BULK SPECIFIC GRAVITY OF COMPACTED HOT MIX ASPHALT (HMA) USING SATURATED SURFACE-DRY SPECIMENS FOP FOR AASHTO T 166 (08)

BULK SPECIFIC GRAVITY OF COMPACTED BITUMINOUS MIXTURES USING PARAFFIN-COATED SPECIMENS FOP FOR AASHTO T 275

Scope

This procedure covers the determination of bulk specific gravity (G_{mb}) of compacted hot mix asphalt (HMA) using three methods – A, B, and C – in accordance with AASHTO T 166. These three methods are for use on specimens not having open or interconnecting voids and/or absorbing more than 2.0 percent water by volume. A fourth and fifth method – D & E – in accordance with AASHTO T 275 and covering specimens having open or interconnecting voids and/or absorbing more than 2.0 percent water by volume is also included.

Overview

- Method A: Suspension
- Method B: Volumeter
- Method C: Rapid test for A or B

- Method D: Suspension for coated specimen
- Method E: Volumeter for coated specimen

Test Specimens

Test specimens may be either laboratory-molded or from HMA 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.

Terminology

Constant Mass: AASHTO T 166 defines constant mass as the mass at which further drying at 52 ±3°C (125 ±5°F) does not alter the mass by more than 0.05 percent. It also states that samples shall initially be dried overnight and that mass determinations shall be made at 2-hour drying intervals. AASHTO T 166 also states that recently molded laboratory samples that have not been exposed to moisture do not need drying.

Apparatus - Method A (Suspension)

- 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.
- Towel: Damp cloth towel used for surface drying specimens.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying the specimens to a constant mass.
- Pan: Pan or other suitable container of known mass, large enough to hold a sample for drying in oven.
- Thermometer: Having a range of 19 to 27°C (66 to 80°F), graduated in 0.1°C (0.2°F) subdivisions.

Procedure - Method A (Suspension)

1. Dry the specimen to constant mass, if required.

   Note 1: To expedite the procedure, steps 1 and 2 may be performed last. To further expedite the process, see Method C.

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".
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. 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.
5. Immerse the specimen for 4 ±1 minutes.
6. Determine and record the submerged weight to the nearest 0.1 g. Designate this submerged weight as "C".
7. Remove the sample from the water and quickly (not to exceed 5 seconds) surface dry with a damp cloth towel.
8. Zero or tare the balance.
9. Determine and record the mass of the SSD specimen to nearest 0.1 g. Designate this mass as "B". Any water that seeps from the specimen during the mass determination is considered part of the saturated specimen.

Calculations - Method A (Suspension)

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

where:

A = Mass of dry specimen in air, g

B = Mass of SSD specimen in air, g

C = Weight of specimen in water at 25 ±1°C (77 ±1.8°F), g

$$\text{Percent Water Absorbed (by volume)} = \frac{B - A}{B - C} \times 100$$

Apparatus - Method B (Volumeter)

- Balance or scale: 5 kg capacity, readable to 0.1 g and conforming to AASHTO M 231.
- Water bath: Thermostatically controlled to 25 ±0.5°C (77±0.9°F).
- Thermometer: Range of 19 to 27°C (66 to 80°F), and graduated in 0.1°C (0.2°F) subdivisions.
- Volumeter: Calibrated to 1200 mL or appropriate capacity for test sample and having a tapered lid with a capillary bore.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying the specimens to a constant mass.
- Pan: Pan or other suitable container of known mass, large enough to hold a sample for drying in oven.
- Towel: Damp cloth towel used for surface drying specimens.

Procedure - Method B (Volumeter)

1. Dry the specimen to constant mass, if required.

   Note 1: To expedite the procedure, steps 1 and 2 may be performed last. To further expedite the process, see Method C.

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".
3. Immerse the specimen in the temperature-controlled water bath for at least 10 minutes.
4. Fill the volumeter with distilled water at 25 ±1°C (77 ±1.8°F) making sure some water escapes through the capillary bore of the tapered lid. Wipe the volumeter dry. Determine the mass of the volumeter to the nearest 0.1 g. Designate this mass as "D".
5. At the end of the ten minute period, remove the specimen from the water bath and quickly (not to exceed 5 seconds) surface dry with a damp cloth towel.
6. Determine and record the mass of the SSD specimen to the nearest 0.1 g. Designate this mass as "B". Any water that seeps from the specimen during the mass determination is considered part of the saturated specimen.
7. Place the specimen in the volumeter and let stand 60 seconds.
8. Bring the temperature of the water to 25 ±1°C (77 ±1.8°F) and cover the volumeter, making sure some water escapes through the capillary bore of the tapered lid.
9. Wipe the volumeter dry.

