
Standard Practice for

Evaluation of the Superpave Gyratory Compactor (SGC) Internal Angle of Gyration

AASHTO Designation: PP 48-03 (2005)



American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Evaluation of the Superpave Gyratory Compactor (SGC) Internal Angle of Gyration

AASHTO Designation: PP 48-03 (2005)¹



1. SCOPE

- 1.1. This practice covers the procedure for the evaluation of the Superpave Gyratory Compactor (SGC) internal angle of gyration using the U.S. Federal Highway Administration Dynamic Angle Validation Kit (DAV).
- 1.2. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 231, Weighing Devices Used in the Testing of Materials
 - R 35, Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
 - T 166, Bulk Specific Gravity of Compacted Hot-Mix Asphalt Mixtures Using Saturated Surface-Dry Specimens
 - T 168, Sampling Hot-Mix Asphalt Paving Mixtures
 - T 209, Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt Paving Mixtures
 - T 312, Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

3. TERMINOLOGY

- 3.1. *Definitions:*
- 3.1.1. *internal angle*—the angle formed between the internal mold diameter and the mold end plates during the compaction of a specimen in a Superpave Gyratory Compactor.
- 3.1.2. *external angle*—the angle formed between the external mold diameter and a stationary reference axis of the machine frame.
- 3.1.3. *top angle, $\alpha(\text{top}, h)$* —the top (uppermost) internal angle resulting from a single measurement on an HMA specimen with a final height h .

- 3.1.4. *bottom angle, $\alpha(\text{bottom}, h)$* —the bottom (lowermost) internal angle resulting from a single measurement on an HMA specimen with a final height h .
- 3.1.5. *effective angle, $\alpha(\text{effective}, h)$* —the operative internal angle of gyration for an SGC when compacting HMA specimens with a specimen final height h .
- 3.1.6. *available mold height*—the internal height available within the mold to compact HMA while the mold is inserted into the SGC and the ram head or mold end plates are in the maximum open position that will still permit gyration.

4. SUMMARY OF PRACTICE

- 4.1. The internal angle of gyration of a Superpave Gyratory Compactor (SGC) is measured dynamically with an instrument inserted into the mold while hot-mix asphalt is compacted. The internal angles at each end of the mold are measured, then averaged to obtain an effective angle of gyration. Analysis Method A is intended for use in SGCs with molds of insufficient height to accommodate a 115 ± 5 mm tall specimen with the instrument. Analysis Method B is intended for use in SGCs with molds of sufficient height to accommodate 115 ± 5 mm final height HMA specimens with the instrument. Analysis Method A can also be used universally in lieu of Analysis Method B on all SGCs.

5. SIGNIFICANCE AND USE

- 5.1. Superpave Gyratory Compactors (SGCs) are used to produce hot-mix asphalt (HMA) mixture specimens in the laboratory to assess and predict pavement performance. SGC specimens are cylindrical with a diameter of 150 mm and a final height of 115 mm. In the fabrication of an SGC specimen, loose HMA is placed inside a metal mold, which is then placed into an SGC. A constant consolidation pressure is applied to the sample while the mold gyrates at a nominally constant angle (referred to as the angle of gyration) and rate. Consistency in the density of the asphalt specimens produced is very important to the validity of the tests performed. Specimens of a consistent density are produced when an SGC maintains a constant pressure and a known constant angle of gyration during the compaction process.
- 5.2. There are several manufacturers and models of SGC. Each model employs a unique method of setting, inducing, and maintaining the angle of gyration. Each model also employs a unique calibration system to measure the angle of gyration externally in relation to the mold. These existing calibration systems can not be used universally on all of the different SGC models commercially available. Inconsistencies in asphalt specimens produced on different SGC models have been attributed to variations in the angle of gyration.
- 5.3. This practice, along with the DAV, provides an independent uniform process to validate the angle of gyration of any manufacturers' SGC model.

6. INTERFERENCES

- 6.1. Debris on the SGC mold, base plates, ram head, reaction surfaces, or on the instrument can cause errant measurement results. Extreme care should be taken to thoroughly clean the SGC, mold, instrument, and any work areas that will be utilized during the measurement procedure. Scarring or irregular surfaces on mold walls and end plates is also known to cause incorrect results. Do not use any equipment that shows signs of damage. The precision required in the execution of this practice necessitates that extreme care must be taken to avoid errors from damaged or improperly maintained equipment.

