**Test Procedure for**

# HAMBURG WHEEL-TRACKING TEST

**TxDOT Designation: Tex-242-F**

***Effective Date: July 2021***

## 1. SCOPE

1.1 This test method determines the premature failure susceptibility of bituminous mixtures due to weakness in the aggregate structure, inadequate binder stiffness, or moisture damage, and other factors including inadequate adhesion between the asphalt binder and aggregate.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

## 2. APPARATUS

2.1 *Wheel-Tracking Device*—an electrically powered device capable of moving a steel wheel with a diameter of 8 ± 0.08 in. (203.2 ± 2.0 mm) and width of 1.85 in. (47 mm) over a test specimen.

2.1.1 The load applied by the wheel must be 158 ± 5 lb. (705 ± 22.2 N).

2.1.2 The wheel must reciprocate over the test specimen, with the position varying sinusoidally over time.

2.1.3 The wheel must be capable of making 52 ± 2 passes across the test specimen per minute.

2.1.4 The wheel must reach maximum speed, approximately 1.0 ft./sec. (0.305 m/s), at the midpoint of the combined specimens.

2.2 *Temperature Control System*—a water bath capable of controlling the test temperature within ± 4°F (2°C) over a range of 77 to 158°F (25 to 70°C).

2.2.1 The water bath must have a mechanical circulating system to stabilize temperature within the specimen tank.

2.3 *Rut Depth Measurement System*—a Linear Variable Differential Transducer (LVDT) device capable of measuring the rut depth induced by the steel wheel within 0.0004 in. (0.01 mm), over a minimum range of 0.8 in. (20 mm).

2.3.1 The system should measure the rut depth at 11 different locations in the wheel's path on the specimens as shown in Figure 1.

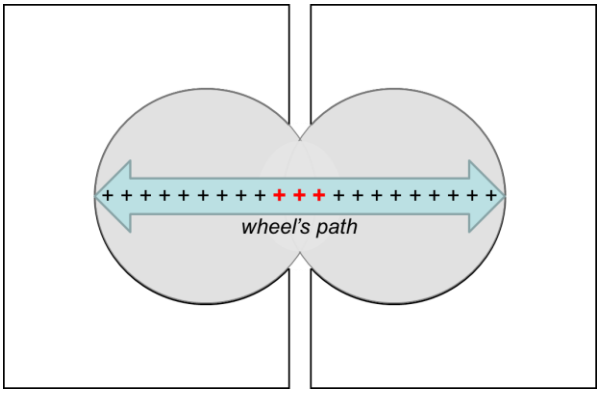


**Figure 1—**Schematic of Rut Depth Measurement Points

2.3.2 The system must take rut depth measurements at least every 100 passes of the wheel.

2.3.3 The system must be capable of measuring the rut depth without stopping the wheel. Reference this measurement to the number of wheel passes.

2.3.4 The system must have a fully automated data acquisition and test control system (computer included).

2.4 *Wheel Pass Counter*—a non-contacting solenoid that counts each wheel pass over the test specimen.

2.4.1 Couple the signal from this counter to the rut depth measurement, allowing the rut depth to be expressed as a fraction of the wheel passes.

2.5 *Specimen Mounting System*—a stainless steel tray that can be mounted rigidly to the machine in the water bath.

2.5.1 This mounting must restrict shifting of the specimen during testing.

2.5.2 The system must suspend the specimen, allowing a minimum of 0.79 in. (20 mm) of free circulating water on all sides of the mounting system.

2.6 *Masonry Saw.*

## 3. MATERIALS

3.1 *Three high-density polyethylene molds,* to secure circular, cylindrical test specimens. Use one mold for cutting the specimen, as shown in Figure 2, and the other two for performing the test, as shown in Figure 3.

3.2 *Capping compound,* able to withstand 890 N (200 lb.) load without cracking.

