absorption of fine aggregate.

1.2 This method determines (after 15 h in water) the bulk specific gravity and the apparent specific gravity as defined in MT-206, the bulk specific gravity on the basis of weight of saturated surface-dry aggregate, and the absorption as defined in MT-206.

1.3 The values stated in acceptable metric unit (SI units and units specifically approved in AASHTO R1 for use with SI units) are to be regarded as the standard.

1.4 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:***

R 1 Metric Practice
T 133 Density of Hydraulic Cement

ASTM Standards:

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

MT Materials Manual:

MT 201 Sampling Roadway Materials
MT 205 Specific Gravity and Absorption of Coarse Aggregate
MT 206 Definitions of Terms Relating to Density and Specific Gravity of Solids, Liquids, and Gases
MT 607 Reducing Field Samples of Aggregate to Testing Size

3 Apparatus:

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

3.2 *Pycnometer* - A flask or other suitable container into which the fine aggregate test sample can be readily introduced and in which the volume content can be reproduced with ± 0.1 cm^3. The volume of the container filled to mark shall be at least 50 percent greater than the space required to accommodate the test sample. A volumetric flask of 500 capacity or a fruit jar fitted with a pycnometer top is satisfactory for a 500-g test sample of most fine aggregates. A Le Chatelier flask as described in AASHTO T 133 is satisfactory for an approximately 55-g test sample.

3.3 *Mold* - A metal mold in the form of a frustum of a cone with dimensions as follows: 40 ± 3 mm inside diameter at the top, 90 ± 3 mm inside diameter at the bottom, and 75 ± 3 mm in height, with the metal having a minimum thickness of 0.8 mm.

3 Apparatus: (continued)

3.4 *Tamper* - A metal tamper weighing 340 ± 15 g and having a flat circular tamping face 25 ± 3 mm in diameter.

4 Sampling:

4.1 Sampling shall be accomplished in general accordance with MT-201.

5 Preparation of Test Specimen:

5.1 Obtain approximately 1000 grams of the fine aggregate from the sample using the applicable procedures described in MT 607.

5.1.1 Dry it in a suitable pan or vessel to constant weight at a temperature of 110 ± 5°C (230 ± 9°F). Allow it to cool to comfortable handling temperature, cover with water, either by immersion or by the addition of at least 6 percent moisture to the fine aggregate and permit to stand for 15 to 19 hours.

5.1.2 As an alternative to Section 5.1.1, where the absorption and specific gravity values are to be used in proportioning concrete mixtures with aggregates used in their naturally moist condition, the requirement for initial drying to constant weight may be eliminated and, if the surfaces of the particles have been kept wet, the 15-h soaking may also be eliminated.

Note 1 - Values for absorption and for specific gravity in the saturated surface-dry condition may be significantly higher for aggregate not oven dried before soaking than for the same aggregate treated in accordance with Section 5.1.1.

5.2 Decant excess water with care to avoid loss of fines, spread the sample on a flat nonabsorbent surface exposed to a gently moving current of warm air, and stir frequently to secure homogeneous drying. If desired, mechanical aids such as tumbling or stirring may be employed to assist in achieving the saturated surface-dry condition. Continue this operation until the test specimen approaches a free-flowing condition. Follow the procedure in Section 5.2.1 to determine whether or not surface moisture is present on the constituent fine aggregate particles. It is intended that the first trial of the cone test will be made with some surface water in the specimen. Continue drying with constant stirring and test at frequent intervals until the test indicates that the specimen has reached a surface-dry condition. If the first trial of the surface moisture test indicates that moisture is not present on the surface, it has been dried past the saturated surface-dry condition. In this case, thoroughly mix a few milliliters of water with the fine aggregate and permit the specimen to stand in a covered container for 30 min. Then resume the process of drying and testing at frequent intervals for the onset of the surface-dry condition.