10. Determine and record the mass of the volumeter and specimen to the nearest 0.1 g. Designate this mass as "E".

    Note 2: Method B is not acceptable for use with specimens that have more than 6% air voids.

Calculations - Method B (Volumeter)

$$G_{mb} = \frac{A}{B + D - E}$$

where:

A = Mass of dry specimen in air, g

B = Mass of SSD specimen in air, g

D = Mass of volumeter filled with water at 25 ±1°C (77 ±1.8°F), g

E = Mass of volumeter filled with specimen and water, g

$$\text{Percent Water Absorbed (by volume)} = \frac{B - A}{B + D - E} \times 100$$

Apparatus - Method C (Rapid Test for Method A or B)

See Methods A or B.

Note 3: This procedure can be used for specimens that are not required to be saved and contain substantial amounts of moisture. Cores can be tested the same day as obtained by this method.

Procedure - Method C (Rapid Test for Method A or B)

1. Determine which method to perform, A or B. Proceed with Method A or B, except that the dry mass, A, is determined last. In method A and B, start on Step 3 and complete that procedure, then continue as follows to determine mass "A".
2. Place the specimen on a large, flat-bottom pan of known mass.
3. Heat at a minimum of 105°C (221°F), until the specimen can be easily separated to the point where the fine aggregate particles are not larger than 6.3 mm (1/4 in.). In no case should the Job Mix Formula mixing temperature be exceeded.
4. Dry to constant mass. Constant mass is defined as the mass at which further drying at the temperature in Step 3 does not change by more than 0.05% after an additional 2 hour drying time.
5. Cool in air to 25 ±5°C (77 ±9°F).
6. Determine and record the mass of the pan and specimen to the nearest 0.1 g.

7. Determine and record the mass of the dry specimen to the nearest 0.1 g by subtracting the mass of the pan from the mass determined in Step 6. Designate this mass as "A".

Calculations - Method C (Rapid Test for Method A or B)

Complete the calculations as outlined in Methods A or B, as appropriate.

Materials - Method D Suspension (Coated Specimens/AASHTO T 275)

- Paraffin or parafilm: Used to coat test specimens.

Apparatus - Method D Suspension (Coated Specimens/AASHTO T 275)

- 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.
- Pan: Pan or other suitable container of known mass, large enough to hold a sample for drying in oven.

Procedure - Method D Suspension (Coated Specimens/AASHTO T 275)

1. Dry the specimen to constant mass, if required. See Note 1.
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".
3. Coat the specimen on all surfaces with melted paraffin, or parafilm coating, sufficiently thick to seal all voids.
4. Allow coating to cool in air at 25 ±5°C (77 ±9°F) for 30 minutes.
5. Determine and record the mass of the coated specimen to the nearest 0.1 g. Designate this mass as "D".
6. Fill the water bath to overflow level with water at 25 ±1°C (77 ±1.8°F).
7. Immerse the specimen in water at 25 ±1°C (77 ±1.8°F) for 4 ±1 minutes.
8. Determine and record the submerged weight to the nearest 0.1 g. Designate this submerged weight as "E".
9. Determine the specific gravity of paraffin or parafilm at 25 ±1°C (77 ±1.8°F) from the manufacturer's literature or other suitable source. Designate this specific gravity as "F".

Calculations - Method D Suspension (Coated Specimens/AASHTO T 275)

$$G_{mb} = \frac{A}{D - E - \left[\frac{D - A}{F}\right]}$$

where:

A = Mass of dry specimen in air, g

D = Mass of specimen with paraffin coating in air, g

E = Weight of specimen with paraffin coating in water, g

F = Specific gravity of paraffin or parafilm at 25 ±1°C (77 ±1.8°F)

Apparatus - Method E Volumeter (Coated Specimens/AASHTO T 275)

- Balance or scale: 5 kg capacity, readable to 0.1 g and conforming to AASHTO M 231.
- Water bath: Thermostatically controlled to 25 ±0.5°C (77±0.9°F).
- Thermometer: Range of 19 to 27°C (66 to 80°F), and graduated in 0.1°C (0.2°F) subdivisions.
- Volumeter: Calibrated to 1200 mL or appropriate capacity for test sample and having a tapered lid with a capillary bore.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying the specimens to a constant mass.
- Pan: Pan or other suitable container of known mass, large enough to hold a sample for drying in oven.
- Towel: Damp cloth towel used for surface drying specimens.

