GDT 115

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to test the rutting susceptibility of asphaltic concrete mixtures with the Asphalt Pavement Analyzer (APA).

B. Apparatus

The apparatus consists of the following:

1. Asphalt Pavement Analyzer (APA)

   A thermostatically controlled device designed to test the rutting susceptibility of asphalt-aggregate mixtures by applying repeated moving loads to compacted test specimens. The following criteria apply to this device.

   a. Chamber temperature

      The APA shall be thermostatically controlled to maintain the temperature of the conditioning chamber within 1.8 ºF (1.0 ºC) of any setting between 39.2° and 161.6 ºF (4º and 72 ºC).

   b. Application of loads

      The APA applies moving loads to three pairs of cylindrical samples (or three beam samples) by means of three wheels mounted on reciprocating carriages. Loads are applied by pneumatic cylinders. Each loading wheel shall be capable of applying a force of up to 100 lbs (454 newtons). Each of the three load cylinders shall be calibrated to the desired test load by an external force transducer, as provided by the manufacturer.

   c. Test hoses

      Loads are transferred to the samples by means of pneumatically pressurized hoses. The hose pressurization system shall be capable of maintaining any pressure at 100 psi (690 kPa). Hoses shall be of the size and properties specified by the manufacturer (Gates 77B Paint Spray and Chemical 3/4 inch (19 mm), 750 psi (5.17 MPa) W.P. GL 07148). The hoses shall be free of cracks and holes in the outer rubber casing. Follow the APA manufacturer's instructions for replacing hoses.

   d. Operable Cycle Counter

      The APA shall have an operable cycle counter which can be preset to the desired number of cycles for a test and shall be capable of stopping the test at the completion of the programmed number of cycles.

   e. Optional Feature

      As an optional feature, the APA may be equipped with rut depth sensors linked to a computer and capable of plotting the deformation of individual samples as it occurs. Final values of automated deformation measurements shall be verified by manual measurements, as detailed below. Manual verification should be performed on all samples with results within ± 0.02 in (± 0.5 mm) of the specified limit or on every tenth test, whichever occurs first.

2. Additional equipment required

   a. Balance, 26.5 lbs (12 000 g) scale, accurate to 0.0032 oz (0.1 g).

   b. Mixing utensils (bowls, spoon, spatula).

   c. Ovens for heating aggregate and asphalt binder.

   d. Superpave gyratory compactor and molds.

C. Sample Size and Preparation

1. Sample Preparation

   a. General

      The test may be performed on roadway cores, samples of plant mix, or samples mixed in the laboratory. Plant mix and samples mixed in the laboratory may be molded beams or cylindrical gyratory specimens.

   b. Roadway Core Specimens

      Roadway core specimens shall be 150 mm (6 in.) in diameter. Cores shall be trimmed with a wet masonry saw to a height of 75 ± 3 mm. Cores less than 72 mm in height may be shimmed with metal discs. End surfaces shall be parallel and perpendicular to the axis of the core. Testing shall be performed on the uncut face of the core.

   c. Plant-produced Mixtures

      Samples of plant-produced mixtures shall be obtained in accordance with AASHTO T 169. Mixture samples shall be reduced to the appropriate test size and compacted to the appropriate number of gyrations, as determined in AASHTO T-312, while the mixture is still hot. (Note: Re-heating of loose plant mixture increases binder stiffness. Air voids may be excessive in samples which have been re-heated prior to compaction, and such samples may be unrepresentative of the mixture even when the air voids are within the specified range.)

   d. Laboratory-prepared Mixtures

      Mixtures shall be batched at the optimum asphalt content according to the Job Mix Formula. Hydrated lime, when used, should be mixed with the aggregate before adding the asphalt cement.

      1) Temperature

         The mixing temperature and the temperature of the asphalt cement and the aggregate prior to mixing shall be as published for the particular source and grade of asphalt cement. Refer to *Asphalt Concrete Mixture Control Temperatures for Performance-graded Asphalt,* published semi-annually by the Office of Materials and Research. For asphalt cement from sources not listed, the temperature to which the asphalt binder must be heated to achieve a viscosity of 290 ± 30 cSt shall be the compaction temperature. For modified asphalt binders, use the compaction temperature recommended by the binder manufacturer.

      2) Aging.

         Test samples shall be aged two hours at compaction temperature or in accordance with the short-term aging procedure in AASHTO T-312. Samples shall not remain at the compaction temperature for more than two hours.