5.2.1 *Cone Test for Surface Moisture* - Hold the mold firmly on a smooth nonabsorbent surface with the large diameter down. Place a portion of the partially dried fine aggregate loosely in the mold by filling it to overflowing and heaping additional material above the top of the mold by holding it with the cupped fingers of the hand holding the mold. Lightly tamp the fine aggregate into the mold with 25 light drops of the tamper. Each drop should start about 5 mm (0.2 in.) above the top surface of the fine aggregate. Permit the tamper to fall freely under gravitational attraction on each drop. Adjust the starting height to the new surface elevation after each drop and distribute the drops over the surface. Remove loose sand from the base and lift the mold vertically. If surface moisture is still present, the fine aggregate will retain the molded shape. When the fine aggregate slumps slightly, it indicates that it has reached a surface-dry condition. Some angular fine aggregate or material with a high proportion of fines may not slump in the cone test upon reaching a surface-dry condition. This may be the case if fines become airborne upon dropping a handful of the sand from the cone test 100 to 150 mm into a surface. For these materials, the saturated surface-dry condition should be considered as the point that one side of the fine aggregate slumps slightly upon removing the mold.

5 Preparation of Test Specimen: (continued)

Note 2 - The following criteria have also been used on materials that do not readily slump:

(1) Provisional Cone Test - Fill the cone mold as described in Section 5.2.1 except only use 10 drops of the tamper. Add more fine aggregate and use 10 drops of the tamper again. Then add material two more times using 3 and 2 drops of the tamper, respectively. Level off the material even with the top of the mold, remove loose material from the base; and lift the mold vertically.

(2) Provisional Surface Test - If airborne fines are noted when the fine aggregate is such that it will not slump when it is at a moisture condition, add more moisture to the sand, and at the onset of the surface-dry condition, with the hand lightly pat approximately 100 g of the material on a flat, dry, clean, dark or dull nonabsorbent surface such as a sheet of rubber, a worn oxidized, galvanized, or steel surface, or a black-painted metal surface. After 1 to 3 s, remove the fine aggregate. If noticeable moisture shows on the test surface for more than 1 to 2 s, then surface moisture is considered to be present on the fine aggregate.

(3) Calorimetric procedures described by Kandhal and Lee, Highway Research Record No. 307, p. 44.

(4) For reaching the saturated surface-dry condition on a single size material that slumps when wet, hard-finish paper towels can be used to surface dry the material until the point is just reached where the paper towel does not appear to be picking up moisture from the surfaces of the fine aggregate particles.

6 Procedure:

6.1 Make and record all weight determinations to 0.1 g.

6.2 Partially fill the pycnometer with water. Immediately introduce into the pycnometer 500 ± 10 g of saturated surface-dry fine aggregate prepared as described in Section 6, and fill with additional water to approximately 90 percent of capacity. Roll, invert, and agitate the pycnometer to eliminate all air bubbles. Adjust its temperature to 23 ± 1.7°C (73.4 ± 3°F), if necessary by immersion in circulating water, and bring the water level in the pycnometer to its calibrated capacity. Determine total weight of the pycnometer, specimen, and water.

Note 3 - It normally takes about 15 to 20 minutes to eliminate air bubbles. Dipping the tip of a paper towel into the pycnometer has been found to be useful in dispersing the foam that sometimes builds up when eliminating the air bubbles.

6.2.1 *Alternative to Weighing in Section 6.2* - The quantity of added water necessary to fill the pycnometer at the required temperature may be determined volumetrically using a buret accurate to 0.15 mL. Compute the total weight of the pycnometer, specimen, and water as follows:

$C = 0.9975V_a + S + W$

where:

C = weight of pycnometer with specimen and water to calibration mark, g,

V_a = volume of water added to pycnometer, mL

S = weight of saturated surface-dry specimen, g, and

W = weight of the pycnometer empty, g.

