

BULK SPECIFIC GRAVITY AND BULK DENSITY OF COMPACTED BITUMINOUS MIXTURES

(A Modification of AASHTO Designation T 166 and PP 75)

1. SCOPE

- 1.1 This procedure covers the determination of bulk specific gravity and bulk density of specimens of compacted bituminous mixtures.
- 1.2 This test procedure consists of three methods for determining bulk specific gravity and bulk density. These methods are referred to as "Method A", "Method C (Rapid Test)", and "Vacuum Method".

Note: If it is desired to use "Method B", which is not included in this procedure, AASHTO T 166 shall be referred to. Method B should not be used with samples that contain open or interconnecting voids and/or absorb more than 2.0 percent water by volume. Method B is not acceptable for specimens that have more than six percent air voids.
- 1.3 Method A should not be used with samples that contain open or interconnecting voids and/or absorb more than 2.0 percent water by volume as determined in Subsection 7.4. If the percent water absorbed by the specimen exceeds 2.0 percent, either Method C, Vacuum Method, or AASHTO T 275 "Bulk Specific Gravity (G_{mb}) of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimens" shall be used.
- 1.4 Referee testing shall be performed in accordance with "Method C".
- 1.5 This test method involves hazardous material, operations, and equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
- 1.6 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. TEST SPECIMENS

- 2.1 Test specimens may be either laboratory molded specimens or samples from an existing bituminous pavement.
- 2.2 Size of specimens - It is recommended that: (1) the diameter of cylindrically molded or cored specimens, or the length of the sides of sawed specimens, be at least four times the maximum size of the aggregate and, (2) the thickness of specimens be at least one and one half times the maximum size of the aggregate.
- 2.3 Specimens obtained from bituminous pavements shall be taken with a core drill, diamond or carborundum saw, or by other suitable means.
- 2.4 Care shall be taken to avoid distortion, bending, or cracking of specimens during and after the removal from the pavement or mold. Specimens shall be stored in a safe, cool place.
- 2.5 Test specimens shall be free from paper, tape, soil, and other foreign materials not intended to be tested as part of the specimen.
- 2.6 If desired, specimens may be separated from other pavement layers by sawing or other suitable means. Care shall be exercised to ensure that specimens are not damaged during the separation process.

3. APPARATUS

- 3.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:
 - 3.1.1 Balance - A balance capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance utilized shall be at least 0.1 gram. The balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the specimen while suspended from the center of the balance.

- 3.1.2 Suspension Apparatus - The wire(s) suspending the holder shall be the smallest practical size to minimize any possible effects of a variable immersed length. The suspension apparatus shall be constructed to enable the container to be immersed to a depth sufficient to cover it and the test sample during weighing.
- 3.1.3 Water bath - The water bath for immersing the specimen in water while suspended under the balance shall be equipped with an overflow outlet or a clearly marked "fill line" for maintaining a constant water level. The level of the water shall be adjusted before testing each specimen, if necessary, to maintain a constant water level.
- 3.1.4 Oven - An oven capable of drying specimens at either 125 ± 5 °F (Method A) or 290 ± 10 °F (Method C).
- 3.1.5 Vacuum Drying Device (For Vacuum Method) – Conforming to the requirements of AASHTO PP 75. Automatic controls of the unit shall be calibrated by the manufacturer prior to initial use.

METHOD A

4. PROCEDURE

- 4.1 Dry the specimen to constant mass. Constant mass shall be defined as the mass at which further drying at 125 ± 5 °F does not alter the mass by more than 0.1 gram. Samples saturated with water shall initially be dried overnight at 125 ± 5 °F and then weighed at two-hour drying intervals. Recently molded laboratory samples, which have not been exposed to moisture, do not require drying.
- 4.2 Cool the specimen to room temperature at 77 ± 9 °F and record the dry mass to the nearest 0.1 gram as "A".
- 4.3 Immerse the specimen in water at 77 ± 2 °F for 4 ± 1 minutes and record the immersed mass to the nearest 0.1 gram as "C". Care shall be exercised to ensure that no trapped air bubbles exist under the specimen.
- 4.4 Remove the specimen from the water, quickly damp dry the specimen surface by blotting with a damp towel, and as quickly as possible determine and record the surface-dry mass to the nearest 0.1 gram as "B". Any water that seeps from the specimen during the surface-dry

weighing operation is considered as part of the specimen. The determination of the immersed mass and surface-dry mass of each specimen will be completed before the next specimen is submerged for its immersed mass determination.

Note: A terry cloth towel has been found to work well. Damp is considered to be when no water can be wrung from the towel.

Note: If desired, the sequence of testing operations may be changed to expedite the test results. For example, first the immersed mass, "C", can be taken, then the surface-dry mass, "B", and finally the dry mass, "A".

- 4.5 Calculate the bulk specific gravity, bulk density, and percent water absorption by volume in accordance with Section 7.

METHOD C (RAPID TEST)

5. PROCEDURE

- 5.1 This procedure can be used for testing specimens which are not required to be saved and which contain a substantial amount of moisture. Specimens obtained by methods that introduce moisture, such as wet coring or sawing, can generally be tested the same day by this method.
- 5.2 Ensure the specimen is at room temperature (77 ± 9 °F).
- 5.3 Immerse the specimen in water at 77 ± 2 °F for 4 ± 1 minutes and record the immersed mass to the nearest 0.1 gram as "C". Care shall be exercised to ensure that no trapped air bubbles exist under the specimen.
- 5.4 Remove the specimen from the water, quickly damp dry the specimen surface by blotting with a damp towel, and as quickly as possible determine and record the surface-dry mass to the nearest 0.1 gram as "B". Any water that seeps from the specimen during the surface-dry weighing operation is considered as part of the specimen. The determination of the immersed mass and surface-dry mass of each specimen will be completed before the next specimen is submerged for its immersed mass determination.

