



Designation: D2726/D2726M – 17

Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures¹

This standard is issued under the fixed designation D2726/D2726M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of bulk specific gravity and density of specimens of compacted asphalt mixtures.

1.2 This test method should not be used with samples that contain open or interconnecting voids or absorb more than 2 % of water by volume, or both, as determined in 11.3.

1.3 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 equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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.*

1.5 *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

D979 Practice for Sampling Bituminous Paving Mixtures

D1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples

D3203 Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving 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 Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing

D6752 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

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

E1 Specification for ASTM Liquid-in-Glass Thermometers

E77 Test Method for Inspection and Verification of Thermometers

E563 Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature

E644 Test Methods for Testing Industrial Resistance Thermometers

E1137 Specification for Industrial Platinum Resistance Thermometers

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bulk density*—as determined by this test method, the mass of a metre cubed (or foot cubed) of the material at 25 °C [77 °F].

3.1.2 *bulk specific gravity*—as determined by this test method, the ratio of the mass of a given volume of material at 25 °C [77 °F] to the mass of an equal volume of water at the same temperature.

4. Summary of Test Method

4.1 The specimen is immersed in a water bath at 25 °C [77 °F]. The mass under water is recorded, and the specimen is taken out of the water, blotted quickly with a damp cloth towel,

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.

and weighed in air. The difference between the two masses is used to measure the mass of an equal volume of water at 25 °C [77 °F].

4.2 This test method provides guidance for determination of the oven dry or thoroughly dry mass of the specimen. The bulk specific gravity is calculated from these masses. Then the density is obtained by multiplying the specific gravity of the specimen by the density of the water.

5. Significance and Use

5.1 The results obtained from this test method can be used to determine the unit weight of compacted dense asphalt mixtures and in conjunction with Test Method D3203, to obtain percent air voids. These values in turn may be used in determining the relative degree of compaction.

5.2 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.

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.

6. Apparatus

6.1 *Balance*, with ample capacity, and with sufficient sensitivity to enable bulk specific gravities of the 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 suspended in water. To avoid erroneous readings by undue displacement of water, use wire or fish line of the smallest practical size to suspend the specimen and holder. Do not use chains, strings, or sash cords. 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 mass of the volume of water equal to the volume of the specimen, obtained from the difference in weight of the saturated surface-dry specimen in air and in water), this means that the balance must have a sensitivity capable of providing both mass values to at least four figures. For example, a sensitivity of 0.1 g [0.0002 lb] would provide four significant figures for mass in the range from 100.1 to 999.9 g [0.221 to 2.204 lb].

6.2 *Water Bath*, capable of maintaining a temperature of 25 ± 1 °C [77 ± 1.8 °F] for immersing the specimen in water while suspended, equipped with an overflow outlet for maintaining a constant water level. The use of an overflow outlet is mandatory.

NOTE 3—The water bath does not need to be a sophisticated device. Any method that maintains 25 ± 1 °C [77 ± 1.8 °F] can be used including tempering, aquarium heaters, stirrers, or other devices.

6.3 *Drying Oven*, capable of maintaining a temperature of 110 ± 5 °C [230 ± 9 °F].

6.4 *Thermometer*—The thermometer shall be one of the following:

6.4.1 A liquid-in-glass partial immersion thermometer of suitable range with subdivisions and maximum scale error of 0.5 °C [1.0 °F] which conforms to the requirements of Specification E1. Calibrate the thermometer in accordance with one of the methods in Test Method E77 or verify its original calibration at the ice point (Note 4 and Note 5).

NOTE 4—Practice E563 provides instructions on the preparation and use of an ice-point bath as a reference temperature.

NOTE 5—If the thermometer does not read 0.0 ± 0.5 °C [32.0 ± 1.0 °F] at the ice point then the thermometer should be recalibrated.

6.4.2 A liquid-in-glass partial immersion thermometer of suitable range with subdivisions and maximum scale error of 0.5 °C [1.0 °F] which conforms to the requirements of Specification E2251. Calibrate the thermometer in accordance with one of the methods in Test Method E77 or verify its original calibration at the ice point (Note 4 and Note 5).