- 6.2. Use a rigid straightedge (such as a rigid stainless steel rule or machined straightedge) on the base of the DAV to inspect for any damage that may affect the measurement. Place the straightedge firmly on the DAV base and slide it across the surface. The straightedge should slide smoothly without catching any raised edges on the DAV base. Repeat the inspection in multiple directions until the entire base has been confirmed to have no raised edges. If a raised edge is detected, repair the base before using the DAV. A similar check shall also be performed on the intermediate plate, SGC mold base plate, and SGC top plate to confirm no raised edges are present.

7. APPARATUS

- 7.1. FHWA SGC Dynamic Angle Validation Kit (DAV) or its equivalent designed to measure the internal angle of gyration dynamically during the compaction process with HMA mixture present in the mold. The DAV is a self-contained instrument placed inside the SGC standard mold, either above or below the HMA, with no external connections. It measures and stores the angle of gyration during the compaction cycle.
- 7.1.1. *Angle Measurement Instrument*—Stainless steel housing containing the measuring instrument, data acquisition and storage system, and power unit.
- 7.1.2. *Intermediate Plate*—Thin hardened steel plate conforming to Ram Heads and Mold Bottoms size and hardness requirements of T 312.
- 7.1.3. *Communication Cable*—Used to connect the DAV to a computer.
- 7.1.4. *Software*—Designed to initialize and start the DAV, retrieve and store data, and analyze results.
- 7.1.5. *Computer*—Required for DAV operation. Operating system must be Windows 98, NT, or higher.
- 7.1.6. *Battery Charger*—Typical battery life is estimated at 3.5 hours. The fixture can not be operated while charging. See manufacturer specifications for charging time.
- 7.1.7. *Static Angle Block*—An NIST traceable angle gauge block with four integral angles used to calibrate and verify the DAV calibration. The block shall be made of a material that permits uniform heating to a temperature of 75°C without distortion.
- 7.1.8. *Rigid Straightedge*—A steel or stainless steel straightedge, 150 mm (6 in.) or greater, for inspecting the DAV base and Static Angle Block for raised edges.
- 7.2. *Superpave Gyratory Compactor (SGC)* and associated equipment as described in T 312. The SGC shall be in good repair with the compaction pressure, specimen height measurement system, and gyration rate verified to be within specifications. The mechanisms used to induce and maintain the angle of gyration shall be set and maintained within the manufacturer's guidelines. The SGC molds, mold end plates, base platens, and ram head surface smoothness shall be confirmed to be within the specifications of T 312. Any equipment not meeting these requirements shall not be used.
- 7.3. *Thermometers*—Armored, glass, or dial-type thermometers with metal stems for determining the temperature of aggregates, binder, and HMA between 10 and 232°C, with a minimum sensitivity of 3°C.

- 7.4. *Balance*—The balance shall have a minimum capacity of 10,000 grams with a sensitivity of 0.1 g. A balance shall conform to the requirements of M 231, Class G5, for determining the mass of aggregates, binder, and HMA.
- 7.5. *Oven*—A forced draft oven, thermostatically controlled to $\pm 3^{\circ}\text{C}$, for heating aggregates, binder, HMA, and equipment as required. An oven capable of maintaining a temperature of 150°C is recommended.
- 7.6. *Miscellaneous*—Miscellaneous equipment may include metal pans for heating HMA specimens, scoops for batching aggregates, containers for heating asphalt binders, mixing spoons, trowels, welders gloves for handling hot equipment, 150-mm diameter paper disks, mechanical mixers, cleaning towels, mineral spirits.

8. HAZARDS

- 8.1. Use standard safety precautions and protective clothing when handling hot materials and preparing test specimens.

9. SAMPLING

- 9.1. Obtain samples of hot-mix asphalt in accordance with T 168.

10. PREPARATION OF APPARATUS

- 10.1. Before each use of the DAV (i.e., on a daily basis), verify the angle measurement system against a set of known angles. The Static Angle Block, which provides a set of four known static angles, can be used to confirm that the DAV is operating within calibration.

Note 1—This verification should be performed at the beginning of each day before the DAV has been used with hot-mix asphalt. Once the DAV has heated up from use, it must be allowed to cool to room temperature before being used in the Static Angle Block. The DAV and the Static Angle Block must be at the same uniform, stable temperature for the verification to be accurate.

11. CALIBRATION AND STANDARDIZATION

- 11.1. The DAV system requires periodic verification and/or calibration. The system shall be standardized prior to initial use and at least once every 12 months. This annual verification is generally considered a factory calibration and includes the following:
- 11.1.1. Verification of the Static Angle Block with an NIST traceable measurement system,
- 11.1.2. Verification of the DAV temperature measurement system,
- 11.1.3. Verification of the DAV angle measurement system over the defined operating temperature range.

12. CONDITIONING

- 12.1. No pre-conditioning of the HMA specimen is required.