

5.9.15 BULK SPECIFIC GRAVITY AND UNIT WEIGHT OF COMPACTED HOT MIX ASPHALT
(HMA) (Kansas Test Method KT-15)

1. SCOPE

This method of test covers the procedure for determining the bulk specific gravity of specimens of compacted asphalt mixtures. The specimens may have been molded in the laboratory or cut or cored from compacted pavements. **KT-15** reflects testing procedures found in **AASHTO T 166** and **AASHTO T 331**.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9.; Sampling and Test Methods Forward

2.2. AASHTO T 166; Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface – Dry Specimens

2.3. AASHTO T 331; Bulk Specific Gravity and Density of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method

3. APPARATUS

3.1. The balance shall conform to the requirements of **Part V, 5.9; Sampling and Test Methods Forward**, for the class of general purpose balance required for the principal sample mass of the sample being tested.

3.2. Wire basket formed of No. 4 (4.75 mm) mesh hardware cloth, 1/4 in (6.3 mm) mesh or perforated shelf or suitable bucket. The size shall be sufficient to fully support the specimen.

3.3. Container with overflow device, for immersing the wire basket, shelf or bucket in water and maintaining a constant water level.

3.4. Measuring device to establish the physical dimensions of a specimen.

3.5. Vacuum chamber with a 1.25 h (0.93kW) pump capable of evacuating a sealed and enclosed chamber to 29.5 in Hg vacuum (100 kPa vacuum) in less than 60 seconds. The chamber shall be large enough to seal samples of 6 in (150 mm) wide by 14 in (350 mm) long by 6 in (150 mm) 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.

3.6. Plastic bags used with the vacuum device shall be one of the two following sizes. The smaller bags shall have a minimum opening of 9.25 in (235 mm) and a maximum opening 10.25 in (260 mm). The

larger bags shall have a minimum opening of 14.75 in (275 mm) and a maximum opening of 15.5 in (294 mm).

3.7. Specimen sliding plate used within the vacuum chamber for reduction of friction on the plastic bags.

4. PROCEDURE

4.1. The bulk specific gravity of a compacted asphalt mix specimen is determined by computing the ratio of its mass in air to its bulk volume. Procedure I is a rapid method which generally provides sufficient accuracy for the routine testing of specimens with dense, impermeable surfaces. Procedure II corresponds to **AASHTO T 331** test method for Bulk Specific Gravity and Density of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method. Procedure III is a laboratory method which is used to determine the bulk specific gravity of saturated specimens, and corresponds to **AASHTO T 166, Method A**. This method is most suitable for testing specimens with slightly permeable surfaces in order to obtain the water absorption. Procedure IV is a method which establishes the bulk specific of specimens which are composed of “open” mixes that typically display high porosity and permeability. In the event of dispute, Procedure IV will take precedence over Procedures I & II. Marshall and Superpave design specimens molded at the estimated “optimum” asphalt content will be subjected to Procedure III to determine the water absorption (by volume). If the water absorption is equal to or greater than 2.0%, Procedure II shall be used for both design and routine or field purposes.

4.2. Procedure I

4.2.1. Weigh specimen at room temperature to the nearest 0.1 g after it has been standing at room temperature for approximately 1 hour after removal from the mold.

4.2.2. Place the specimen in the basket or bucket and determine its mass to the nearest 0.1 g while immersed in water with a temperature of $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$). The mass of the specimen in water shall be determined as quickly as possible after the specimen is immersed. This method should not be used if the specimen contains open or interconnecting voids.

4.3. Procedure II

4.3.1. Dry the specimen to constant mass and weigh it to the nearest 0.1g.

NOTE: Constant mass shall be defined as the mass at which further drying at $125 \pm 5^\circ$ ($52 \pm 3^\circ\text{C}$) does not alter the mass by more than 0.05%. The specimen shall initially be dried overnight at $125 \pm 5^\circ$ ($52 \pm 3^\circ\text{C}$) and then weighed at one-hour¹ intervals.

4.3.2. Cool the specimen to $77 \pm 5^\circ\text{F}$ ($25 \pm 3^\circ\text{C}$) or less.

¹ **AASHTO T 166** and **T 331** require a two-hour interval.

4.3.3. Select an appropriate size bag. For all 4 in (100 mm) diameter samples and samples with 6 in (150 mm) diameter and less than 2 in (50 mm) thickness, it is possible to use the bag with the smaller opening size.

4.3.4. Place a bag inside the vacuum chamber on top of the sliding plate.

4.3.5. Gently open the bag and place the specimen in the plastic bag on top of the sliding plate, while being careful not to handle the bag in such a manner that would create a puncture.

4.3.6. 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.

4.3.7. 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.

4.3.8. Remove the sealed specimen from the vacuum chamber. Handle the sealed specimen with extreme care.

4.3.9. Weigh the sealed specimen in air to the nearest 0.1g.

4.3.10. Weigh the sealed specimen while immersed in water at $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$) to the nearest 0.1 g. Verify that no air bubbles are entrapped underneath the plastic bag material. This can be accomplished by placing the sealed specimen in water with the plastic bag oriented in a vertical direction.

4.3.11. Reweigh the sealed specimen in air to the nearest 0.1 g.

4.4. Procedure III

4.4.1. For cores, dry the specimen to constant mass. Cool the specimen to room temperature and weigh the dry mass to the nearest 0.1 g, and record as A. Immerse the specimen in a $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$) water bath, let saturate for 4 ± 1 minutes, then weigh and record mass as C. Remove the immersed and saturated specimen from the water bath, quickly damp dry the saturated specimen with a damp absorbent cloth and as quickly as possible, weigh and record the specimen as B. Any water which seeps from the specimen during the weighing operation is considered as part of the saturated specimen.

