FLORIDA DEPARTMENT OF TRANSPORTATION
State Materials Office
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Florida Method of Test
for
Maximum Specific Gravity of Asphalt Paving Mixtures

Designation: FM 1-T209

1. SCOPE

This method covers the determination of the maximum specific gravity of uncompacted bituminous paving mixtures.

2. REFERENCED DOCUMENTS

FM 1-T168 Sampling Bituminous Paving Mixtures.

AASHTO M 231

3. APPARATUS

3.1. Balance - A balance, with a capability of 8 kg or greater, accurate to 0.1 g conforming to the requirements of ***AASHTO M231*, *Class G2***.

3.2. Container - A glass volumetric flask having a capacity of at least 2000 ml. Side arm flasks will not be acceptable. Containers shall be sufficiently strong to withstand a partial vacuum and shall have a rubber stopper with a hose connection. A small piece of fine wire mesh covering the hose opening shall be used to minimize loss of fine material. The top surfaces of all containers shall be smooth and substantially plane.

3.3 Thermometers –

a) Calibrated liquid-in-glass, total immersion type, of suitable range with gradations at least every 0.2°F (0.1°C) and a maximum scale error of 0.45°F (0.25°C) as prescribed in ***ASTM Specification E1***

b) Electronic thermometric device meeting the same gradation and scale error requirements as the liquid-in-glass, total immersion type.

3.4 Vacuum Pump – Capable of evacuating air from the vacuum container to a residual absolute pressure of 30 mm of Hg.

3.5 Manometer - A mercury or digital type suitable for measuring, to the nearest 1 mm, the vacuum being applied to the system. The manometer shall be placed at the farthest location within the system from the vacuum pump and shall be

placed higher than the flasks (see ***Figure 1***). The manometer shall be equipped with an adjustable valve to regulate the level of vacuum during testing.

3.6 Moisture Trap - A suitable moisture trap of one or more 1000 ml filter flasks (see ***Figure 1***), or equivalent, shall be installed between the vacuum vessel and vacuum source to reduce the amount of water vapor entering the vacuum pump. A refrigerated cold trap is acceptable.

3.7 Orbital Shaker Table - A shaker table with a orbit of 3/4 inch (19.0 mm) with sufficient load capacity to shake at least two containers and specimens.

3.8 Electronic Control Device – A device which controls and monitors the vacuum pressure, vacuum time, and shaker frequency may be used, provided all of the testing requirements of this procedure have been met. The device must be calibrated per the manufacturer's recommendations. The AutoRice device, manufactured by InstroTek, Inc., has been determined to meet these requirements and has been approved for use.

3.9 Water Bath (optional) – a container capable of heating water and maintaining the temperature of the water to 77.0 ± 2.0°F (25.0 ± 1.0°C). The water bath must of sufficient size for immersion of two flasks and of a depth where each flask can be submerged in water to the height of the neck of each flask.

4. SAMPLES

The sample shall be obtained in accordance with ***FM 1-T168***, the Florida Method of Sampling Bituminous Paving Mixtures. The test sample shall consist of two specimens of approximately 1000 g to 1100 g each.

5. CALIBRATION

5.1. Calibrate the volumetric container by accurately determining the mass of the container and the water required to fill it at 77.0 ± 2.0°F (25.0 ± 1.0°C). A cover plate will be used to ensure accurate filling of the container, taking care not to entrap air beneath the cover plate. Designate this mass as (D).

5.2. Due to the use of an orbital shaker table, abrasion inside the volumetric container will occur. This shall be corrected by calibrating the container once per month or sooner if the dry weight of the flask changes by more than 0.4 g since the last calibration.

6. PROCEDURE

6.1. Separate the particles of each specimen, taking care not to fracture the mineral particles, so that the conglomerates of the fine aggregate are no larger than 1/4 in. (6.0 mm). If the mixture is not sufficiently soft to be separated manually by hand, place it in a large flat pan and warm in an oven only long enough to allow the mix to be broken apart with bare fingers. If the mix is too hot to handle with bare hands, a spatula may be used to separate the particles until the mix cools enough to allow it to be broken apart with bare fingers.

6.2. Cool the specimens to room temperature, then place each specimen in separate containers and weigh. Designate the mass of each specimen, excluding the mass of the container, as (A). Shake the container vigorously until the specimen moves freely inside the container. Add sufficient water and wetting agent to cover the specimens.

Caution: From this point forward care must be taken to ensure no particles are lost which will affect the results.

Note 1: To facilitate the release of entrapped air, a suitable wetting agent such as Aerosol OT in concentration of 0.01 percent (1 ml of 10% solution in 1000 ml of water) will be used.

6.3 Remove entrapped air by subjecting each specimen to a partial vacuum of 30 ± 2 mm Hg absolute pressure. The correct vacuum should be achieved within 2 minutes. Once the correct vacuum is achieved, agitate the containers and contents continuously at 270 ± 10 rpm for 15 ± 2 minutes and release the vacuum as soon as agitation is complete.

