Designation: D6752/D6752M – 17

Standard Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method[1]

This standard is issued under the fixed designation D6752/D6752M; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of bulk specific gravity of compacted asphalt mixtures by the vacuum sealing method.

1.2 This method can be used for compacted cylindrical and cubical laboratory and field asphalt mixture specimens.

1.3 The bulk specific gravity of the compacted asphalt mixtures may be used in calculating the unit weight of the mixture.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalent; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 *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 requirements prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

D8 Terminology Relating to Materials for Roads and Pavements

D2726/D2726M Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

D3203/D3203M Test Method for Percent Air Voids in Compacted Asphalt Mixtures

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

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

D5361/D5361M Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing

D7227/D7227M Practice for Rapid Drying of Compacted Asphalt Specimens Using Vacuum Drying Apparatus

2.2 *AASHTO Standards:*[3]

M323 Standard Specification for Superpave Mix Design

3. Terminology

3.1 For definitions of terms used in this standard, refer to Terminology D8.

4. Significance and Use

4.1 The results obtained from this method can be used to determine the unit weight of compacted asphalt mixtures, and in conjunction with Test Method D3203/D3203M, to obtain

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.21 on Specific Gravity and Density of Asphalt Mixtures.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from the American Association of State Highway Transportation Officials (AASHTO), 441 N. Capitol Street, NW, Washington, DC 20001.

percent air voids. These values in turn may be used in determining the relative degree of compaction.

4.2 Since specific gravity has no units, it must be converted to density in order to do calculations that require units. This conversion is made by multiplying the specific gravity at a given temperature by the density of water at the same temperature.

4.3 This method can be used for 100 mm [4 in.] and 150 mm [6 in.] diameter cylindrical as well as cubical asphalt mixture specimens to correct for inconsistencies in sample weight determinations resulting from drainage of water from samples and inaccuracy in saturated surface dry weight of absorptive coarse and open graded mixes. Asphalt mixes such as stone matrix asphalt (SMA), porous friction course, and coarse graded mixes with significant surface texture and interconnected voids can be tested with this method. Follow manufacturer recommendation for appropriate bag sizes to be utilized with cubical and abnormally shaped samples.[4]

NOTE 1—The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

5. Apparatus

5.1 *Balance,* with ample capacity, and with sufficient sensitivity to enable bulk specific gravity of specimens to be calculated to at least four significant figures, that is, to at least three decimal places. It shall be equipped with a suitable apparatus to permit weighing the specimen while it is suspended in water. The balance shall conform to Guide D4753 as a class GP2 balance.

NOTE 2—Since there are no more significant figures in the quotient (bulk specific gravity) than appear in either the dividend (the mass of the specimen in air) or in the divisor (the volume of the specimen, obtained from the difference in mass of the specimen in air and in water), this means that the balance must have a sensitivity capable of providing both mass and volume values to at least four figures. For example, a sensitivity of 0.1 g [0.00022 lb] would provide four significant figures for the determination of a mass in the range from 130.0 to 999.9 g [0.29 to 2.20 lb] when the specific gravity is 2.300.

5.2 *Water Bath,* with minimum dimensions (length × width × depth) of 610 by 460 by 460 mm [24 by 18 by 18 in.] or a large cylindrical container, for completely submerging the specimen in water while suspended, equipped with an overflow outlet for maintaining a constant water level.

NOTE 3—It is preferable to keep the water temperature constant by using a temperature-controlled heater. Also, to reduce the chance for the bag to touch the sides of the water tank, it is preferable to elevate the water tank to a level at which the sample can be placed on the weighing mechanism while standing up, and the placement of the sample and the bag in the water tank can easily be inspected.

5.3 *Cushioned Holder,* for water displacement of the sample, having no sharp edges.

NOTE 4—To avoid accidental puncture of the plastic bags in the water bath, plastic-coated cushioned holders have been found to work well for this test method.

5.4 *Vacuum Chamber,* with a 0.93 kW [1.25 hp] pump capable of evacuating a sealed and enclosed chamber to a minimum pressure of 10 mm Hg [10 Torr] in less than 60 s, when at sea level. The chamber shall be large enough to seal samples of 150 mm [6 in.] wide by 350 mm [14 in.] long by 150 mm [6 in.] thick. The device shall automatically seal the plastic bag and exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic to the asphalt specimen. The air exhaust and vacuum operation time should be calibrated at the factory prior to initial use. The air exhaust system should be calibrated to bring the chamber to atmospheric pressure in 80 to 120 s, after the completion of the vacuum operation. The vacuum system should be provided with a latch to control the chamber door opening.

5.5 *Vacuum Measurement Gauge,* independent of the vacuum sealing device that could be placed directly inside the chamber, to verify vacuum performance and the chamber door sealing condition of the unit. The gauge shall be capable of reading 3 mm Hg [3 Torr] pressure.