Procedure - Method E Volumeter (Coated Specimens/AASHTO T 275)

1. Dry the specimen to constant mass, if required. See Note 1.
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”.
3. Coat the specimen on all surfaces with paraffin, or parafilm coating, sufficiently thick to seal all voids.
4. Allow coating to cool in air at 25 ±5°C (77 ±9°F) for 30 minutes.
5. Determine and record the mass of the coated specimen to the nearest 0.1g. Designate this mass as “C”.
6. Fill the volumeter with distilled water at 25 ±1°C (77 ±1.8°F) and place the coated specimen in the volumeter.

7. Bring the temperature of the water to 25 ±1°C (77 ±1.8°F) and cover the volumeter, making sure some water escapes through the capillary bore of the tapered lid.
8. Wipe the volumeter dry.
9. Determine and record the mass of the volumeter and specimen to the nearest 0.1 g. Designate this mass as "E".
10. Determine the specific gravity of paraffin or parafilm at 25 ±1°C (77 ±1.8°F) from the manufacturer's literature or other suitable source. Designate this specific gravity as "F".

Calculations - Method E Volumeter (Coated Specimens/AASHTO T 275)

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

where:

A = Mass of dry specimen in air, g

C = Mass of specimen with paraffin coating in air, g

D = Mass of volumeter filled water at 25 ±1°C (77 ±1.8°F), g

E = Mass of volumeter filled with specimen with paraffin coating and in water at 25 ±1°C (77 ±1.8°F), g

F = Specific gravity of paraffin or parafilm at 25 ±1°C (77 ±1.8°F)

Report

Results shall be reported on standard forms approved for use by the agency. Report the G_{mb} to 3 decimal places and absorption to 2 decimal places. Report the method performed.

PERFORMANCE EXAM CHECKLIST

BULK SPECIFIC GRAVITY OF COMPACTED HOT MIX ASPHALT (HMA) USING SATURATED SURFACE-DRY SPECIMENS FOP FOR AASHTO T 166

BULK SPECIFIC GRAVITY OF COMPACTED BITUMINOUS MIXTURES USING PARAFFIN-COATED SPECIMENS FOP FOR AASHTO T 275

Participant Name _____ Exam Date _____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
Method A:		
1. Mass of dry sample in air determined.		
a. Dried overnight at 52 ±3°C (125 ±5°F) and at successive 2-hour intervals to constant mass?	_____	_____
b. Cooled in air to 25 ±5°C (77 ±9°F)?	_____	_____
c. Dry mass determined to 0.1g?	_____	_____
2. Water at the overflow?	_____	_____
3. Balance zeroed?	_____	_____
4. Immersed weight determined.		
a. Water at 25 ±1°C (77 ±1.8°F)?	_____	_____
b. Immersed at 4 ±1 minutes?	_____	_____
c. Immersed weight determined to 0.1g?	_____	_____
5. Sample rapidly surface dried with damp towel?	_____	_____
6. Saturated surface dry (SSD) mass determined to 0.1g?	_____	_____
7. G_{mb} calculated to 0.001?	_____	_____
8. Calculated percent water absorbed determined to be less than 2.0 percent?	_____	_____
Method B:		
1. Specimen dried, cooled, and mass determined as in Method A?	_____	_____
2. Saturated surface dry (SSD) mass determined to 0.1g.		
a. Immersed at least 10 minutes at 25 ±1°C (77 ±1.8°F)?	_____	_____
b. Sample rapidly dried with damp towel?	_____	_____
c. Specimen mass determined to 0.1g?	_____	_____
d. Any water that seeps from specimen included in mass?	_____	_____