- 5.5 Place the specimen in a large, flat-bottom drying pan of known weight. Place the pan and specimen in a 290 ± 10 °F oven. Leave the specimen in the oven until it can be easily separated to the point where particles of the fine aggregate portion are not larger than 1/4 inch. During separation of material, ensure that no material is lost. Place the separated specimen in the 290 ± 10 °F oven and dry to constant mass. (Constant mass shall be determined as follows: Dry the sample for a minimum of 1 hour at 290 ± 10 °F. Record the weight of the sample to the nearest 0.1 gram. Continue drying and weighing until the weight does not change more than 0.1 gram at drying intervals of a minimum of 30 minutes.)
- 5.6 Cool the pan and specimen to room temperature at 77 ± 9 °F. Weigh the pan and specimen, subtract the mass of the pan, and record the dry mass of the specimen to the nearest 0.1 gram as "A".
- Note:** For Method C, the drying of specimens to constant weight may be accomplished in a microwave oven, as described in Arizona Test Method 719.
- 5.7 Calculate the bulk specific gravity, bulk density, and percent water absorption by volume in accordance with Section 7.

VACUUM METHOD

6. PROCEDURE

- 6.1 This procedure can be used for testing specimens, which are to be saved, and which contain a substantial amount of moisture. Specimens obtained by methods that introduce moisture, such as wet coring or sawing, can generally be tested the same day by this method.
- 6.2 Turn on the vacuum drying device. Follow the manufacturer's recommendations for warm up and self-test procedures.
- 6.3 Run the vacuum drying device without any specimens. The pressure reading on the display should indicate a known dry point value as recommended by the manufacturer. If the indicated dry point is not achieved, refer to the manufacturer's trouble shooting instructions.
- 6.4 Ensure the specimen is at room temperature (77 ± 9 °F).

- 6.5 Remove any standing water from the surface of the specimen by using a paper towel or an absorptive cloth.
- 6.6 Dry the cold trap and the specimen chamber. Place the specimen inside the vacuum chamber.
- Note:** Two 4-inch diameter specimens, that are less than 3-inches in thickness can be placed side-by-side in the chamber during a single drying cycle. Larger specimens shall be placed in the chamber individually.
- Note:** Water and/or ice may buildup in the moisture trap during a drying cycle. Wipe off any free standing water in the moisture trap between drying specimens. This will expedite specimen drying.
- 6.7 Place the lid on the vacuum chamber and press the lid down to ensure secure contact between the lid and the chamber. Press the appropriate key on the vacuum drying device to begin the drying process.
- 6.8 The vacuum drying device will automatically stop when the specimen is dry. The unit shall be calibrated to sense the "dry specimen condition". The "dry specimen condition" shall be determined from the calibrated pressure at which no water remains in the chamber. The pressure is monitored throughout the drying process to ensure that the "dry specimen condition" pressure is achieved in the device.
- 6.9 Remove the specimen from the vacuum drying device. Weigh the specimen and record the dry mass of the specimen to the nearest 0.1 gram as "A".
- 6.10 Immerse the specimen in water at 77 ± 2 °F for 4 ± 1 minutes and record the immersed mass to the nearest 0.1 gram as "C". Care shall be exercised to ensure that no trapped air bubbles exist under the specimen.
- 6.11 Remove the specimen from the water, quickly damp dry the specimen surface by blotting with a damp towel, and as quickly as possible determine and record the surface-dry mass to the nearest 0.1 gram as "B". Any water that seeps from the specimen during the surface-dry weighing operation is considered as part of the specimen. The determination of the immersed mass and surface-dry mass of each specimen will be completed before the next specimen is submerged for its immersed mass determination.

Note: If desired, the sequence of testing operations may be changed to expedite the test results. For example, first the immersed mass, "C", can be taken, then the surface-dry mass, "B", and finally the dry mass, "A".

- 6.12 Calculate the bulk specific gravity, bulk density, and percent water absorption by volume in accordance with Section 7.

7. CALCULATION

- 7.1 Calculate and record the bulk specific gravity of the specimen to the nearest 0.001 as follows:

$$\text{Bulk Specific Gravity} = \frac{A}{B - C}$$

Where: A = mass of dry specimen
B = mass of surface-dry specimen
C = mass of immersed specimen

- 7.2 Calculate and record the bulk density of the specimen to the nearest 0.1 lb/cu ft by multiplying the bulk specific gravity by 62.3 lbs/cu ft.

- 7.3 For laboratory molded specimens of 1/2-inch or 3/4-inch asphaltic concrete mixes, the range of bulk density results for three replicate specimens shall not differ by more than 2.5 lbs/cu ft. For laboratory molded specimens of asphaltic concrete Base Mixes, the range of bulk density results for three replicate specimens shall not differ by more than 3.0 lbs/cu ft. If the respective requirement is not met, the entire set of specimens shall be discarded and a new set of specimens shall be prepared and tested.

- 7.4 Calculate and record the percent water absorbed by the specimen to the nearest 0.01 percent (on volume basis) as follows:

$$\text{Percent Water Absorption by Volume} = \frac{B - A}{B - C} \times 100$$

8. REPORT

- 8.1 The method that was used.
- 8.2 The bulk specific gravity to the nearest 0.001.
- 8.3 The bulk density to the nearest 0.1 lb/cu ft.
- 8.4 The absorption to the nearest 0.01 percent.