5.6 *Plastic Bags,* used with the vacuum device shall be one of the two following sizes. The smaller bags shall have a minimum opening of 241 mm [9.50 in.] and maximum opening of 260 mm [10.25 in.] and the larger bags shall have a minimum of 375 mm [14.75 in.] and a maximum opening of 394 mm [15.5 in.]. The bags shall be of plastic material that will not adhere to asphalt film, is puncture resistant, is capable of withstanding sample temperatures of up to 70 °C [158 °F], is impermeable to water, and contains no air channels for evacuation of air from the bag. The bags shall have a minimum thickness of 0.100 mm [0.004 in.] and maximum thickness of 0.152 mm [0.006 in.]. The apparent specific gravity for the bags shall be provided by the manufacturer. The apparent specific gravity provided for each size bag shall account for the different sample weights and bag weight used during testing.

5.7 *Specimen Sliding Plate,* used within the chamber for reduction of friction on the plastic bags.

5.8 *Bag-Cutting Knife,* or scissors.

6. Sampling

6.1 Test specimens may be molded from laboratory-prepared samples or taken from asphalt pavement in the field. Field samples should be obtained in accordance with Practice D5361/D5361M.

7. Test Specimens

7.1 It is recommended, (*1*) that the diameter of cylindrically molded or cored specimens, or the length of the sides of sawed

[4] Bulk specific gravity determined by this method may be lower than the results obtained by Test Method D2726/D2726M. As a result, air voids determined from these bulk specific gravity values may be higher than the air voids values determined using Test Method D2726/D2726M. These differences may be more pronounced for coarse aggregate mixtures. Users of this method are cautioned to evaluate any alteration in percent asphalt content or aggregate gradations for mix designs with a known positive performance history.

specimens be at least equal to four times the maximum size of the aggregate; and (*2*) that the thickness of specimens be at least one and one-half times the maximum size of the aggregate. Pavement specimens are to be taken by such means as coring, sawing of blocks, and so forth.

7.2 Take care to avoid distortion, bending, or cracking of specimens during and after removal from pavement or mold. Store specimens in a safe, cool place.

7.3 Specimens shall be free of foreign materials such as sealcoat, tack coat, foundation material, soil, paper, or foil. When any of these materials is visually evident, it shall be removed. Sealcoat, tackcoat, or irregular surfaces that may result in the plastic bag not complying with the sample shall be removed by sawing the bottom or the top faces, or both, of the sample.

7.4 If desired, specimens may be separated from other pavement layers by sawing or other suitable means.

7.5 Use a brush or a soft sanding block to break sharp edges around the top and bottom corners of the sample.

8. Procedure

8.1 This procedure can be used for compacted field and laboratory specimens. Specifically, use this procedure if the asphalt mix is absorptive as determined by Test Method D2726/D2726M and for coarse and open graded mixes. For asphalt mixes such as stone matrix asphalt (SMA), porous friction course, and coarse graded mixes with significant surface texture and interconnected voids, follow the procedure outlined in this section for determination of bulk specific gravity.

8.2 *Mass of Unsealed Specimen:*

8.2.1 *Laboratory-Prepared Specimens*—Determine the mass of the specimen after it has cooled to room temperature. Designate this mass as *A*.

8.2.2 *Cores and Specimens Containing Moisture*—Dry the specimen and designate this mass as *A*. Vacuum drying, Practice D7227/D7227M, or other approved methods may be used to dry the sample to constant mass.

8.3 *Mass of Sealed Specimen:*

8.3.1 Select an appropriate size bag. For all 100 mm [4 in.] diameter samples and samples with 150 mm [6 in.] diameter and less than 75 mm [3 in.] thickness, use the bag with smaller opening size as specified in 5.6. For 150 mm [6 in.] samples with greater than 50 mm [2 in.] thickness, use the larger opening size bags as specified in 5.6. For samples that weigh more than 5500 g [12.1 lb] or abnormally shaped samples, use manufacturer's recommendation for appropriate bag size and configuration.

NOTE 5—Protect the bag during storage. Rough handling, storing in proximity to sharp objects such as tools, aggregate, or inside drawers will damage the plastic bag. Refer to manufacturer's recommendation for handling and safe storage.

8.3.2 Inspect an appropriate size bag for holes or irregularities, record the bag mass and place a bag inside the vacuum chamber on top of the specimen sliding plate.

8.3.3 Gently open the bag and place the specimen in the plastic bag on top of the specimen sliding plate, being careful to handle the bag in such a manner that would prevent a puncture. Avoid dropping or impacting the bag, and follow manufacturer's recommendations for handling the specimens and the bags.

8.3.4 Allow the vacuum chamber to remove the air from the chamber and the plastic bag. The vacuum chamber shall automatically seal the bag once the air is removed.

8.3.5 Exhaust air into the chamber until the chamber door opens indicating atmospheric pressure within the chamber. The chamber door latch can be used to avoid automatic opening of the door after completion of the test.

8.3.6 Remove the sealed sample from the vacuum chamber. Handle the sealed sample with extreme care to prevent puncturing the bag. Gently pull on the bag and if the bag easily separates from the sample, the bag may be punctured; repeat the sealing process with a new bag.

8.3.7 Immediately place the sample in the water tank on top of the weighing mechanism and determine the mass of the sealed specimen in a water bath at 25 ± 1 °C [77 ± 2 °F]. Designate this mass as *E*.