4.4.1.1. Specimens are defined to be at room temperature when meeting the following procedure: Check surface temperature. Let the specimen set for 5 minutes while at ambient air conditions (no flow of any type should be flowing across the specimen). Recheck the surface temperature. The original check and recheck must fall within $77 \pm 5^\circ\text{F}$ ($25 \pm 3^\circ\text{C}$) or the specimen temperature has not stabilized to room temperature.

NOTE: If desired, the sequence of testing operations can be changed to expedite the test results. For example, first the mass of saturated damp dry specimen can be taken. Then the saturated specimen in water can be weighed. The dry mass of the specimen can be determined last.

NOTE: Terry cloth has been found to work well for an absorbent cloth. Damp is considered to be when no water can be wrung from the towel.

4.5. Procedure IV

4.5.1. Dry the specimen to constant mass (see **NOTES** in **Section 4.3.1 and 4.4.1.1** of this test method).

4.5.2. After the specimen has cooled to room temperature, weigh it to the nearest 0.1 g.

4.5.3. Measure the height of the specimen to the nearest 0.001 in (0.025 mm) at four approximately equally spaced locations and average the four measurements. The diameter of the test specimen shall be determined to the nearest 0.001 in (0.025 mm) by averaging three diameters measured at $120 \pm$ degree angles to each other at about midheight of the specimen. The average diameter shall be used in calculations.

5. CALCUALTIONS

A = Mass of dry specimen in air, g.

B = Mass of saturated specimen in air after 4 minutes in water, g.

C = Mass of saturated specimen in water, g.

D = Mass of sealed specimen in air, g.

E = Mass of sealed specimen in water, g.

F = Apparent specific gravity of plastic sealing material at $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$).

V = Calculated volume of specimen at $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$).

G = Mass of specimen weighed immediately in water, g.

d = Specimen diameter (in [mm]).

h = Specimen height (in [mm]).

5.1. Procedure I: Bulk Specific Gravity (G_{mb})

$$G_{mb} = \frac{A}{(A-G)}$$

5.2. Procedure II: Bulk Specific Gravity of Plastic Sealed Specimens

$$G_{mb} = \frac{A}{(D - E) - \left(\frac{D-A}{F}\right)}$$

5.3. Procedure III: Bulk Specific Gravity and Absorption of Saturated Samples

$$G_{mb} = \frac{A}{(B-C)}$$

Calculate the percent of water absorbed by the specimen as follows:

$$\% \text{ Water Absorbed (Volume Basis)} = \frac{100 \times (B-A)}{(B-C)}$$

5.4. Procedure IV: Bulk Specific Gravity by Physical Dimensions

$$\text{Vol (in}^3\text{)} = (0.7854) (d^2) (h) \text{ (English)}$$

$$\text{Vol (mm}^3\text{)} = (0.7854) (d^2) (h) \text{ (SI)}$$

$$\text{Unit wt. (lb/ft}^3\text{)} = \frac{3.8096 \text{ (mass in grams)}}{\text{Volume in in}^3} \text{ (English)}$$

$$\text{Unit wt. (kg/m}^3\text{)} = \frac{1,000,000 \text{ (mass in grams)}}{\text{Volume in mm}^3} \text{ (SI)}$$

$$G_{mb} = \frac{\text{Unit weight in lb/ft}^3}{62.243^d} \text{ (English)}$$

$$G_{mb} = \frac{\text{Unit weight in kg/m}^3}{997.04^d} \text{ (SI)}$$

NOTE: Density of water varies based on temperature. Since the water bath temperature is fixed at $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$), use the specified values. For tests not restrained by the $77 \pm 2^\circ\text{F}$ ($25 \pm 1^\circ\text{C}$) requirement, temperature correction can be determined by selecting the proper density for water from **Table 1**.

Table 1
Density of Water

	Temperature		Density	
	°C	°F	kg/m ³	lb/ft ³
	15	59.0	999.09	62.371
	16	60.8	998.94	62.362
	17	62.6	998.77	62.351
	18	64.4	998.60	62.341
	19	66.2	998.40	62.328
	20	68.0	998.20	62.316
	21	69.8	997.99	62.302
	22	71.6	997.77	62.289
	23	73.4	997.54	62.274
	24	75.2	997.30	62.259
	25	77.0	997.04	62.243
	26	78.8	996.78	62.227
	27	80.6	996.50	62.209
	28	82.4	996.23	62.193
	29	84.2	995.94	62.175
	30	86.0	995.65	62.156
	31	87.8	995.34	62.137
	32	89.6	995.03	62.118
	33	91.4	994.70	62.097
	34	93.2	994.37	62.077
	35	95.0	994.03	62.055

NOTE: The table was derived from the table 10-28 of Lange's Handbook of Chemistry; Twelfth Edition; Copyright 1979.

5.5. SG_{corr.}

$$SG_{corr.} = \left(\frac{d_w}{997.04} \right)$$

Where: d_w = density of water at temperature other than 77 ± 2°F (25 ± 1°C).

6. PRECISION

6.1. Duplicate determinations by multi laboratory, multi operator shall check to within 0.031. This value is derived from the 2006 Independent Assurance Gyratory Comparisons.