BULK SPECIFIC GRAVITY (G_{mb}) AND DENSITY OF COMPACTED ASPHALT MIXTURES USING AUTOMATIC VACUUM SEALING METHOD FOP FOR AASHTO T 331

Scope

This method covers the determination of bulk specific gravity (G_{mb}) of compacted asphalt mixture specimens in accordance with AASHTO T 331-13.

Overview

This method is used when specimens have open or interconnecting voids or absorb more than 2.0 percent of water by volume, or both, according to the FOP for AASHTO T 166.

Bulk specific gravity (G_{mb}) determined by this method may be lower, and air voids higher, than the results determined according to the FOP for AASHTO T 166. The differences may be more pronounced for coarse and absorptive mixtures. This procedure should be followed during laboratory mix designing if it will be used for control or assurance testing.

Test Specimens

Test specimens may be either laboratory-molded or sampled from asphalt mixture pavement. For specimens it is recommended that the diameter be equal to four times the maximum size of the aggregate and the thickness be at least one and one half times the maximum size of the aggregate.

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Terminology

Constant Mass: The state at which a mass does not change more than a given percent, after additional drying for a defined time interval, at a required temperature.

Apparatus

- Bag cutter: knife or scissors
- Balance or scale: 5 kg capacity, readable to 0.1 g, and fitted with a suitable suspension apparatus and holder to permit weighing the specimen while suspended in water, conforming to AASHTO M 231.
- Suspension apparatus: Wire of the smallest practical size and constructed to permit the container to be fully immersed.
- Water bath: For immersing the specimen in water while suspended under the balance or scale and equipped with an overflow outlet for maintaining a constant water level.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying the specimens to a constant mass.
- Thermometer: Having a range of 19 to 27°C (66 to 80°F), graduated in 0.1°C (0.2°F) subdivisions.

- Plastic bags: puncture resistant impermeable plastic bags that will not stick to the specimen and capable of withstanding temperatures up to 70°C (158°F). Between 0.100 mm (0.004 in.) and 0.152 mm (0.006 in.) thick. The bag correction factor (apparent specific gravity) is supplied by the manufacturer.
  - Small bag: less than 35 g with an opening between 235 mm (9.25 in.) and 260 mm (10.25 in.)
  - Large bag: 35 g or more with an opening between 375 mm (14.75 in.) and 394 mm (15.5 in.)

Note 1: The bag correction factor is usually located in the operator's manual. See the manufacturer's recommendations to ensure proper handling of bags.

- Specimen sliding plates: removable level and smooth-sided planar filler plates shall be inserted into the chamber to keep the samples of various heights level with the seal bar while being sealed.
- Specimen support plate: a plate with a cushioning membrane on top large enough to fully support the specimen and can easily slide on top of the smooth-sided plates.
- Vacuum chamber and sealing device: meeting the requirements of AASHTO T 331
- Vacuum gauge: meeting the requirements of AASHTO T 331

Procedure

Recently molded laboratory samples that have not been exposed to moisture do not need drying.

1. Dry the specimen to constant mass, if required.
   a. Oven method
      i. Initially dry overnight at 52 ±3°C (125 ±5°F).
      ii. Determine and record the mass of the specimen. Designate as M_p.
      iii. Return the specimen to the oven for at least 2 hours.
      iv. Determine and record the mass of the specimen. Designate as M_n.
      v. Determine percent change by subtracting the new mass determination, M_n, from the previous mass determination, M_p, divide by the previous mass determination, M_p, and multiply by 100.
      vi. Continue drying until there is no more than 0.05 percent change in specimen mass after 2-hour drying intervals (constant mass).
      vii. Constant mass has been achieved; sample is defined as dry.
   b. Vacuum dry method according to the FOP for AASHTO R 79.
2. Cool the specimen in air to 25 ±5°C (77 ±9°F), and determine and record the dry mass to the nearest 0.1 g. Designate this mass as A.