8.3.8 To ensure tight seal in the bag, remove the sample from water and cut the bag open. Remove the sample from the bag and determine its mass. Designate this mass as *C*. Compare this mass with initial dry mass in 8.2.1 (mass *A*). If mass *C* is greater than mass *A* by 5 g, then dry and retest the sample, otherwise continue with the calculation step.

8.3.9 Calculate the mass of the sealed specimen in air by summing the masses in either 8.2.1 or 8.2.2 and 8.3.2. Designate this mass as *B*.

9. Calculations

9.1 Calculate the bulk specific gravity of the sealed specimen as follows:

$$\text{Bulk Specific Gravity} = \frac{A}{[C+(B-A)] - E - \frac{B-A}{F_T}} \quad (1)$$

where:

A = initial mass of dry specimen in air, g,
B = mass of dry, sealed specimen, g (A + mass of plastic bag from 8.3.2),
C = final mass of specimen after removal from sealed bag, g,
E = mass of sealed specimen underwater, g, and
F_T = apparent specific gravity of plastic sealing material at 25 °C [77 °F], provided by the manufacturer.

9.2 Calculate the density of the specimen as follows:

$$\text{Density} = (\text{Bulk Specific Gravity})\,\gamma \quad (2)$$

where:

γ = density of water at 25 °C [77 °F] (997.0 kg/m^3, 0.997 g/cm^3 or 62.24 lb/ft^3).

10. Verification

10.1 *System Verification:*

10.1.1 The vacuum settings of the device shall be verified once every three months, after major repairs, after each shipment or relocation.

10.1.2 Verification shall be performed with a vacuum gauge capable of being placed inside the chamber and reading the vacuum setting of the sealing device.

10.1.3 Place the gauge inside the chamber and record the setting. The gauge should indicate a reading of 10 mm Hg [10 Torr] or less. The unit shall not be used if the gauge reading is above 10 mm Hg [10 Torr].

10.1.4 Vacuum gauge used for verification shall be standardized once every twelve months.

NOTE 6—On line vacuum gages, while capable of indicating vacuum performance of the pump, are not suitable for use in enclosed vacuum chambers and can not accurately measure vacuum levels.

10.2 *Plastic Bag Verification:*

10.2.1 The plastic bag apparent specific gravity provided by the manufacturer shall be verified periodically.

10.2.2 Compact a 4.75-mm [#4] mixture sample of asphalt in a Marshall compactor or a Gyratory compactor to a minimum dimension of 100 mm [4 in.] diameter by 60 mm [2.4 in.] thickness. The sample should be compacted to produce air voids in the range of 4 % to 8 % at 6 % asphalt content. Refer to AASHTO M323 for more information regarding preparation of 4.75-mm [#4] mixtures.

10.2.3 Take three bags from each size and use the procedure in Section 8 to measure the bulk specific gravity of the compacted 4.75-mm mixture sample, for each individual bag.

10.2.4 Average the sample bulk specific gravities (or densities) obtained with each bag.

10.2.5 Using Test Method D2726/D2726M, measure the bulk specific gravity of the same sample.

10.2.6 The average bulk specific gravity (or density) calculated for the asphalt sample shall be within ±0.010 g/cm^3 or ±0.624 lb/ft^3 of the bulk specific gravity (or density) determined by Test Method D2726/D2726M for the same asphalt sample.

10.2.7 This section shall be repeated for each bag size.

11. Report

11.1 Report the following information:

11.1.1 Apparent specific gravity of plastic bag to three decimal places.

TABLE 1 Criteria for Judging Acceptability of Bulk Specific Gravity Test Results

Test and Type of Index[A]	Standard Deviation	Acceptable Range of Two Results (D2S)
Single-operator precision	0.0124	0.035
Multi-laboratory precision	0.0135	0.038

[A] The precision estimates were obtained from FHWA pooled fund round-robin study conducted by National Center for Asphalt Technology (NCAT). The precision limits were obtained using Practice C670. A total of 18 laboratories participated in this study. Each laboratory tested 27 samples using this method. Samples were prepared and compacted by NCAT.

11.1.2 Bulk specific gravity at 25 ± 1 °C [77 ± 2 °F] to four significant figures.

11.1.3 Density to four significant figures.

12. Precision and Bias[5]

12.1 *Precision*—Criteria for judging the acceptability of bulk specific gravity test results obtained by this test method are given in Table 1.

12.2 The figures given in Column 2 are the standard deviations that have been found to be appropriate for the conditions of test described in Column 1. The figures given in Column 3 are the limits that should not be exceeded by the difference between results of two properly conducted tests.

12.3 The values in Column 3 are the acceptable range for two tests. When more than two results are being evaluated, the range given in Column 3 must be increased. Multiply the standard deviation(s) in Column 2 by the multiplier given in Table 1 of Practice C670 for the number of actual tests. For example: for three tests the value is 0.0124X 3.3 = 0.041. Additional guidance and background is given in Practice C670.

12.4 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure for measuring density, no statement on the bias of this test method is being made.

13. Keywords

13.1 bulk specific gravity; compacted asphalt mixtures; density

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D04-1020. Contact ASTM Customer Service at service@astm.org.