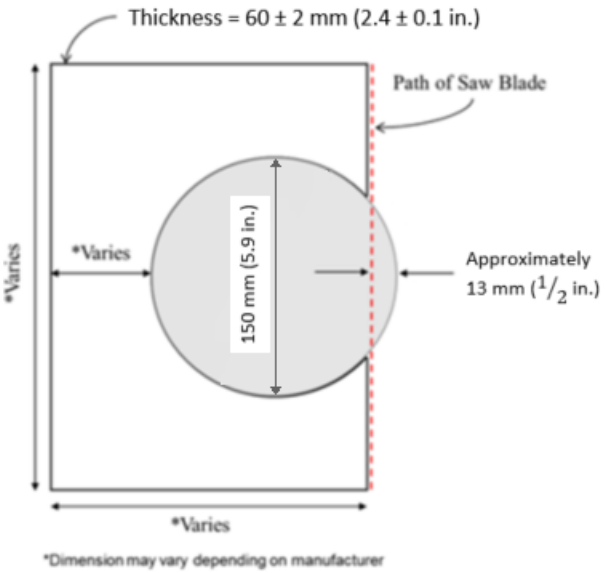


**Figure 2—**Schematic of Specimen Cutting Setup

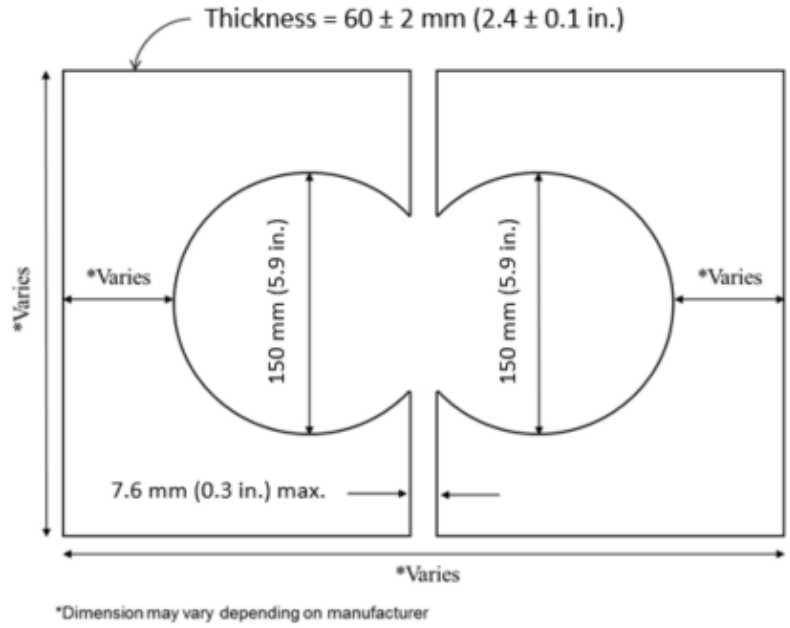


**Figure 3—**Top View of Test Specimen Configuration for the Hamburg Wheel-Tracking Device

## 4. SPECIMENS

4.1 *Laboratory-Molded Specimens*—Prepare two specimens in accordance with Tex-241-F. Specimen diameter must be 150 mm (5.9 in.), and height must be 62 ± 1 mm (2.40 ± 0.04 in.).

4.1.1 Density of test specimens must be 93 ± 0.5%, except for Permeable Friction Course (PFC) mixtures, Thin Bonded Wearing Course (TBWC), and Crack Attenuating Mix (CAM).

**Note 1**—Mixture weights for laboratory-molded specimens that achieve the density requirement typically vary between 2,400 and 2,600 g.

4.1.2 For PFC mixtures, mold test specimens to 50 gyrations (Ndesign).

**Note 2**—Mixture weights for laboratory-molded PFC specimens that achieve the required specimen height at Ndesign typically vary between 2,000 and 2,200 g.

4.1.3 For TBWC mixtures, mold test specimens to 50 gyrations (Ndesign).

**Note 3**—Mixture weights for laboratory-molded TBWC specimens that achieve the required specimen height at Ndesign typically vary between 2,200 and 2,600 g.

4.1.4 For CAM mixtures, mold test specimens to 95 ± 0.5% density.

**Note 4**— Mixture weights for laboratory-molded specimens that achieve the density requirement typically vary between 2,400 and 2,600 g.

4.2 *Core Specimens*—Specimen diameter must be 145 ± 5 mm (5.7 ± 0.2 in.). There is not a specific density requirement for core specimens.

**Note 5**—Use a 6-in. nominal core bit (outside diameter) to sample cores for this test.

## 5. PROCEDURE

5.1 *Laboratory-Molded Mixtures:*

5.1.1 Mold two specimens in accordance with Section 4.

5.1.2 Calculate the density of the specimens in accordance with Tex-207-F and Tex-227-F.

**Note 6**—Calculate the bulk specific gravity ($G_a$) of PFC specimens using dimensional analysis in accordance with Tex-207-F, Part VIII.

