



# Standard Test Method for Determining the Relative Density (Specific Gravity) and Absorption of Fine Aggregates Using Infrared<sup>1</sup>

This standard is issued under the fixed designation D7172; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the relative density (specific gravity) and absorption of fine aggregates.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**C29/C29M** Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate

**C125** Terminology Relating to Concrete and Concrete Aggregates

**C128** Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

**C566** Test Method for Total Evaporable Moisture Content of Aggregate by Drying

**C670** Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

**C702** Practice for Reducing Samples of Aggregate to Testing Size

**C1252** Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)

**D8** Terminology Relating to Materials for Roads and Pavements

**D75** Practice for Sampling Aggregates

**D4753** Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

2.2 **AASHTO Standards:**<sup>3</sup>

**T-84** Test Method for Specific Gravity and Absorption of Fine Aggregate

2.3 **Other Documents:**<sup>4</sup>

**Operational Instructions**

## 3. Terminology

3.1 **Definitions**—As defined in **C125** and **D8**:

3.1.1 **Automatic Volumetric Mixer (AVM), *n***—an automated unit to hold and agitate a volumetric flask while applying a vacuum to the flask.

## 4. Significance and Use

4.1 Bulk relative density (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 relative density (specific gravity) is used in the computation of voids in aggregate in **C1252** and **C29/C29M**. Bulk relative density (specific gravity) determined on the saturated surface dry (SSD) basis is used if the aggregate is wet, that is, if its absorption has been satisfied. Conversely, the bulk relative density (specific gravity) determined on the oven-dry basis is used for computations when the aggregate is dry or assumed to be dry.

4.2 Apparent relative density (specific gravity) pertains to the relative density of the solid material making up the constituent particles not including the pore space within the particles that is accessible to water. This value is not widely used in construction aggregate technology.

4.3 Water absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee **D04** on Road and Paving Materials and is the direct responsibility of Subcommittee **D04.51** on Aggregate Tests.

Current edition approved June 1, 2014. Published September 2014. Originally approved in 2006. Last previous edition approved in 2006 as D7172 – 06<sup>ε1</sup>. DOI: 10.1520/D7172-14.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

<sup>3</sup> Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

<sup>4</sup> Available from ThermoFisher Scientific, 2555 Kerper Boulevard, P.O. Box 797, Dubuque, Iowa 52004-0797, U.S.A., or online at <http://cp-thermofisher.kb.net/display/4/kb/article.aspx?aid=259320&n=1&docid=15899&tab=search>.

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 24 hours in water. Aggregates mined from 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 24 hours soaked condition: For an aggregate that has been in contact with water and that had free moisture on the particle surface, the percentage of free moisture can be determined by deducting the absorption from the total moisture content determined according to **C566** by drying.

## 5. Apparatus

5.1 *Balance*—A balance or scale, conforming to the requirements of **D4753**, accurate and readable to within 0.1 % of the test sample mass at any point within the range of use.

5.2 *Thermometer*—Shall be capable of accurately measuring the temperature throughout a range of 0 to 50°C, and be readable to 0.5°C.

5.3 *Large Neck Volumetric Flask*—with a capacity of 500 mL.

5.4 *Timer*—capable of at least 5 min.

5.5 *AVM Unit (Automatic Volumetric Mixer)*—The unit shall perform an automated process for removing entrapped air. It shall consist of the following devices: an orbiting mixer that can securely hold a 500 mL large neck volumetric flask, a clamp and clamping rod capable of securely holding the neck of the volumetric flask, a vacuum pump, hose, and a stopper capable of fitting the mouth of the volumetric flask. (See **Note 1**.)

5.6 *Infrared Unit*—The device shall be automatically capable of detecting SSD using an infrared source and detector. It shall consist of an orbital mixer, water pump, infrared source, infrared detector, and a mixing bowl with a lid. The lid of the mixing bowl shall consist of two sapphire lenses and contain an injection nozzle for water injection. (See **Note 1**.)

**NOTE 1**—Units similar to the SSDetect formerly manufactured by Barnstead International<sup>5</sup> meet criteria described in Sections 5.3, 5.5 and 5.6

5.7 *Distilled Water*.

## 6. Sampling

6.1 Sampling shall be accomplished in accordance with Practice **D75**.

## 7. Preparation of Test Specimen

7.1 Obtain 1.5 kg  $\pm$  10 g of the fine aggregate from the sample using the applicable procedures described in Practice **C702**.

<sup>5</sup> There is no source of supply of the apparatus known to the committee at this time. If you are aware of suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend.

7.2 Dry it in a suitable pan or vessel to constant mass at a temperature of 110  $\pm$  5°C. Allow it to cool to 23  $\pm$  2°C.

7.3 Split the test sample according to Practice **C702** into two 500  $\pm$  5g samples. Discard excess.

## 8. Calibration

8.1 Calibration of the water pump and the infrared unit shall be performed once a month.

8.2 *Calibration of Water Pump:*

8.2.1 Fill the infrared device with distilled water per manufacturers' instructions.

8.2.2 Weigh a clean container. Place the container under the nozzle in the lid to collect the water. Position the container so as to minimize splashing. (See **Note 2**.)

**NOTE 2**—A 125-mL Erlenmeyer flask or similar container is recommended.

8.2.3 Follow manufacturers' instructions regarding initiation of an automatic preset number of injections from the nozzle into the test flask. (See **Note 3**.)

**NOTE 3**—A total of 3000 injections is recommended.

8.2.4 At the end of the collection cycle, remove the container and place it on a scale to obtain the total mass. Subtract the empty container mass obtained in step 8.2.2 from this value and enter the resulting amount into the Infrared device, per manufacturers' instructions.

8.3 *Calibration of Infrared Unit:*

8.3.1 Check and ensure that the water reservoir on the infrared unit is full. Turn on the power to the unit and allow it to warm-up per manufacturers' instructions.

8.3.2 Initiate infrared unit calibration routine per manufacturers' instructions.

8.3.3 Insert exactly 500.0 g of Ottawa Silica sand into the mixing bowl and initiate the calibration process. After the unit completes the calibration procedure, the unit will indicate the calibration result. (See **Note 4**.)

8.3.4 Return to the normal operation mode of the unit per the manufacturers' instructions.

8.3.5 Dry the Ottawa silica sand back to a constant mass at a temperature of 110  $\pm$  5°C, so it can be used for future calibrations.

**NOTE 4**—A calibration material can be obtained from the unit manufacturer. When the calibration result is shown, it indicates that the calibration process is complete.

## 9. Procedure

9.1 Make and record all mass determinations to 0.1 g.

9.2 Determine the mass of a 500 mL, large neck volumetric flask filled to its calibration capacity with water at 23  $\pm$  2°C. Record the mass and discard the water.

9.3 *Film Coefficient and Apparent Relative Density (Specific Gravity) Determination:*

9.3.1 Place approximately 250 mL of 23  $\pm$  2°C water in the flask measured in 9.2.

9.3.2 Place the flask and water from 9.3.1 on a balance and zero the balance.

9.3.3 Set the timer to 5 min, start when instructed in 9.3.4.