T 324

HAMBURG WHEEL-TRACK TESTING OF COMPACTED HOT-MIX ASPHALT (HMA)
FOP FOR AASHTO T 324

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Scope

This FOP describes the AASHTO test method to test the rutting and moisture-susceptibility of hot-mix asphalt (HMA) samples in the Hamburg Wheel-Tracking Device.

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Significance

Compacted samples of HMA are submerged in a temperature controlled water bath and tested under a concentrated load by a reciprocating rolling-wheel device. The rut depth and number of passes are measured. The performance of the HMA is evaluated, to determine the failure susceptibility of the HMA due to weakness in the aggregate structure, inadequate binder stiffness, or moisture damage.

Apparatus

04 - Hamburg Wheel-Tracking Machine.
- Temperature Control System – a water bath capable of controlling the temperature within ±1.0°C (1.8°F) over a range of 25 to 70°C (77 to 158°F).

05 - Impression Measurement System – An LVDT (Linear Value Displacement Transducer) capable of measuring the depth of the impression of the wheel within 0.01 mm.
- Wheel pass counter.
- Specimen Mounting System.
- Balance.
- Ovens.
- Superpave Gyratory Compactor.
- Bowls, spoons spatula etc.

Note 1: For more complete description of the required apparatus refer to AASHTO T 324.

06 ## Calibration / Equipment Verification

- Water bath temperature is within ±1°C (1.8°F) of the temperature readout (every six months).
- The LVDT height is within ±0.05mm (0.002in) between the three calibration blocks (10mm, 20mm, and 30mm) (0.4 inch, 0.8 inch, and 1.2 inch).
- The load on the wheel is 705 ±4.5N (158 ±1.0 lb) in the middle of the stroke at the correct elevation.
- The wheel reciprocates, back and forth, at 50 ±5 passes per min.

07 ## Specimen Preparation

Two test specimens are prepared for each test. The specimens may be either slab or cylinders.

Prepare laboratory mixed samples in

accordance with the FOP for AASHTO R 30.

If plant produced HMA is used, sample should be obtained in accordance with AASHTO T 168 and reduced to testing size.

The sample shall be brought to the compaction temperature range by careful, uniform heating in an oven immediately prior to molding.

08 **Slab Specimens** - Compact using a Linear Kneading Compactor (or equivalent) to an air void content of 7.0 ±2.0%. Specimens shall be 320 mm (12.5 inch) long and 260 mm (10.25 inch) wide. Thickness of 38 mm (1.5 inch) to 100 mm (4 inch) can be used and shall be at least twice the nominal maximum aggregate size.

09 **Superpave Gyratory Compactor Specimens -** Compact in accordance with the FOP for AASHTO T 312 to the air void content of 7 ±2.0%. Thickness (height) of 38 mm (1.5 inch) to 100 mm (4 inch) can be used and shall be at least twice the nominal maximum aggregate size.

- After compacting, remove specimens from the molds and cool at room temperature on a flat clean surface.

10 **Field Compacted (Core/Slab) Specimen** – Wet saw-cut compacted specimens taken from HMA pavements. Cores shall be 250 mm (10 inch); slabs shall be approximately 260 mm (10.25 inch) wide and 320 mm (12.5 inch) long. Slab thickness of 38 mm (1.5 inch) to 100 mm (4 inch) may be used. A height of 38 mm (1.5 inch) is typically used, but the core or slab may be wet saw-cut to adjust the height to fit the specimen mounting system.

Note 2: The sample should be loaded such that it is level to the surface of the mold. It must be trimmed if it is too tall or shimmed if it is too short. The down pressure of the wheel is calibrated at the center, level to the top of the mold. Even a small change in elevation will change the down pressure significantly.

Note 3: Dimensions of Field Compacted Specimens are subject to the dimensions of the mold. A different size may be necessary for proper mounting, i.e. 305mm (12 inch) cores may be more appropriate for some agencies/equipment.

11 • Determine the bulk specific gravity (G_{mb}) of each of the compacted specimens in accordance with Method "A" of the FOP for AASHTO T 166.

• Determine maximum specific gravity (G_{mm}) of the mix on a companion sample. FOP for AASHTO T 209.