6 Procedure: (continued)

6.2.2 *Alternative to the Procedure in Section 6.2* - Use a Le Chatelier flask initially filled with water to a point on the stem between the 0 and the 1 -mL mark. Record this initial reading with the flask and contents within the temperature range of 23 ± 1.7°C (73.4 ± 3°F). Add 55 ± 5 g of fine aggregate in the saturated surface-dry condition (or other weight as necessary to result in raising the water level to some point on the upper series of graduation). After all fine aggregate has been introduced, place the stopper in the flask and roll the flask in an inclined position, or gently whirl it in a horizontal circle so as to dislodge all entrapped air, continuing until no further bubbles rise to the surface. Take a final reading with the flask and contents within 1°C (1.8°F) of the original temperature.

6.3 Remove the fine aggregate from the pycnometer, dry to constant weight at a temperature of 110 ± 5°C (230 ± 9°F), cool in air at room temperature for 1 ± ½ h, and weigh.

6.3.1 If the Le Chatelier flask method is used, a separate sample portion is needed for the determination of absorption. Weigh a separate 500 ± 10 g portion of the saturated surface-dry fine aggregate, dry to constant weight, and reweigh.

Note 4 - In lieu of weighing the sample that has been removed from the pycnometer, a second 500 ± 10 g portion of the saturated surface dry sample may be used to determine the dry weight.

6.4 Determine the weight of the pycnometer filled to its calibration capacity with water at 23 ± 1.7°C (73.4 ± 3°F).

6.4.1 *Alternative to Weighing in Section 6.4* - The quantity of water necessary to fill the empty pycnometer at the required temperature may be determined volumetrically using a buret accurate to 0.15 mL. Calculate the weight of the pycnometer filled with water as follows:

$B = 0.9975\ V + W$

where:

B = weight of flask filled with water, g,

V = volume of flask, mL, and

W = weight of the flask empty, g.

7 Bulk Specific Gravity:

7.1 Calculate the bulk specific gravity, 23/23°C (73.4/73.4°F), as defined in MT-206 as follows:

$\text{Bulk sp gr} = A/(B + S - C)$

where:

A = weight of oven-dry specimen in air, g,

B = weight of pycnometer filled with water, g,

C = weight of pycnometer with specimen and water to calibration mark, g, and

S = weight of saturated surface-dry specimen, g.

7.2 If the Le Chatelier flask method was used, calculate the bulk specific gravity, 23/23°C, as follows:

$$\text{Bulk sp gr} = \frac{S_1(A/S)}{0.9975(R_2 - R_1)}$$

where:

R_1 = initial reading of water level in Le Chatelier flask,

R_2 = final reading of water level in Le Chatelier flask, and

S_1 = weight of saturated surface-dry specimen used in Le Chatelier flask, g.

8 Bulk Specific Gravity (Saturated Surface-Dry Basis):

8.1 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 basis) = *A/(B+S-C)*

8.2 If the Le Chatelier flask method was used, calculate the bulk specific gravity, 23/23°C, on the basis of saturated surface-dry aggregate as follows:

$$\text{Bulk sp gr (saturated surface-dry basis)} = \frac{S_1}{0.9975(R_2 - R_1)}$$

9 Apparent Specific Gravity:

9.1 Calculate the apparent specific gravity, 23/23°C (73.4/73.4°F), as defined in MT-206 as follows:

Apparent sp gr = *A/(B+A-C)*

10 Absorption:

10.1 Calculate the percentage of absorption, as defined in ASTM C 125, as follows:

Absorption, % = [*(S-A)/A*] *x 100*

11 Report:

11.1 Report specific gravity results to the nearest 0.01 and absorption to the nearest 0.1 percent. The Appendix gives mathematical interrelationships among the three types of specific gravities and absorption. These may be useful in checking the consistency of reported data or calculating a value that was not reported by using other reported data.

11.2 If the fine aggregate was tested in a naturally moist condition other than the oven dried and 15-h soaked condition, report the source of the sample and the procedures used to prevent drying prior to testing.