6.4 After releasing the vacuum in ***Section 6.3***, slowly fill each flask to within 0.5 in (13 mm) of the top of the flask with water at a temperature of 77.0 ± 2.0°F (25.0 ± 1.0°C), taking care not to introduce air into the specimen. Determine the temperature of the water within each container to verify that it is within the allowable temperature range 77.0 ± 2.0°F (25.0 ± 1.0°C). If the temperature is outside of this range, then adjust the temperature through the addition of warm or cold water as needed. After filling each flask as described above, if necessary, the flasks may be placed in a water bath at 77.0 ± 2.0°F (25.0 ± 1.0°C) to maintain the temperature of the water inside the flasks prior to the tasks in ***Section 6.5.***

6.5 Between 9 and 11 minutes after releasing the vacuum in ***Section 6.3***, perform and complete the following steps:

6.5.1 Remove the thermometers from the containers and completely fill each container with water at a temperature of 77.0 ± 2.0°F (25.0 ± 1.0°C) using a cover plate, taking care not to entrap air beneath the cover plate,

6.5.2 Wipe the excess moisture from the exterior of the container and the cover plate, and

6.5.3 Determine the mass of the filled flasks (including the cover plate), designating this mass as (E). If the surface dry portion of the test is not to be performed, then this is the final step in the test procedure.

To determine the surface dry mass of the specimen, complete ***Section 6.6*** and ***Section 6.7.***

6.6 Drain water from the specimens. To prevent loss of fine particles, decant water through a No. 200 sieve (75 µm).

6.7 Spread each specimen in a pan before an electric fan to remove surface moisture. Conglomerations of mixture should be broken apart and stirred at frequent intervals to facilitate uniform drying. Care must be taken to prevent loss of particles of mixture. Weigh each specimen at 15-minute intervals. When the loss in mass for a specimen is less than 0.5 g for this time interval, the specimen may be considered to be in the surface-dry condition. Transfer each specimen into a tared pan and obtain the mass. Designate this final surface-dry mass of each specimen as (B). This procedure requires about 2 hours but may be more or less depending on the mixture.

Note 2: If the final surface-dry mass of a specimen (B) is less than the original mass of the dry specimen (A), then use the original mass (A) in-place of the surface-dry mass (B) in the maximum specific gravity calculation.

7. CALCULATIONS

7.1 Calculate the specific gravity of each specimen as follows:

7.1.1 When the dryback procedure is used, the maximum specific gravity ($G_{mm,SSD}$) is calculated as follows:

$$G_{mm,\ SSD} = A/(B+D-E)$$

Where: A = mass of dry specimen in air, g.

B = final surface-dry mass of specimen, g.

D = mass of flask filled with water at 77.0 ± 2.0°F (25.0 ± 1.0°C), g.

E = mass of flask filled with water and specimen at 77.0 ± 2.0°F (25.0 ± 1.0°C), g.

7.1.2 When the dryback procedure is not used (in situations where a correction factor will be used), the formula in ***Section 7.1.1*** is modified as follows:

$$G_{mm,\ dry} = A/(A+D-E)$$

Where: A = mass of dry specimen in air, g.

D = mass of flask filled with water at 77.0 ± 2.0°F (25.0 ± 1.0°C), g.

E = mass of flask filled with water and specimen at 77.0 ± 2.0°F (25.0 ± 1.0°C), g.

A correction factor should be developed and applied to the $G_{mm,\ dry}$ in accordance with ***Section 7.4***.

7.2 Calculate the difference between the specific gravities of the two specimens. If the difference between the two specimens is more than 0.013 the test is considered invalid and shall be performed again with new specimens. This applies to the specific gravities determined using either formula as given in ***Section 7.1.1*** or ***Section 7.1.2*****.**

7.3 The specific gravity of the test will be the average of the specific gravities of both specimens. This applies to the specific gravities determined using either formula as given in ***Section 7.1.1*** or ***Section 7.1.2*****.**

7.4 During production the dryback procedure will not be performed and the $G_{mm,dry}$ will be used. At the mix design stage, it is necessary to calculate a correction factor to determine an accurate maximum specific gravity value. The correction factor will be included on the mix design and used during production. Determine the correction factor using two G_{mm} tests (four flasks). The correction factor is determined using the dryback procedure and calculated as given in ***Section 7.1.1***, ***Section 7.2***, and ***Section 7.3***. This value is referred to as $G_{mm,\ SSD}$. Additionally, for the same two tests, the maximum specific gravity is calculated as given in ***Section 7.1.2*****,** ***Section 7.2***, and ***Section 7.3***. This value is referred to as $G_{mm,\ dry}$. For each of the two tests, the $G_{mm,\ dry}$ is subtracted from the $G_{mm,\ SSD}$. These two differences are then averaged to obtain the correction factor. During production, the correction factor is then

added to the $G_{mm,\ dry}$ values to obtain corrected $G_{mm,\ SSD}$ values. The correction factor is either a negative value or equal to zero.