12 • Calculate the air void content in percent (P_a) for each specimen, using the formula at the left. The target air void content for laboratory-compacted specimens is 7.0 ±2.0%. Field-compacted specimens are tested at the air void content at which they are obtained.

$$P_a = 100\left(1 - \frac{G_{mb}}{G_{mm}}\right)$$

where:

P_a = Percentage of air voids (nearest 0.1%)
G_{mm} = maximum specific gravity (T 209)
G_{mb} = Bulk specific gravity (T 166)

Calculation Example

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Percentage Air Voids

$$P_a = 100\left(1 - \frac{2.363}{2.552}\right) = 7.41, \text{ say } 7.4\%$$

where:

G_{mb} = 2.363
G_{mm} = 2.552

14 **Specimen Mounting** – Using Plaster-of-Paris at approximately a 1:1 ratio of plaster to water, rigidly mount the specimen in the mounting tray. The height of plaster should be equal to the height of the specimen to fill air space between the specimen and the tray. The plaster layer underneath the specimen shall not exceed 2 mm (0.08 inch). Allow the plaster to set for at least one hour.

15 **Test Temperature –** Based on the applicable specifications.

16 ## Procedure

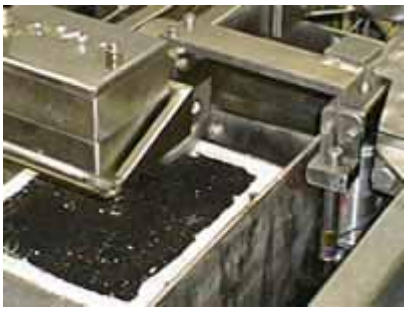
1. Close drain valve.
2. Place mounted specimens and spacers in the wheel-tracker device.
3. Fill the device with hot water until the float device floats to the horizontal position. Adjust water temperature as necessary.
4. 17 Bring to test temperature and hold for 30 minutes.
5. 18 Lower the wheels onto the specimen.

19 6. Ensure the micro-control unit's LVDT readout reads between 10 mm (0.4 inch) and 18 mm (0.7 inch) this will be subtracted from the total displacement on the screen readout.

Note 4: To adjust the LVDT height, loosen the two screws on the LVDT mount and slide the LVDT up or down to the desired height. Tighten the screws.

Note 5: If the LVDT is mounted such that starting between 10 mm (0.4 inch) and 18 mm (0.7 inch) is not applicable, follow manufacturer's instructions.

20 7. Start the test.



21 The wheel-tracking device will shut off at 20,000 passes or when the average LVDT displacement (read from the micro-control unit, not the screen) is 40.90 mm (1.6 inch) or greater for an individual specimen.

Note 6: The wheel-tracking device may be programmed to a maximum allowed deformation. If the maximum allowed deformation is reached before 20,000 passes, the wheel will lift off the failed sample but continue testing the second sample.

22 8. Turn off machine and main power supply.

9. Open the valves beneath the tanks to drain the baths.

23 10. Raise the wheels and remove the specimens and spacers.

11. Clean the water bath, heating coils, wheels, and temperature probe with water and scouring pads (or as per manufacturer's recommendation).

24 12. Use a wet-dry vacuum to remove particles that have settled to the bottom.

13. Clean the filter elements and spacers.

14. Turn the wheels after each test so that the same section of the wheel is not in contact with the test specimen from test to test.

25 ## Calculations

Results of the wheel-tracker tests are plotted on a graph displaying rut depth (typically in millimeters) versus the number of passes for each test. A line is plotted for the left wheel, the right wheel, and an average of both wheels.

An examination of the graph can reveal the number of passes to failure, the maximum rut depth occurring, and a stripping inflection point.

26 When using appropriate software, data may be manipulated in several ways including a regression report, a wheel-tracking report, and a wheel-tracking test**.**

27 The **regression report** is a plot of the creep slope, the stripping slope, and the resulting stripping inflection point (SIP). This is a useful

28 report for evaluating failed specimens. Use of the report requires the operator to examine the graph and select two points that represent a linear creep slope and two points that represent a linear stripping slope. The software will then plot both lines and give an SIP and the number of passes to the point (see figure 1). The report can be used to evaluate when stripping of a sample occurs.

The **wheel-tracking test** simply plots the passes versus the rutting depth for the left wheel, the right wheel and the average. This is the same graph produced by the wheel-tracking report without all the other report information. Use this report as a quick view of the test results.

