ILLINOIS TEST PROCEDURE 85

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

Effective Date: April 1, 2012
Revised Date: May 10, 2019

1 SCOPE

1.1 This procedure 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 to 19 hours soaking in water. This method is not intended to be used with lightweight aggregates.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2 REFERENCED DOCUMENTS

2.1 Illinois Test Procedures (ITP):

- ITP 2, Sampling of Aggregates
- ITP 11, Materials Finer Than No. 200 (75µm) Sieve in Mineral Aggregates by Washing
- ITP 19, Bulk Density ("Unit weight") and Voids in Aggregate
- ITP 248, Reducing Samples of Aggregate to Testing Size
- ITP 255, Total Evaporable Moisture Content of Aggregate by Drying

2.2 Illinois Specifications:

- Illinois Specification 201, Aggregate Gradation Sample Size Table

2.3 *AASHTO Standards:*

- M 231, Weighing Devices Used in the Testing of Materials

2.4 *ASTM Standard:*

- E 11, Woven Wire Test Sieve Cloth and Test Sieves
- E 29 (Illinois Modified), Using Significant Digits in Test Data to Determine Conformance with Specifications

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3 TERMINOLOGY

3.1 *Definitions:*

3.1.1 *Absorption* – the increase in the mass of aggregate due to water in the pores of the materials but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered "dry" when it has been maintained at a temperature of 230±9˚F (110± 5℃) for sufficient time to remove all uncombined water by reaching a constant mass.

3.1.2 *Specify 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 gas-free distilled water at stated temperatures. Values are dimensionless.

3.1.2.1 *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.

3.1.2.2 *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.

3.1.2.3 *Bulk Specific Gravity (SSD)* – the ratio of the mass in air of a unit volume of aggregate, including the mass of water within the voids filed to the extent achieved by submerging in water for approximately 15 to 19 hours (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.

4 SIGINIFICANCE AND USE

4.1 Bulk specific gravity is the characteristic generally used for calculation of the volume occupied by the aggregate in various mixtures containing aggregate, including Portland cement concrete, bituminous concrete, and other mixtures that are proportioned or analyzed on an absolute volume basis. Bulk specific gravity is also used in the computation of voids in aggregate in ITP 19. Bulk specific gravity (SSD) is used if the aggregate is wet, that is, if its absorption has been satisfied. Conversely, the bulk specific gravity (oven-dry) is used for computations when the aggregate is dry or assumed to be dry.

4.2 Apparent specific gravity pertains to the relative density of the solid material making up the constituent particles not including the pore space within the particles which is accessible to water.

4.3 Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition, when it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential. The laboratory standard for absorption is that obtained after submerging dry aggregate for approximately 15 to 19 hours in water. Aggregates mined form below the water table may have a higher absorption when used, if not allowed to dry. Conversely, some aggregates when used may contain an amount of absorbed moisture less than the 15-hour soaked condition. For an aggregate that has been in contact with water and that has free moisture on the particle surfaces, the percentage of free moisture can be determined by deducting the absorption form the total moisture content determined by ITP 255.

5 APPARATUS

5.1 *Balance* – The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of AASHTO M 231. For accurate SSD determination; a metal weigh pan with the capability of showing the water marks should be utilized.

5.2 *Sample Container* – A solid bucket of approximately equal breadth and height with a capacity of approximately 366in^3 (6000cm^3), or a wire mesh basket with No. 10 (2.0mm) mesh or smaller, may be used. The bucket/basket shall be constructed in a way to prevent the trapping of 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 *Suspended Apparatus* – A nonabsorbent line of material (wire, fishing line, etc.) that suspends the sample container such that the entire handle of the sample container is below the surface of the water.

5.5 *Sieves* – A No. 8 (2.36mm) sieve, conforming to ASTM E 11.

5.6 *Oven* – An oven of sufficient size, capable of maintaining a uniform temperature of 230±9˚F (110±5˚C). The oven shall be specifically designed for drying. In addition, a gas burner or electric hot plate may be used. Microwave ovens are not permitted for drying aggregate gradation samples.

5.7 *Weigh Pan*- An uncoated Aluminum pan used on a balance that can visually show the presence of moisture.

6 SAMPLING

6.1 Field samples of coarse aggregate shall be taken according to ITP 2. Field sample size shall meet the minimum requirements in the Illinois Specification 201.

