Designation: D1188/D1188M – 22

Standard Test Method for Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Coated Samples[1]

This standard is issued under the fixed designation D1188/D1188M; 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 of specimens of Parafilm-coated, compacted asphalt mixtures.

1.2 This method should be used with samples that contain open or interconnecting voids or absorb more than 2.0 % of water by volume, or both.

NOTE 1—A method for calculating the percent water absorbed by the specimen on a volume basis is described in Test Method D2726/D2726M.

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 equivalents; 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, health, and environmental practices and determine the applicability of regulatory limitations 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]

D979/D979M Practice for Sampling Bituminous Paving Mixtures

D1461 Test Method for Moisture or Volatile Distillates in Asphalt Mixtures

D2726/D2726M Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt 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 Mixture Specimens Using Vacuum Drying Apparatus

E1 Specification for ASTM Liquid-in-Glass Thermometers

E1137/E1137M Specification for Industrial Platinum Resistance Thermometers

3. Significance and Use

3.1 This test method is useful in calculating percent air voids as given in Test Method D3203/D3203M. Since specific gravity has no units, it must be converted to density when this type of measurement is required. This conversion is made by multiplying the specific gravity at a given temperature by the density of water at the same temperature.

NOTE 2—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,

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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.

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.

4. Apparatus

4.1 *Balance,* with ample capacity and with sufficient sensitivity to enable bulk specific gravities to 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 it is suspended in water. To avoid erroneous readings by undue displacement of water, use wire or fishing 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 3—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 would provide four significant figures for the determination of a mass in the range from 130.0 to 999.9 g when the specific gravity is 2.300.

4.2 *Water Bath,* capable of maintaining a temperature of 25 ± 1 °C [77 ± 1.8 °F] for immersing the specimen in water while suspended, and equipped with an overflow outlet for maintaining a constant water level. The water in the bath shall always be kept at the same level as the overflow outlet. The use of an overflow outlet is mandatory.

NOTE 4—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.

4.3 *Thermometer,* for measuring the temperature of the water bath, with a temperature range from at least 20 to 30 °C [68 to 86 °F] with a tolerance range of ±0.25 °C [±0.45 °F].

4.3.1 Thermometers that can meet these requirements include a 17C [17F] Specification E1, a Class A Pt-100 RTD (Specification E1137/E1137M) with a three or four-wire configuration at the connection terminal, and an NTC thermistor. The electronic sensors need to be in a stainless steel metal sheath and paired with an appropriate meter capable of displaying the temperature to at least two decimal places.

NOTE 5—The ASTM 17C has a maximum scale error of 0.1 °C and Class A Pt-100 RTD thermometers have a tolerance range of ±0.1 °C. This tolerance range is also typically available for thermistor thermometers.

5. Materials

5.1 *Parafilm*—100 mm [4 in.] wide roll of elastomeric film obtainable from most scientific suppliers.

NOTE 6—Parafilm rolls come in various lengths. Typical lengths range from 38 to 76 m [125 to 250 ft].

5.2 *Polyurethane Foam Mat (Two Pieces)*—To be used for pressing the Parafilm onto the surface of the specimen. One piece of the foam mat shall be larger than the specimen diameter (working surface). The second piece shall be approximately the same diameter of the specimen (interface between specimen and load used to press film onto surface).

NOTE 7—The soft, compressible interface between the counter and specimen, and between the top of the specimen helps minimize the potential for sharp aggregate edges to puncture the film.

5.3 *Calibration Specimen*—A smooth-sided aluminum cylinder approximately the same size as the asphalt mixture specimens being tested.

NOTE 8—Aluminum is used for the calibration specimen because it is readily available from local machine shops and has a specific gravity that is close to that of traditional compacted dense-graded asphalt mixture specimens (from around 2.64 to 2.81).

6. Test Specimens

6.1 Test specimens may be molded from laboratory-mixed field samples or be cut from asphalt pavement in the field. Field samples should be obtained in accordance with Practice D979/D979M. Pavement specimens shall be taken from pavements with a core drill, diamond or carborundum saw, or other suitable means, in accordance with Practice D5361/D5361M.

6.2 *Size of Specimens*—It is recommended (*1*) 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.

6.3 Take pavement specimens from pavements with a core drill, diamond or carborundum saw, or by other suitable means.

6.3.1 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.

6.3.2 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 in accordance with 6.3.3.

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

7. Procedure

7.1 *Mass of Uncoated Specimens:*

7.1.1 For cores and for other specimens that may contain moisture or solvents, thoroughly dry specimens under a fan until a constant mass has been achieved and determine the mass of the specimen. A constant mass is defined as less than a 0.05 % change in mass between consecutive 15 min drying intervals. Other methods such as Practice D7227/D7227M may be used to dry the specimen as long as a constant mass is achieved (mass repeats within 0.1 %). Designate this mass as *A*.

7.1.2 Laboratory-prepared specimens, including plant-mixed, laboratory compacted specimens, are considered to be dry and can be tested without additional drying.

7.2 *Mass of Coated Specimen:*

7.2.1 Cut Parafilm for wrapping the specimen ends.

7.2.1.1 For 100 mm [4 in.] diameter specimen, cut two approximately 100 mm [4 in.] and one 200 mm [8 in] lengths of Parafilm.

