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DETERMINING MAXIMUM SPECIFIC GRAVITY OF HOT MIX ASPHALT (HMA) MIXTURES

SCOPE

This test method is intended to determine the maximum specific gravity (G_{mm}) of HMA paving mixtures, commonly referred to as Rice specific gravity. This method uses a flask pycnometer and is based on Iowa Test Method 510 and AASHTO procedure T209-90.

REFERENCED DOCUMENTS

AASHTO T209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

IM 357 Preparation of Bituminous Mix Sample for Test Specimens

Iowa Test Method 510 Method of Test for Determining Maximum Specific Gravity of Bituminous Paving Mixtures Using a Flask Pycnometer

APPARATUS

- Balance 10,000-gram minimum capacity and capable of weighing to the nearest 0.1 gram
- Pycnometer (four-liter, thick-walled glass Erlenmeyer flask without side discharge nozzle, with top surface of opening ground plane and smooth, and with rubber stopper hose connection)
- Vacuum pump or water aspirator for evacuating air from the pycnometer
- Manometer for measuring absolute pressure - **NOTE:** The manometer must not be connected to the vacuum tube coming from the pump, but is to be connected to the pycnometer through a separate tube.
- Thermometers, ASTM 15F (30 to 180°F) [ASTM 15C (-2 to 80°C)], softening point and a general purpose – of suitable range – with graduations every 0.5°F (0.2°C)
- Large, flat, weighing pan about 16 in. x 24 in. x 2 3/4 in. (400 mm x 600 mm x 70 mm) with one end formed in the shape of a chute, for cooling and weighing the sample and for transferring the sample into the pycnometer.
- Glass 4 in. x 4 in. (100 mm x 100 mm) cover plate for accurate filling of pycnometer flask
- Scoop, spatula or trowel, and bulb syringe
- Elevated water container, with gravity discharge valve and tubing, of sufficient capacity to conduct a complete test
- Funnel for transferring sample from weighing pan into the pycnometer
- Equipment meeting AASHTO T209 will also be considered acceptable

PROCEDURE

Pycnometer Calibration

Calibration of the pycnometer will be performed prior to being put in service. Pycnometer calibration will be performed by accurately determining the weight of water at 77 ± 0.5°F (25 ± 0.2°C) required to fill it. Accurate filling of the pycnometer may be ensured by the use of the cover plate.

The following notes apply to both the Erlenmeyer flask apparatus and the alternate equipment identified in #11.

NOTE: It is recommended that the calibration of the pycnometer be confirmed at least once a week or when a correlation problem exists.

NOTE: Cover plate and pycnometer combinations are not interchangeable. The cover plate used for calibration should also be used for routine testing. If a different cover plate is used, however, the calibrated mass (weight) used in G_{mm} determinations must be appropriately adjusted by the difference in mass (weight) between the original cover plate and its replacement.

Test Procedure

1. Obtain and transfer to the large, flat pan a test sample weighing between 2,000 and 2,500 grams by following the procedure in IM 357.

2. The ignition oven and density portions of the field sample are normally taken first and the G_{mm} sample obtained from the remainder. When the remaining amount is less than 2,000 grams, additional material may be obtained by re-heating and re-mixing density specimens, or the sample may be obtained solely from density specimens. Results obtained with density specimen material must be so identified on the report.

   NOTE: Heat the density specimens only long enough to allow the specimens to be broken up and thoroughly mixed, using care not to overheat.

3. Separate the particles of the warmed sample so that the conglomerates of fine aggregate particles are not larger than 1/4 in. (6 mm). Use care not to fracture the aggregate particles. Discard any fractured particles found. Allow to cool to room temperature.

4. Add about 2 1/2 in. (60 mm) of water at about the same temperature as the sample to the calibrated pycnometer. Tare the pycnometer and water. Transfer the sample into the pycnometer. Determine the sample weight by weighing the pycnometer to the nearest 0.1 gram. Alternately, the sample weight may be determined by weighing the large, flat pan and sample contents to the nearest 0.1 gram, transferring the sample to the calibrated pycnometer, then weighing the empty pan and determining the difference.

5. If necessary, add water to cover the sample. Remove any loosely trapped air by stirring, being sure to avoid the loss of any sample.

6. Fill the pycnometer to about 6 in. (150 mm) from the top with water at the same temperature as that already present.

   NOTE: Water may be pulled into the vacuum pump if the pycnometer is filled too high.

   NOTE: The general-purpose thermometer, which has been calibrated with the ASTM 15F (15C) thermometer, may be used to determine temperatures for routine testing. The ASTM 15F (15C) thermometer must be used for determining temperatures when calibrating the pycnometer and for referee testing.

7. Insert rubber stopper and connect vacuum hose. Apply the vacuum necessary to attain between 1.0 in. and 1.2 in. (25.5 mm and 30 mm) of mercury (H_g) absolute pressure, as measured by a manometer, to the pycnometer contents for 15 minutes. During the vacuum period agitate the pycnometer and contents using a mechanical vibratory device, or occasionally shake the pycnometer manually, or jar it by striking it with an open hand, being careful not to allow material to get vacuumed out. This will facilitate the removal of gas bubbles trapped in the mix and on the interior surface of the pycnometer.

8. Remove the vacuum apparatus from the pycnometer and fill with water to the top of the neck of the pycnometer. Allow the water filled pycnometer to stand 10 minutes or until the water level in the neck remains constant (time to reach equilibrium between pycnometer and the water varies with test temperature and room temperature).

9. Tip the pycnometer slightly and use a glass cover plate and bulb syringe to add water until the pycnometer is completely full.

10. Dry the outside of the pycnometer and glass plate with a clean cloth, chamois or paper towel, and weigh to the nearest 0.1 gram. Immediately after weighing, remove the glass plate and determine the temperature of the water to the nearest 0.5°F (0.2°C) with the general purpose thermometer.

11. Pour off water and dispose of sample.

CALCULATIONS

$$G_{mm} = \frac{WR}{W + W_1 - W_2}$$

Where: W = Weight of sample, g

W_1 = Weight of pycnometer filled with water at test temperature, g. (This value must be determined anytime the test temperature changes from the calibration temperature by more than ± 0.5°F (0.2°C).

W_2 = Weight of pycnometer filled with water and sample, g

R = Correction multiplier obtained from Table 2

$$R = \frac{d_t}{0.99707}$$

Where: d_t = density of water at test temperature, g/cc

0.99707 = density of water at 77°F (25°C), g/cc