$G_{mm,\ SSD\ \#1} - G_{mm,\ dry\ \#1}$ = Difference #1

$G_{mm,\ SSD\ \#2} - G_{mm,\ dry\ \#2}$ = Difference #2

Diff. #1 + Diff. #2 = Sum of Differences

Sum of Differences ÷ 2 = Correction Factor

$G_{mm,\ dry}$ + Correction Factor = Corrected $G_{mm,\ SSD}$

Note 3: All calculations in ***Section 7*** should be rounded to the third decimal place (0.001).

8. PRECISION

Criteria for judging the acceptability of specific gravity test results obtained by this method are given in the table entitled "Specific Gravity Test Results." The figures given in column 2 are the standard deviations that have been found to be appropriate for the conditions of test described in column 1. The figures given in column 3 are the limits that should not be exceeded by the difference between the results of two properly conducted tests. For single-operator precision, a test result is defined as the maximum specific gravity for one specimen (i.e., one flask). For multi-laboratory precision, a test result is defined as the average maximum specific gravity of two specimens (i.e., two flasks). These precision values were determined through a round-robin interlaboratory study using plant-produced asphalt mixtures and include the variability associated with sampling, splitting and testing the asphalt mixture. Separate analyses were conducted for the dryback and non-dryback procedures and the results were not significant enough to warrant two precision statements. Therefore, the precision values given below apply to tests conducted using either the dryback or non-dryback procedure.

Precision of Specific Gravity Test Results

Test and Type Index	Standard Deviation (1S)	Acceptable Range of Two Test Results (D2S)
Single-operator precision	0.00449	0.013
Multi-laboratory precision	0.00557	0.016

Basis of estimate: 4 replicates, 6 materials, 13 laboratories

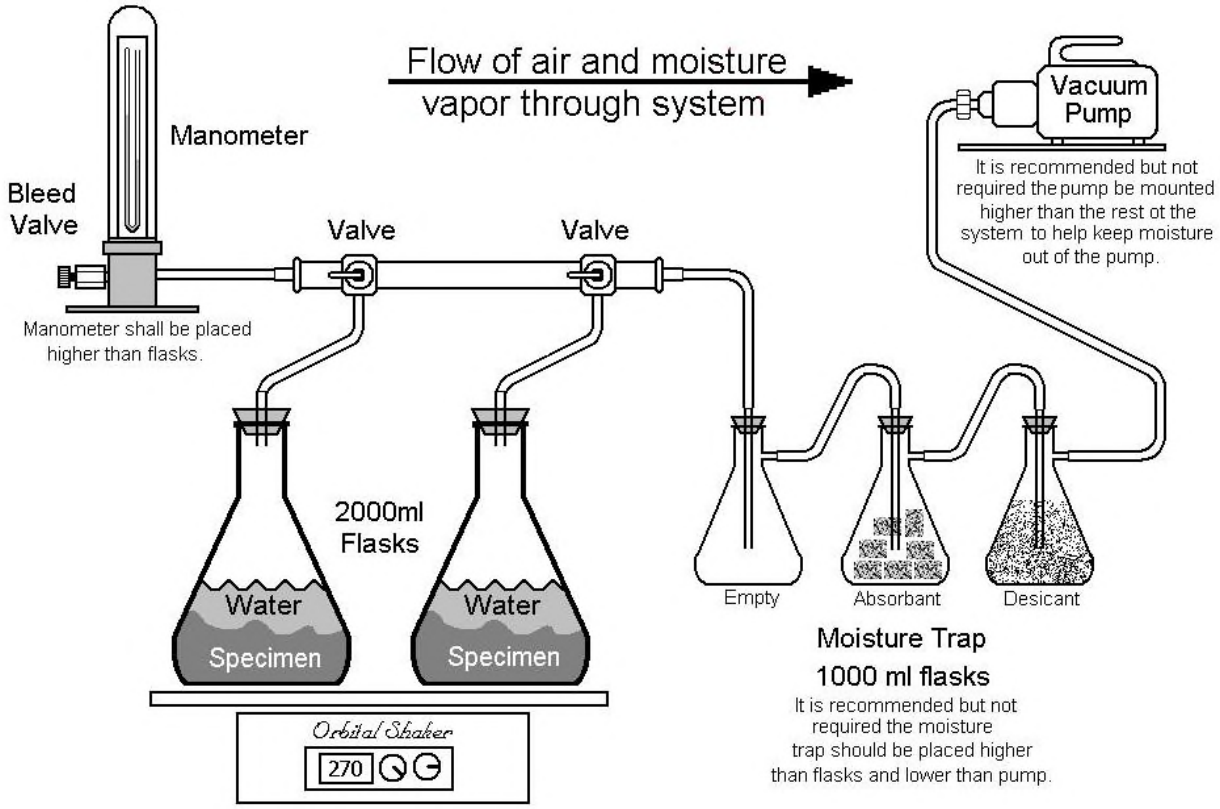

FIGURE 1

An example of the correct arrangement of testing apparatus (**Note** - The purpose of the train of small filter flasks is to trap water vapor from the vacuum vessel, that otherwise would enter the vacuum pump and decrease the pump's ability to provide high vacuum).