METHOD OF TEST FOR DETERMINING THE DENSITY OF HOT MIX ASPHALT (HMA) BY MEANS OF THE SUPERPAVE GYRATORY COMPACTOR (SGC)

SCOPE

This method describes the procedures for compacting hot mix asphalt samples using the SGC and determining their percent compaction. This method consolidates the provisions of AASHTO TP4 and makes the following exceptions:

- Compaction temp
- Compacting to N_{max} instead of N_{des}
- Use leveling load

REFERENCED DOCUMENTS

Standard Specification 2303 Hot Mix Asphalt
AASHTO TP4 Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor
I.M. 321 Compacted Density of Asphalt Concrete
I.M. 357 Preparation of Bituminous Samples for Test

APPARATUS

- SGC, including a device for measuring and recording the height of the specimen throughout the compaction process. The compactor may also include a printer or a computer and software for collecting and printing the data.
- Specimen molds (150 mm in diameter)
- Thermometer with a range of 38 to 200°C (100 to 400°F).
- Balance with a minimum capacity of 6,000 gram and readable to at least 1 gram.
- Forced Draft Oven capable of maintaining a constant temperature of 177 ± 3°C (350 ± 5°F) and large enough to hold 2 molds and mix pans.
- Pan between approximately 200 $in.^2$ and 300 $in.^2$ in size.
- Safety equipment: insulated gloves, long sleeves, apron, etc.

General Equipment:

- Calibration equipment recommended by compactor manufacturer
- Paper discs with a diameter of 150 mm (6 in.).
- Lubricating materials recommended by compactor manufacturer
- Scoop or trowel for moving mixture
- Funnel or other device for ease of loading mixture into mold.

PROCEDURE

CALIBRATION

The means of calibrating the gyratory vary with different manufacturers. Refer to the operation manual of the particular brand and model of gyratory available for use. Calibration of the following items should be verified at the noted intervals unless manufacturer's recommendations are more stringent:

Item	Tolerance	Calibration Interval
Height	Record to nearest 0.1 mm, Compact to 115 ± 5 mm	Daily
Angle	1.25° ± 0.02°	See I.M. 208
Pressure	600 ± 18 kPa	See I.M. 208
Speed of Rotation	30.0 ± 0.5 gyrations per minute	See I.M. 208
Mold dimension	149.90 to 150.00 mm	See I.M. 208
Platen dimension	149.50 to 149.75 mm	See I.M. 208

COMPACTOR PREPARATION

1. Turn the compactor on and allow for warm-up before proceeding.
2. Lubricate the mold or gyratory parts as recommended by the manufacturer.
3. Perform the height calibration per manufacturer's recommendations.
4. Set the specified number of gyrations, N_{des} or N_{max}.

TESTING

1. Obtain the material for the test specimen by following the procedure in I.M. 357.
2. Weigh into separate pans for each specimen the amount of hot mix asphalt mixture required which will result in a compacted specimen 115 ± 5 mm in height. Spread the material uniformly in the pan to between 1 to 2 in. of thickness.

   This will normally be about 4800 grams.

3. Heat the pans of mixture in the oven to a temperature of 135 ± 2°C (275 ± 5°F) as checked by a thermometer with the bulb in the center of the mixture sample. The oven temperature may not exceed 143°C (290°F).

   a) Heat the mold, base plate, top plate (if used) and funnel (if used) in the oven for each specimen compacted for a minimum of 30 minutes. In between tests, a minimum of 5 minutes reheating should be used.

4. Place a paper disc in the bottom of the mold.

5. Place the mixture into the mold in one lift. A funnel or other device may be used to place the mixture into the mold. Take care to avoid segregating the mix in the mold, but work quickly so that the mixture does not cool excessively during loading. Level the mix in the mold and place a paper disc on top.

6. Place the mold in the gyratory.

> Note: Some gyratories allow charging the mold with mix after the mold has been positioned in the compactor.

7. If the desired number of gyrations (N_{des} or N_{max}) has not been entered into the gyratory, do that now. The number of gyrations to apply is determined from the Job Mix Formula (JMF).

8. Apply the load to the mixture in the mold.

9. Apply the gyratory angle to the specimen.

10. Compact to N_{des} or N_{max} as specified.

11. After compaction is complete, remove the angle from the specimen, apply the leveling load, and raise the loading ram if needed (this is done automatically on some gyratories).

12. Extrude the specimen from the mold. Take care not to distort the specimen when removing the specimen from the mold. Remove the paper discs while the specimen is still warm to avoid excessive sticking.

> Note: A cooling period of 5 to 10 minutes before extruding the specimen may be necessary with some mixtures; a fan may help speed the cooling process.

13. Record or print the height data for each specimen compacted.

14. After the specimens have cooled, they may be tested for bulk specific gravity, G_{mb} per I.M. 321.

CALCULATIONS

To determine the lab density of a compacted specimen at any gyration level (back calculate), use the G_{mb} of the final compacted specimen and the height of the specimen at different numbers of gyrations. The corrected density is calculated as follows:

$$G_{mb(corrected)} = \frac{G_{mb} h_m}{h_x}$$

Where: $G_{mb(corrected)}$ = Corrected bulk density of the specimen.
G_{mb} = Bulk specific gravity of the specimen.
h_m = Height of the extruded specimen, mm.

h_x = Height of the specimen during compaction at x gyrations, mm.

Report the corrected bulk specific gravity of the specimen, $G_{mb(corrected)}$, to 3 decimal places.

Given: G_{mb} = 2.369
h_m = 117.5 mm

Calculate $G_{mb(corrected)}$ at: N_{ini} = 8 gyrations h_8 = 135.4 mm
N_{des} = 109 gyrations h_{109} = 119.4 mm

$$G_{mb(corrected)} @ N_{ini} = \frac{2.369 \times 117.5\,mm}{135.4\,mm} = 2.056$$

$$G_{mb(corrected)} @ N_{des} = \frac{2.369 \times 117.5\,mm}{119.4\,mm} = 2.331$$