The information can also be analyzed without software, see AASHTO T 324 for Stripping Inflection Point (SIP) calculation.

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Report

- HMA Production (Plant or Lab)
- Specimen production
  - Field: Slab or Core
  - Lab: Slab or SGC specimen
- Number of passes at maximum impression
- Maximum impression
- Test temperature
- Specimen(s) air voids
- Creep slope
- Strip slope
- Stripping inflection point (SIP)

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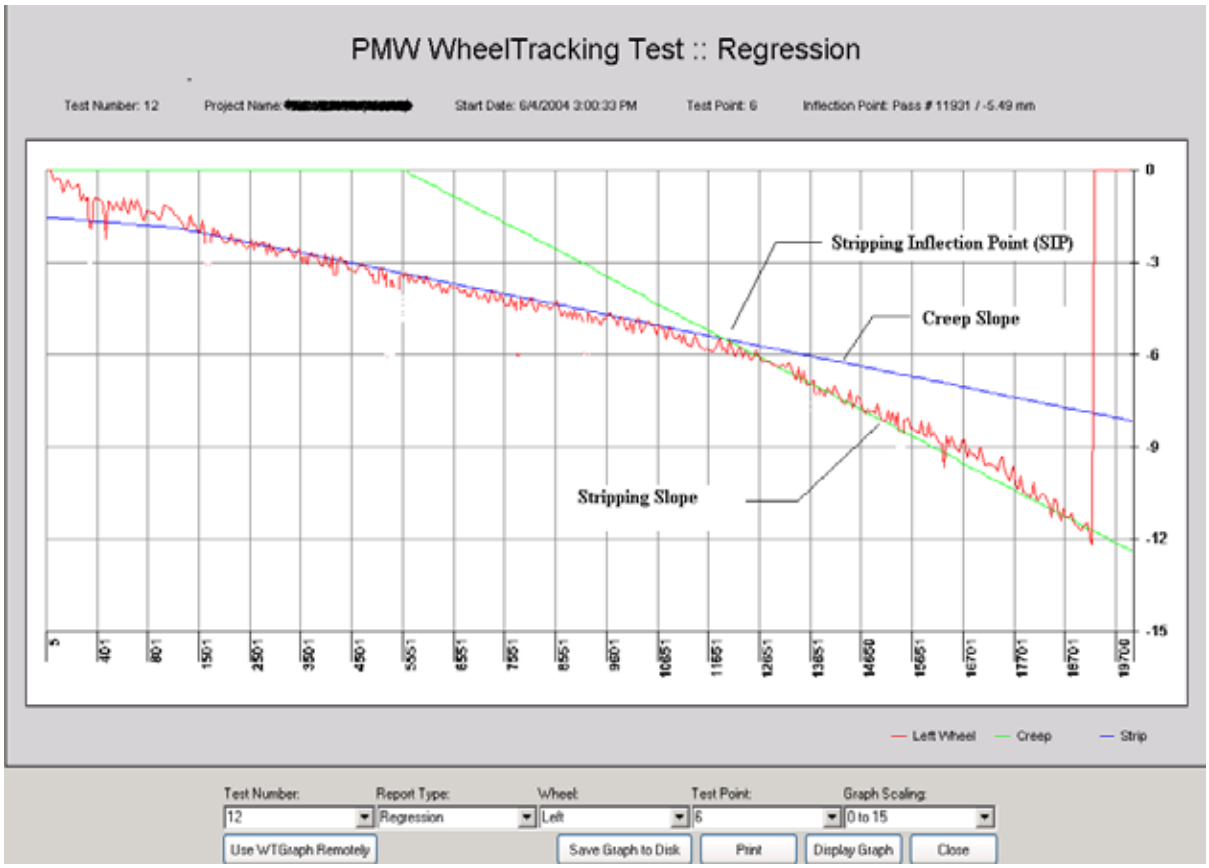
Tips!

- Check agency guidelines on correct test temperature.
- Check the correct setting of the LVDT readout.
- Follow all manufacturers' instructions.

Example Regression Graph (Figure 1)



REVIEW QUESTIONS

1. How many test specimens are prepared for each test?

2. What are the different types of specimens?

3. List the main steps of the procedure.

4. What does SIP stand for?