5.1.3 Allow the specimens to stand at room temperature (75 ± 5°F) for a minimum of 24 hr. before testing.

5.1.4 Test laboratory-molded specimens within three days of molding.

5.2 *Roadway Cores:*

5.2.1 Trim the bottom of the core to remove unwanted paving layers.

5.2.2 For cores greater than 64 mm (2.5 in.) in height, trim the bottom of the core to achieve a 62 ± 1 mm (2.40 ± 0.04 in.) total core height.

5.2.3 For cores less than 60 mm (2.4 in.) in height:

- mix capping compound,
- place the core with surface facing downward in a 6-in. diameter plastic mold,
- spread the capping compound on top of the core to achieve a 62 ± 1 mm (2.40 ± 0.04 in.) total core height,
- allow the capping compound to dry for a minimum of 24 hr., and
- remove the plastic mold from the capped core.

5.3 Place a prepared specimen in the cutting template mold. Ensure the sample is pushed to the back of the template mold, and use a masonry saw to cut it along the flat edge of the mold as shown in Figure 2.

5.3.1 The cut across the specimen should be approximately 13 mm (1/2 in.) deep.

5.4 Place the high-density polyethylene molds into the mounting tray and fit specimens into each one.

5.4.1 For cores less than 150 mm (5.9 in.) in diameter, place plastic spacers around the cores to secure them.

5.5 Ensure that the samples are firmly seated together and that there are no gaps at their interface. Fasten the mounting trays into the empty water bath by hand tightening the mounting hardware.

5.6 Start the software supplied with the machine, and enter the specimen or core information into the computer. Test temperature should be 122 ± 2°F (50 ± 1°C) for all specimens.

5.7 Fill the water bath, monitoring the temperature of the water on the computer screen.

5.8 Once the water has reached the desired temperature, saturate the combined test specimens in the water for an additional 30 min.

5.9 Start the test using the software supplied with the machine. The testing device automatically stops the test when the device has applied the number of desired passes or when the maximum allowable rut depth has been reached.

5.10 Open the report program, select the Midpoint Data Set option, and record the rut depth at every 5,000 passes and number of cycles at failure.

**Note 7**—The Midpoint Data Set option reports rut depth based on the average deformation at the three center points as shown in Figure 1.

5.11 Visually inspect the samples and note any stripping.

**Note 8**—Visibly clean aggregate, excessive fines in the water bath, or water that appears muddy after performing the test are all indications that the material is prone to stripping. Excessive stripping can lead to premature pavement failure and should be addressed in the mix design. Examples of stripping can be seen below in Figures 4-6.

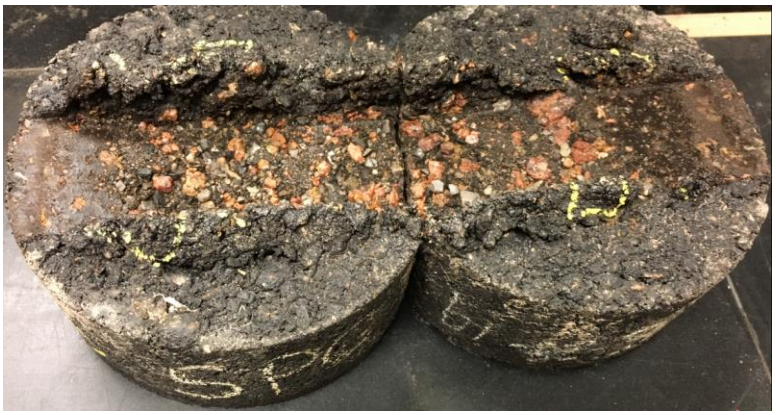

**Figure 4—**Example of Visibly Stripped Aggregate in Hamburg Sample

**Figure 5—**Example of Excessive Fines in the Water Bath

**Figure 6—**Example of Muddy Water after Performing Hamburg Test

## 6. REPORT

6.1 Report the following for each test:

- specimen type;
- rut depth at 5,000; 10,000; 15,000; and 20,000 passes (when available);
- rut depth at failure, mm;
- number of passes to failure;
- stripping inflection point (when available); and
- note any visible stripping.

## 7. REPORT FORMS

7.1 Hamburg Wheel-Tracking Test

## 8. ARCHIVED VERSIONS

8.1 Archived versions are available.