6.4.3 A platinum resistance thermometer (PRT) with a probe which conforms to the requirements of Specification E1137. The PRT shall have a 3- or 4-wire connection configuration and the overall sheath length shall be at least 50 mm (2 in.) greater than the immersion depth. Calibrate the PRT system (probe and readout) in accordance with Test Methods E644 or verify its original calibration at the ice point (Note 4 and Note 5). Corrections shall be applied to ensure accurate measurements within 0.5 °C [1.0 °F].

6.4.4 A metal-sheathed thermistor with a sensor substantially similar in construction to the PRT probe described in 6.4.3. Calibrate the thermistor system (sensor and readout) in accordance with Test Methods E644 or verify its original calibration at the ice point (Note 4 and Note 5). Corrections shall be applied to ensure accurate measurements within 0.5 °C [1.0 °F].

7. Standardization

7.1 *Balance*—Standardize at least once each twelve months.

7.2 *Temperature-Measuring Devices*—Standardize at least once every twelve months.

7.3 *Drying Oven*—Standardize thermometric devices at least once every twelve months.

NOTE 6—The terms of standardization, verification, calibration, and check are defined in Specification D3666 Section 3.

8. Sampling

8.1 Specimens may be either laboratory-molded asphalt mixtures or from asphalt pavements.

8.2 Obtain field samples in accordance with Practice D979.

8.3 Pavement specimens shall be taken from pavements with a core drill, diamond or carborundum saw, or by other suitable means, in accordance with Practice D5361.

9. Test Specimens

9.1 *Size of Specimens*—It is recommended (I) that the diameter of cylindrically molded or cored specimens, or the

length of the sides of sawed 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.

9.2 Care shall be taken to avoid distortion, bending, or cracking of specimens during and after removal from pavements or mold. Specimens shall be stored in a safe, cool place.

9.3 Specimens shall be free of foreign materials such as seal coat, tack coat, foundation material, soil, paper, or foil. When any of these materials is visually evident, it shall be removed by sawing. Wire brushing to remove paper, soil, and foil is acceptable if all traces of the materials are eliminated.

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

10. Procedure

10.1 *For Cores and for Other Specimens that May Contain Moisture or Solvent*—Only specimens that are known to be thoroughly dry (that is, laboratory-prepared dried specimens), are to be tested in accordance with 10.2. All others are assumed to contain moisture or solvent and are to be tested in accordance with 10.1. The sequence of testing for 10.1 is: in water, saturated surface-dry, dry.

10.1.1 *Mass of Specimen in Water*—Completely submerge the specimen in the water bath at $25 \pm 1^\circ\text{C}$ [$77 \pm 1.8^\circ\text{F}$] for 3 to 5 min then determine the mass by weighing in water. Designate this mass as *C*. If the temperature of the specimen differs from the temperature of the water bath by more than 2°C [3.6°F], the specimen shall be immersed in the water bath for 10 to 15 min, instead of 3 to 5 min.

10.1.2 *Mass of Saturated Surface-Dry Specimen in Air*—Within 15 s of removing the sample from the water bath, surface dry the specimen by blotting quickly with a damp cloth towel and then determine the mass by weighing in air. Designate this mass as *B*.

10.1.3 After determining the mass in water and in a saturated surface-dry condition, thoroughly dry the specimen to a constant mass at $110 \pm 5^\circ\text{C}$ [$230 \pm 9^\circ\text{F}$]. Allow the specimen to cool and weigh in air. Designate this mass as *A*. Other methods may be used to dry the specimen as long as a constant mass is achieved (mass repeats within 0.1 %).

NOTE 7—Drying the specimen at the required temperature of 110°C [230°F] will change the characteristics and shape of the specimen. This will make the specimen unsuitable for further testing. Drying the specimen at a reduced temperature such as 52°C [125°F], in order to keep it intact, will not meet the requirements of this test method.

10.1.3.1 Practice D7227, microwave drying, or other approved methods may be used to dry the specimen if the specimen is not overheated and documentation exists showing that the results are equivalent to oven drying. The interval of time between readings to determine constant mass must be sufficient to ensure that all moisture and solvent has been removed. This interval is dependent on the size of the specimen and can be determined by experimentation and confirmed with the oven-dried comparisons. Documentation must exist to validate the intervals.