6.2 Thoroughly mix the sample of aggregate and reduce it to the approximate quantity needed using the applicable procedure in ITP 248. Reject all material passing a No. 8 (2.36mm) sieve by dry sieving. When running slag products this method is further modified to require that all samples be washed and dried prior to testing using ITP 11.

6.3 The minimum mass of test sample to be used is given below. When testing gradations that are too large to fit in the sample container, the sample may be split into multiple samples. If multiple samples are tested the weights will be combined prior to calculations.

Gradation	Minimum Mass of Test Sample, g
CA/CM 01	9,700-9,800
CA/CM 02 & 03	7,800-8,200
CA/CM 04 & 05	4,800-5,200
CA/CM 06 - 09	3,800-4,200
CA/CM 10 - 11	2,800-3,200
CA/CM 12 - 20	1,900-2,100

7 PROCEDURE

7.1 Immerse the aggregate in water at room temperature for period of 15 to 19 hours.

7.2 Decant the water off the test sample. Thoroughly wash the sample in cool water to remove dust or other coatings from the surface. Decant off excess water. Place sample on large, absorbent cloth. Roll particles with a clean, dry towel until all visible signs of water are removed. Take care to avoid evaporation of water from aggregate pores during the operation of saturated surface drying. Once the material is at surface dry condition (see 7.3), gently introduce the sample to the weigh pan. Do not agitate the material once in the weigh pan. Determine the mass of all test samples, while in the saturated surface dry condition, to the nearest 1 gram on a specified balance or scale.

7.3 To check for an accurate saturated surface dry condition, the water streaks in the weigh pan shall be used. After obtaining the surface dry weight introduce the test sample into the sample basket/bucket, do not immerse. Tilt the weigh pan so the bottom of the pan is vertical. Then immediately check the bottom of the weigh pan for the presence of water spots. The following figures and descriptions shall be used to access the sample for accurate saturated surface dry condition:

7.3.1 If there are no or very few spots present (see Fig. 1); the sample is too dry and must be re-soaked for a minimum of 30 minutes. Then resume the process of drying the test sample to saturated surface dry condition (see 7.2).

Figure 1

7.3.2 If there is enough water present for the spots to run or the water to pool at the bottom of the weigh pan, then the sample is too wet and must be spread back out on the absorbent cloth and continue drying to obtain the saturated surface dry condition (see Figures 2 & 3).

Figure 2

Figure 3

7.3.3 Accurate saturated surface dry condition is obtained when the bottom of the weigh pan has water streaks present but there is no sign of pooled water anywhere (see Figures 4 & 5).

Figure 4

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Figure 5

7.4 After determining the mass, immediately place the saturated-surface-dry test sample in the sample container and determine its mass in water at 73.4±3˚F (23.0± 1.7˚C), having a density of 62±0.1lb/ft^3 (997± 2 kg/m^3). Take care to remove all entrapped air before determining the mass by agitating the container while immersed.

7.5 Dry the test sample to a constant mass in a specified oven at a temperature of 230±9˚F (110±5˚C). After the test sample has been dried to constant mass and cooled to room temperature; determine the mass to the nearest 1 gram. Constant mass is defined as the sample mass at which there has not been more than a 0.5 gram mass loss during an additional 1 hour of drying. This should be verified occasionally.

8 CALCULATIONS

8.1 *Specific Gravity*:

8.1.1 *Bulk Specific Gravity* – Calculate the bulk specific gravity, as follows:

Bulk sp gr = $A/(B-C)$ *(1)*

Where:

A = Mass of oven-dry test sample in air, g:
B = Mass of saturated-surface-dry test sample in air, g; and
C = Mass of saturated test sample in water, g.

8.1.2 *Bulk Specific Gravity* (Saturated-Surface-Dry) – Calculate the bulk specific gravity, as follows:

Bulk sp gr (saturated-surface-dry) = $B/(B-C)$ *(2)*

8.1.3 Apparent Specific Gravity – Calculate the apparent specific gravity, as follows:

Apparent sp gr = $A/(A-C)$ *(3)*

8.2 Absorption – Calculate the percentage of absorption, as follows:

Absorption, percent = $[(B - A)/A] \times 100$ *(4)*

9 REPORT

9.1 Report all specific gravities to the nearest 0.001.

All rounding shall be according to ASTM E 29 (Illinois Modified).

9.2 Report the absorption result to the nearest 0.1 percent.