2. Laboratory Compaction of Specimens

   A Superpave gyratory compactor approved in accordance with AASHTO PP-35 shall be used to compact samples. Laboratory-prepared specimens shall be compacted to the design number of gyrations (N_{des}) as determined in AASHTO T-312, with a final height of 115 ± 5 mm (4.5 in.). If the APA does not accommodate 115 mm high compacted specimens, the specimens shall be compacted or sawed to a height of 75 ± 1 mm. Only the bottom portion of the compacted specimens should be sawed off. The uncut side of the specimen shall be tested. Compacted specimens should be left at room temperature, approximately 77 ºF (25 ºC), to allow the entire specimen to cool for a minimum of 3 hours.

3. Air Void Content

   Determine the bulk specific gravity of the test specimens in accordance with AASHTO T-166. Determine the maximum specific gravity of the test mixture in accordance with AASHTO T 209. Determine air void content in accordance with AASHTO T 269.

4. Test Temperature

   The test temperature shall be as specified in the contract specifications. Verify the temperature of the testing chamber before commencing each test. The testing chamber thermostat should be calibrated according to the manufacturer's recommendations.

5. Preheating Specimens

   Place the specimens in the molds; install the molds in the APA test chamber or a separate calibrated oven for a minimum of four hours to bring the specimens to test temperature. Specimens should not be held at elevated temperatures for more than 24 hours prior to testing.

D. Procedures

1. Calibration

   The following items should be checked for calibration no less than once per year: (1) preheating oven, (2) APA temperature, (3) APA wheel load, and (4) APA hose pressure. Instructions for each of these calibration checks is included in this section.

   a. Temperature calibration of the preheating oven.

      1) The preheating oven must be calibrated with a NIST traceable thermometer (an ASTM No. 65C (65 °C) calibrated thermometer conforming to ASTM E1 is recommended) and a metal thermometer well to avoid rapid heat loss when checking the temperature.

      2) Temperature Stability

         a) Set the oven to the chosen temperature (e.g., 147 °F (64 °C). Place the thermometer in the well and place them on the center of the shelf where the samples and molds will be preheated. It usually takes an hour or so for the oven chamber, well and thermometer to stabilize. After one hour, open the oven door and read the thermometer without removing it from the well. Record this temperature. Close the oven door.

         b) Thirty minutes after obtaining the first reading obtain another reading of the thermometer. Record this temperature. If the readings from step a.2).a) and a.2).b) are within 0.8°F (0.4 °C), then average the readings. If the readings differ by more than 0.8 °F (0.4 °C) then continue to take readings every thirty minutes until the temperature stabilizes within 0.8 °F (0.4 °C) on two consecutive readings.

      3) Temperature Uniformity

         a) To check the uniformity of the temperature in the oven chamber, move the thermometer and well to another location in the oven so that they are on a shelf where samples and molds will be preheated, but as far as possible from the first location. Take and record readings of the thermometer at the second location every thirty minutes until two consecutive readings at the second location are within 0.8 °F (0.4 °C).

         b) Compare the average of the two readings at the first location with the average of the stabilized temperature at the second location. If the average temperatures from the two locations are within 0.8 °F (0.4 °C), then the oven temperature is relatively uniform and it is suitable for use in preheating APA samples. If the average of the readings at the two locations differ by more than 0.8 °F (0.4°C) then you must find another oven that will hold this level of uniformity and meets calibration.

      4) Temperature Accuracy

         a) Average the temperatures from the two locations. If that average temperature is within 0.8 °F (0.4 °C) of the set point temperature on the oven, then the oven is reasonably accurate and calibration is complete.

         b) If the set point differs from the average temperature by more than 0.8 °F (0.4 °C), then adjust the oven set point appropriately to raise or lower the temperature inside the chamber so that the thermometer and well will be at the desired temperature (e.g., 147 °F (64 °C).

c) Place the thermometer and well in the center of the shelf. At thirty-minute intervals, take readings of the thermometer. When two consecutive readings are within0.8 °F (0.4 °C), and the average of the two consecutive readings are within 0.8°F (0.4°C) of the desired test temperature (e.g., 147 °F (64 °C), then the oven has been properly adjusted and calibration is complete. If these two conditions are not met, then repeat steps a.4).b) and a.4).c).

b. APA Temperature Calibration

1) The APA must be calibrated with a NIST traceable thermometer (an ASTM 149 °F (65 °C) calibrated thermometer is recommended) and a metal thermometer well to avoid rapid heat loss when checking the temperature.