10.2 *For Laboratory-Prepared Thoroughly Dry Specimens:*

10.2.1 *Mass of Dry Specimen in Air*—Determine the mass by weighing the specimen after it has been standing in air at room temperature for at least 1 h. Designate this mass as *A*.

10.2.2 *Mass of Specimen in Water*—Use the same procedure as described in 10.1.1.

10.2.3 *Mass of Saturated Surface-Dry Specimen in Air*—Surface dry the specimen by blotting quickly with a damp cloth towel and then determine the mass by weighing in air. Designate this mass as *B*.

11. Calculation

11.1 Calculate the bulk specific gravity of the specimen as follows:

$$\text{Bulk sp gr} = A/(B - C) \quad (1)$$

where:

- A* = mass of the dry specimen in air, g [lb],
- $(B - C)$ = mass of the volume of water for the volume of the specimen at 25°C [77°F],
- B* = mass of the saturated surface-dry specimen in air, g [lb], and
- C* = mass of the specimen in water, g [lb].

11.2 Calculate the density of the specimen as follows:

$$\text{Density} = \text{Bulk sp gr} \times 997.0 \text{ (or } 62.24) \quad (2)$$

where:

$$997.0 \text{ (} 0.997 \text{ g/cm}^3 \text{)} = \text{density of water in kg/m}^3 \text{ at } 25^\circ\text{C} \text{ [} 77^\circ\text{F]}.$$

11.3 Calculate the percent water absorbed by the specimen (on volume basis) as follows:

$$\text{Percent water absorbed by volume} = \frac{B - A}{B - C} \times 100 \quad (3)$$

11.4 If the percent water absorbed by the specimen in 11.3 exceeds 2.0 %, use Test Method D1188 or D6752.

11.5 This test method has been written expressing density in kilograms per cubic metre. Conversion to express the density in pounds per cubic foot is acceptable.

12. Report

12.1 Report the following:

- 12.1.1 Bulk specific gravity of the mixture to the third decimal place as: bulk specific gravity at 25°C [77°F],
- 12.1.2 Density of the mixture with four significant figures in kg/m^3 or lb/ft^3 as: density at 25°C [77°F],
- 12.1.3 Type of mixture,
- 12.1.4 Size of sample, and
- 12.1.5 Water absorption, to the nearest 0.1 %.

13. Precision and Bias

13.1 *Precision:*

13.1.1 *Single-Operator Precision*—The single-operator standard deviations (1s limits) for specimens prepared in accordance with 10.2, for mixtures containing aggregate with absorption of less than 1.5 %, are shown in Table 1. The results of two properly conducted tests on the same material, by the

TABLE 1 Precision Estimates^A

	1s limit	d2s limit
Single-Operator Precision:		
12.5-mm nominal max agg.	0.008	0.023
19.0-mm nominal max agg.	0.013	0.037
Multilaboratory Precision:		
12.5-mm nominal max agg.	0.015	0.042
19.0-mm nominal max agg.	0.015	0.042

^A Based on an interlaboratory study conducted under NCHRP Project 9-26 involving 150-mm diameter specimens with 4.5 % air voids, 26 laboratories, two materials (a 12.5-mm mixture and a 19.0-mm mixture), and three replicates.

The precision statement in 13.1 was derived from data resulting from laboratories that compacted samples sent out by the AMRL.

same operator, using the same equipment, should be considered suspect if they differ by more than the d2s single operator limits shown in Table 1.

13.1.2 *Multilaboratory Precision*—The multilaboratory standard deviations (1s limits) for specimens prepared in accordance with 10.2, for mixtures containing aggregate with absorption of less than 1.5 %, are shown in Table 1. The results of two properly conducted tests on the same material, by different operators, using different equipment, should be considered suspect if they differ by more than d2s multilaboratory limits shown in Table 1.

13.2 *Bias*—No information can be presented on the bias of the procedure because no material having an accepted reference value is available.

14. Keywords

14.1 air voids; compaction; density; specific gravity; unit weight

SUMMARY OF CHANGES

Committee D04 has identified the location of selected changes to this standard since the last issue (D2726/D2726M – 14) that may impact the use of this standard. (Approved Jun. 1, 2017.)

(1) Revised subsections 10.1.2, 11.4, 11.5, and 12.1.5.

(2) Revised Note 1.

(3) Replaced “bituminous” with “asphalt” throughout.

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