Note 1: 3000 to 6000 g laboratory compacted specimens may be considered room temperature after 2 hr. under a fan. Cooling time may be reduced for smaller specimens.

3. Fill the water bath to overflow level with water at 25 ±1°C (77 ±1.8°F) and allow the water to stabilize
4. Seal the specimen.
   a. Use a large bag for 150 mm (6 in.) in by 50 mm (2 in.) or greater specimens. Use a small bag for smaller specimens.
   b. Set the heat-sealing bar temperature according to manufacturer's directions.
   c. Inspect the bag for holes and irregularities.
   d. Determine and record the mass of the bag. Designate as B.
   e. Adjust filler plates in the vacuum chamber, adding or removing plates as needed.
   f. Place specimen support plate on top of filler plates.
   g. Place the bag on top of the specimen support plate in the vacuum chamber.
   h. Insert the specimen into the bag with the smoothest plane of the specimen on the bottom.

Note 2: Inserting the specimen into the bag may be done inside the chamber while holding the bag open with one hand over the sliding plate and gently inserting the specimen with the other hand. There should be about 25 mm (1 in.) of slack between the presealed bag end and the specimen.

   i. Grab the unsealed end of the bag on each side.
   j. Gently pull and center the bag over the seal bar, overlapping at least 25 mm (1 in.). Ensure that there are no wrinkles in the bag along the seal bar before closing the lid.
   k. Close the lid and engage the lid-retaining latch.

Note 3: The vacuum pump light will illuminate "red," and the vacuum gauge on the exterior of the chamber will become active, or a digital reading will show the vacuum state. It is normal for the bag to expand or "puff up" during this process.

   l. Once sealed, the 'de-vac' valve will open, and air will enter the chamber, causing atmospheric pressure to collapse the bag around the specimen.
   m. Disengage the lid-retaining latch, and carefully remove the sealed specimen from the chamber. Gently pull on the bag where it appears loose. Loose areas indicate a poor seal and the process must then be restarted at Step 4 with a new bag and a new initial mass.
5. Zero or tare the balance with the immersion apparatus attached, ensuring that the device is not touching the sides or the bottom of the water bath.
6. Fully submerge the specimen and bag shaking to remove the air bubbles. Ensure no air is trapped under the bag or in the bag creases. Place the specimen on its side in the suspension apparatus.
7. Allow water level and scale to stabilize.
8. Determine and record the submerged weight to the nearest 0.1 g. Designate this submerged weight as E.

Note 4: Complete Steps 4 through 7 in 1 min. or less to reduce potential for bag leaks.

9. Cut the bag open.
10. Remove the specimen from the bag.
11. Determine the mass of the specimen. Designate as C.
12. Compare this mass, C, with initial dry mass determined in Step 2, A.
    If more than 0.08 percent is lost or more than 0.04 percent is gained, return to Step 1.
13. Calculate G_{mb} and record to three decimal places.

Calculations

Calculate constant mass using the following formula:

$$\%Change = \frac{M_p - M_n}{M_p} \times 100$$

Where:

M_p = previous mass measurement, g

M_n = new mass measurement, g

Calculate the bulk specific gravity (G_{mb}) using the following formula:

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

Where:

G_{mb} = bulk specific gravity

A = mass of dry specimen in air, g

B = mass of the bag in air, g

C = final mass of the specimen after removal from the sealed bag, g

E = mass of the sealed specimen underwater, g

F = bag correction factor (apparent specific gravity), provided by the bag manufacturer

Example

$$G_{mb} = \frac{4833.6\ g}{4833.6\ g + 50.2\ g - 2860.4\ g - \left(\frac{50.2\ g}{0.756}\right)} = 2.470$$

Given:

A = 4833.6 g
B = 50.2 g
C = 4833.6 g
E = 2860.4 g
F = 0.756

Report

- Results on forms approved by the agency
- Sample ID
- G_{mb} to the nearest 0.001