2) Temperature Stability

a) Turn on the APA main power and set the chamber temperature controller so that the inside the testing chamber is at anticipated testing temperature (e.g., 147 °F (64 °C). Also, set the water temperature controller to achieve the anticipated testing temperature. (Note: Experience has shown that the temperature controller on the APA is not always accurate. The thermometer should always be considered chamber temperature.) Place the thermometer in the well and place them on the left side of the APA where the samples and molds will be tested (Note: It may be helpful to remove the hose rack from the APA during temperature calibration to avoid breaking the thermometer).

b) It usually takes about four hours for the APA to stabilize. After the temperature display on the controller has stabilized, open the chamber doors and read the thermometer without removing it from the well. Record this temperature. Close the chamber doors.

c) Thirty minutes after obtaining the first reading obtain another reading of the thermometer. Record this temperature. If the readings from step b.2).b) and b.2).c) are within 0.8 °F (0.4 °C), then average the readings. If the readings differ by more than 0.8 ° F (0.4 °C) then continue to take readings every thirty minutes until the temperature stabilizes within 0.8 °F (0.4 °C) on two consecutive readings.

3) Temperature Uniformity

a) To check the uniformity of the temperature in the APA chamber, move the thermometer and well to the right side of the APA, where the samples are tested. Take and record readings of the thermometer at the second location every thirty minutes until two consecutive readings at the second location are within 0.8 F(0.4 °C).

b) Compare the average of the two readings obtained in b.2).c) and b.3).a). If the average temperatures from the two locations are within 0.8 °F (0.4 °C), then the APA temperature is relatively uniform and it is suitable for use. If the average of the readings at the two locations differ by more than 0.8 °F (0.4 °C) then consult with the manufacturer on improving temperature uniformity.

4) Temperature Accuracy

a) Average the temperatures from the two locations. If that average temperature is within 0.8 °F (0.4 °C) of the desired test temperature (e.g., 147 °F (64 °C), then the APA temperature is reasonably accurate and calibration is complete.

b) If the average temperature differs from the desired test temperature (e.g., 147 °F 64 °C) by more than 0.8 °F (0.4 °C), then adjust the APA temperature controller so that the thermometer and well will be at the desired test temperature. (Note: It is advisable to keep the water bath set at the same temperature as the test chamber.)

c) Place the thermometer and well in the center of the shelf. At thirty minute intervals, take readings of the thermometer. When two consecutive readings are within 0.8 °F (0.4 °C), and the average of the two consecutive readings are within 0.8 °F (0.4 °C) of the desired test temperature (e.g., 147 °F (64 °C), then the APA temperature has been

properly adjusted and calibration at that temperature is complete. Record the current set points on the temperature controllers for later reference. If these two conditions are not met, then repeat steps b.4).b) and b.4).c).

c. APA Wheel Load calibration of the air cylinders at the three test positions.

1) The APA wheel loads will be checked with the calibrated load cell provided with the APA. The loads will be checked and adjusted one at a time while the other wheels are in the down position and bearing on a dummy sample or wooden block of approximately the same height as a test sample. Calibration of the wheel loads should be accomplished with the APA at room temperature. A sheet is provided to record the calibration loads.

a) Remove the hose rack from the APA.

b) Jog the wheel carriage until the wheels are over the center of the sample tray when the wheels are in the down position.

c) Raise and lower the wheels 20 times to heat up the cylinders.

d) Adjust the bar on top of the load cell by screwing it in or out until the total height of the load cell-load bar assembly is 4 1/8 in (105 mm).

e) Position the load cell under one of the wheels. Place wooden blocks or dummy samples under the other two wheels.

f) Zero the load cell.

g) Lower all wheels by turning the cylinder switch to CAL.

h) If the load cell is not centered left to right beneath the wheel, then raise the wheel and adjust the position of the load cell. To determine if the load cell is centered front to back beneath the wheel, unlock the sample tray and move it SLOWLY until the wheel rests in the indentation on the load cell bar (where the screw is located).

i) After the load cell has been properly centered, adjust the pressure in the cylinder to obtain 100 ± 1 lbs(445 ± 5 N) Allow three minutes for the load cell reading to stabilize between adjustments. Record the pressure and the load.

j) With the wheel on the load cell remaining in the down position, raise and lower the other wheels one time. Allow three minutes for the load cell reading to stabilize. Record the pressure and the load.

k) With the other wheels remaining in the down position, raise and lower the wheel over the load cell. Allow three minutes for the load cell reading to stabilize. Record the pressure and the load.

l) Repeat steps c.1).e) through c.1).k) for each wheel/cylinder.

m) Return the load cell to the first wheel and repeat steps c.1).e) through c.1).k).

n) Place the load cell under the second wheel and repeat steps c.1).e) through c.1).k).