Procedure Element	**Trial 1**	**Trial 2**
3. Mass of volumeter filled with distilled water at 25 ±1°C (77 ±1.8°F) determined?	_____	_____
4. SSD specimen placed into volumeter and let stand for 1 minute?	_____	_____
5. Temperature of water brought to 25 ±1°C (77 ±1.8°F) and volumeter covered, allowing some water to escape through the capillary bore of the tapered lid?	_____	_____
6. Volumeter wiped dry, and mass of volumeter and contents determined?	_____	_____
7. G_{mb} calculated to 0.001?	_____	_____
8. Calculated percent water absorbed determined to be less than 2.0 percent?	_____	_____
Method C/A:		
1. Immersed weight determined.		
a. Water at 25 ±1°C (77 ±1.8°F)?	_____	_____
b. Immersed at 4 ±1 minutes?	_____	_____
c. Immersed weight determined to 0.1g?	_____	_____
2. Sample rapidly surface dried with damp cloth?	_____	_____
3. Saturated surface dry mass determined to 0.1g?	_____	_____
4. Dry mass determined by:		
a. Heating in oven at a minimum of 105°C (221°F)?	_____	_____
b. Breaking down to 6.3 mm (1/4 in.) particles?	_____	_____
c. Drying in oven to constant mass (change less than 0.05 percent in 2 hours of additional drying)?	_____	_____
d. Cooled in air to 25 ±5°C (77 ±9°F) and mass determined to 0.1g?	_____	_____
5. G_{mb} calculated to 0.001?	_____	_____
6. Calculated percent water absorbed determined to be less than 2.0 percent?	_____	_____
Method C/B:		
1. Saturated surface dry (SSD) mass determined to 0.1g.		
a. Immersed at least 10 minutes at 25 ±1°C (77 ±1.8°F)?	_____	_____
b. Sample rapidly dried with damp towel?	_____	_____
c. Specimen mass determined to 0.1g?	_____	_____
d. Any water that seeps from specimen included in mass?	_____	_____
2. Mass of volumeter filled with distilled water at 25 ±1°C (77 ±1.8°F) determined to 0.1g?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
3. SSD specimen placed into volumeter and let stand for 1 minute?	_____	_____
4. Temperature of water brought to 25 ±1°C (77 ±1.8°F) and volumeter covered, allowing some water to escape through the capillary bore of the tapered lid?	_____	_____
5. Volumeter wiped dry, and mass of volumeter and contents determined to 0.1g?	_____	_____
6. Dry mass determined by:		
a. Warming in oven at a minimum of 105°C (221°F)?	_____	_____
b. Breaking down to 6.3 mm (¼ in.) particles?	_____	_____
c. Drying in oven to constant mass (change less than 0.05 percent in 2 hours of additional drying)?	_____	_____
d. Cooled in air to 25 ±5°C (77 ±9°F) and mass determined to 0.1g?	_____	_____
7. G_{mb} calculated to 0.001?	_____	_____
8. Calculated percent water absorbed determined to be less than 2.0 percent?	_____	_____
Method D:		
1. Mass of dry sample in air determined to 0.1g.		
a. Dried overnight at 52 ±3°C (125 ±5°F) and at successive 2 hour intervals to constant mass?	_____	_____
b. Cooled in air to 25 ±5°C (77 ±9°F)?	_____	_____
c. Mass of dry sample determined to 0.1g?	_____	_____
2. Specimen sufficiently coated to seal all voids and cooled for 30 minutes?	_____	_____
3. Mass of coated specimen determined to 0.1g?	_____	_____
4. Immersed weight determined to 0.1g.		
a. Water at 25 ±1°C (77 ±1.8°F)?	_____	_____
b. Immersed at 4 ±1 minutes?	_____	_____
c. Immersed weight determined to 0.1g?	_____	_____
5. Specific gravity of coating determined?	_____	_____
6. G_{mb} calculated to 0.001?	_____	_____
Method E:		
1. Mass of dry sample in air determined to 0.1g?		
a. Dried overnight at 52 ±3°C (125 ±5°F) and at successive 2 hour intervals to constant mass (or by other means, if allowed)?	_____	_____
b. Cooled in air to, 25 ±5°C (77 ±9°F)?	_____	_____
c. Mass of dry sample determined to 0.1g?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
2. Specimen sufficiently coated to seal all voids and cooled for 30 minutes?	_____	_____
3. Mass of coated specimen determined to 0.1g?	_____	_____
4. Mass of volumeter filled with distilled water at 25 ±1°C (77 ±1.8°F) determined to 0.1g?	_____	_____
5. SSD specimen placed into volumeter?	_____	_____
6. Temperature of water brought to 25 ±1°C (77 ±1.8°F) and volumeter covered, allowing some water to escape through the capillary bore of the tapered lid, and let stand for 1 minute?	_____	_____
7. Volumeter wiped dry, and mass of volumeter and contents determined to 0.1g?	_____	_____
8. G_{mb} calculated to 0.001?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

_____
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Examiner Signature _____WAQTC #:_____