7.2.1.2 For 150 mm [6 in.] diameter specimen, cut at least two approximately 150 mm [6 in.] and one 200 mm [12 in.] lengths of Parafilm. More than two pieces of 150 mm [6 in.] Parafilm may be needed to cover the ends of the cylindrical specimen.

7.2.2 Peel the backing off one of the shorter lengths of Parafilm. Grasp opposite sides of the film and stretch the film so that the dimensions increase by about 50 %.

NOTE 9—For example, a 100 mm by 100 mm [4 by 4 in.] piece of Parafim should be stretched to about 150 by 150 mm [6 by 6 in.].

7.2.2.1 Place the stretched film over one end of the specimen and press the film onto and around the specimen. Take care not to puncture the film when coating rough surfaces. It may be necessary to use two pieces of Parafilm to completely cover the ends of 150 mm [6 in.] diameter specimens.

7.2.2.2 Turn the specimen over and place on the foam mat. Cover the other end of the specimen with another sheet of the stretched Parafilm.

7.2.2.3 Eliminate the air pockets from both Parafilm-coated surfaces. After both ends have been wrapped (and working on the foam mat), place the second piece of foam on top of the specimen and press down on top of the foam. Another cylindrical specimen can be used to press down on the foam. This will eliminate the air pockets from both surfaces.

7.2.2.4 Trim off excess Parafilm. Use a sharp knife to trim the excess film from the sides of the specimen. Leave a border of compressed Parafim that is sufficient to hold the Parafilm in place until the side of the specimen is wrapped and compressed. Take care not to damage the specimen. There should be a minimum of 15 mm [approximately 0.5 in.] of film remaining on the sides of the specimen.

7.2.3 Cover circumference of specimen. Peel the backing off of the remaining piece of film. Grasp the film at the ends and stretch out to about 400 mm [16 in.].

7.2.3.1 With the specimen still on the foam mat, place one end of the stretched film on the side of the specimen and roll the specimen over so that the film is stretched tightly over the surface.

7.2.3.2 Fold and press the edges around and over the ends of the specimen. Make sure that any pockets of air are eliminated.

7.2.4 When specimens have rough or uneven surfaces or both, it may be necessary to use an additional layer of stretched Parafilm to prevent any water from leaking under the film. In these cases, care is needed to keep any air from being trapped within the film coating.

7.2.5 Determine the mass of the coated specimen in air. Designate this mass as *D*.

7.3 *Mass of Coated Specimen in Water:*

7.3.1 Completely submerge the coated specimen in the water bath at 25 ± 1 °C [77 ± 1.8 °F] for 3 to 5 min, then determine the mass by weighing in water. Measure the temperature of the water and if it is different from 25 ± 1 °C [77 ± 1.8 °F], a correction to the bulk specific gravity to 25 °C must be made in accordance with 9.3. 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. Designate this mass as *E*.

7.4 *Apparent Specific Gravity of Parafilm:*

7.4.1 Determine the specific gravity of the calibration specimen. Determine the mass of the calibration specimen in air and then under water at 25 °C [77 °F] ± 1 °C [1.8 °F]. Calculate the specific gravity of the calibration specimen as:

$$G_{Al} = (A_{Al}) / (A_{Al} - B_{Al}) \quad (1)$$

where:

A_{Al} = dry mass in air, g, and
B_{Al} = mass under water, g.

7.4.2 Dry and wrap calibration cylinder with Parafilm as described in 7.2 and determine the dry, wrapped mass and the mass of the wrapped specimen under water.

7.4.3 Determine the specific gravity of the Parafilm at 25 °C [77 °F] ± 1 °C [1.8 °F]:

$$F = (D_{Al} - A_{Al}) / (D_{Al} - E_{Al} - A_{Al} / G_{Al}) \quad (2)$$

where:

D_{Al} = dry mass of wrapped calibration specimen, g, and
E_{Al} = mass of wrapped calibration specimen under water, g.

8. Moisture Correction (if specimen is not dried prior to testing)

8.1 In case the specimen has been obtained during construction or from a pavement and contains moisture, it is necessary to correct the masses determined in the following sections.

8.2 The moisture may be determined by one of two methods.

8.2.1 Determine the original mass of the sample. Then dry the uncoated sample to a constant mass in an oven maintained at a temperature of approximately 110 °C [230 °F]. A constant mass is defined as less than a 0.05 % change in mass between consecutive 15 min drying intervals. Designate this oven-dry mass as E_{dry}. The mass of the moisture, E_{moist} is:

$$E_{moist} = E_{original} - E_{dry} \quad (3)$$

where:

$E_{original}$ = original mass of the specimen, g, and
E_{dry} = oven-dry mass, g.

8.2.1.1 Subtract E_{moist} from any further determinations of mass in subsequent sections.

8.2.2 Alternatively, determine the mass of moisture in the specimens by using Test Method D1461. This method should be used if the asphalt binder material in the mixture contains any distillates volatile at a temperature of 110 °C [230 °F]. The mass of the moisture is then subtracted from any determination of mass in the following sections.

9. Calculations

9.1 Calculate the bulk specific gravity of the film-coated specimen as follows:

$$\text{Bulk Specific Gravity} = A / D - E - ((D - A) / F) \quad (4)$$

where:

A = mass of dry specimen in air, g,
D = mass of dry, coated specimen, g,
E = mass of coated specimen under water, g, and