o) Place the load cell under the third wheel and repeat steps c.1).e) through c.1).k). The current cylinder pressures will be used to set wheel loads to 100 lbs. (445 N).

d. Replacement of the APA hoses

1) New hoses shall be placed in service in accordance with as follows:

a) Remove the hose rack from the APA.

b) Remove the used hoses from the hose rack. Place the new hose on the barbed nipples and secure with the hose clamps.

c) Position the hoses in the rack such that the hose curvature is vertical. Tighten the nuts at the ends of the hoses only until the hoses are secure. Over-tightening will affect the contact pressure and hose life.

d) Place the hose rack back into the APA and make sure that the hoses are aligned beneath the wheels.

e) Prior to testing, break in the new hoses by running 8000 cycles on a set of previously tested samples at a temperature of 131 °F (55 °C) or higher.

e. APA Hose Pressure Check

1) The air pressure in the APA test hoses shall be checked with a NIST traceable test gauge or transducer with a suitable range. The check shall be made while the APA is operating. Since the hoses are connected in series, it is satisfactory to connect the test gauge to the end of the right-most hose. The pressure should not fluctuate outside of the range of 100 ± 5 psi (690 ± 34 kPa) during normal operation. Adjust the pressure as necessary with the hose pressure regulator.

Note: The Ashcroft test gauge model 450182As02L200# has been found to be satisfactory for this purpose. This gauge may be available through Grainger (Stock No. 2F008).

2. Test Procedure (Note: Many APA's have been manufactured or retrofitted with Programmable Logic Controls and PC-based control systems. Follow the manufacturer's instructions for setting controls and performing the test procedure with this system. See also B.1.e above.)

a. Set the hose pressure gap reading to 100 ± 5 psi (690 ± 34 kPa). Set the load cylinder pressure reading for each wheel to achieve a load of 100 ± 5 lb. (445 ± 22 N).

b. Stabilize the testing chamber temperature at the temperature selected in D.1.b.2).a).

c. Secure the preheated, molded specimens in the APA. The preheated APA chamber should not be open more than 6 minutes when securing the test specimens into the machine. Close the chamber doors and allow 10 minutes for the temperature to re-stabilize prior to starting the test.

d. Apply 25 cycles to seat the specimens before the initial measurements. Make adjustments to the hose pressure as needed during the 25 cycles.

(Note: For APA's equipped with automatic measurement systems, steps D.2.e through D.2.l are unnecessary. Some APA users have reported significant differences in rut depths between the automatic measurements and manual measurements.)

e. Open the chamber doors unlock and pull out the sample holding tray.

f. Place the rut depth measurement template over the specimen. Ensure that the rut depth measurement template is properly seated and firmly rests on top of the testing mold.

g. Zero the digital measuring gauge so that the display shows 0.00 in (0.00 mm) with the gauge completely extended. The display should also have a bar below the "inc." position. Take initial readings at each of the four outside locations on the template. The center measurement is not used for cylindrical specimens. Measurements shall be determined by placing the digital measuring gauge in the template slots and sliding the gauge slowly across the each slot. Record the smallest measurement for each location to the nearest 0.0004 in (0.01 mm).

h. Repeat steps f and g , for each set of cylinders in the testing position. All measurements shall be completed within six minutes.

i. Push the sample holding tray in and secure. Close the chamber doors and allow 10 minutes for the temperature to equalize.

j. Set the PRESET COUNTER to 8000 cycles.

k. Start the test. When the test reaches 8000 cycles, the APA will stop and the load wheels will automatically retract.

l. Repeat steps D.2.e through D.2.h to obtain final measurements.

E. Calculations

1. The rut depth at each location is determined by subtracting the final measurement from the initial measurement.
2. Determine the overall average rut depth for each test position. Use the average of all twelve measurements to calculate the average rut depth.
3. Calculate the average rut depth from the three test positions. Also, calculate the standard deviation for the three test positions.
4. Outlier evaluation - If the standard deviation of the set is greater than or equal to 0.079 in (2.0 mm), the position with the rut depth farthest from the average may be discarded. The testing procedure, device calibration, and test specimens should be investigated to determine the possible causes for the excessive variation.
5. The APA rut depth for the mixture is the average of the six cylindrical specimens at 8000 cycles.

F. REPORT

The test report shall include the following information:

- The laboratory name, technician name, and date of test.
- The mixture type and description.
- Average air void content of the test specimens.
- The test temperature.
- The average rut depth, to the nearest 0.1 mm, at 8000 cycles.
- The wheel load and hose pressure.

Georgene M. Geary, P.E., State Materials and Research Engineer

David Graham, P.E., Director of Construction