Colorado Procedure – Laboratory 5112-14

Standard Method of Test for

Hamburg Wheel-Track Testing of Compacted Bituminous Mixtures

(This document is a description of the test method used by the Colorado Department of Transportation to test samples in the Hamburg Wheel-Tracking Device.)

1. SCOPE

1.1 This method describes the testing of submersed, compacted bituminous mixtures in a reciprocating rolling wheel device. This test provides information about the rate of permanent deformation from a moving, concentrated load. A laboratory compactor is used to prepare slab specimens. Alternatively, field cores of large diameter (10 in.) or saw-cut slab samples may be tested.

1.2 The potential for moisture damage effects are evaluated since the specimens are submerged in temperature-controlled water during loading.

2. REFERENCED DOCUMENTS

2.1 Colorado Procedures:

CP 44	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
CP 51	Determining the Maximum Specific Gravity of Bituminous Mixtures
CP 55	Reducing Field Samples of Hot Mix Asphalt to Testing Size
CP-L 5116	Linear Kneading Compaction of Bituminous Mixtures

2.2 AASHTO Procedures:

T 324-04	Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalts (HMA)

3. SIGNIFICANCE AND USE

3.1 This test measures the rutting and moisture susceptibility of an asphalt paving mixture.

4. SUMMARY OF METHOD

4.1 A laboratory-compacted slab of a bituminous mixture, a saw-cut slab, or a core taken from a compacted pavement, is repetitively loaded using a reciprocating steel wheel. The specimen is submerged in a temperature controlled water bath of 40° to 55°C. The deformation of the specimen, caused by the wheel loading, is measured.

4.2 The impression is plotted as a function of the number of wheel passes. An abrupt increase in the rate of deformation coincides with stripping of the asphalt from the aggregate in the specimen.

5. APPARATUS

5.1 *Hamburg Wheel-Tracking Machine* - An electrically powered machine capable of moving a 203.6 mm (8 in.) diameter, 47 mm (1.85 in.) wide steel wheel over a test slab. The load on the wheel is 158 lbs. (705 N). The wheel shall reciprocate over the slab, with the position varying sinusoidally over time. The wheel shall make approximately 50 passes across the slab per minute. The maximum speed of the wheel shall be approximately 0.305 m/s (1.1 ft/sec), and will be reached at the midpoint of the slab.

5.2 *Temperature Control System* - A water bath capable of controlling the temperature within ± 0.5°C over a range of 25° to 70°C. This bath shall have a mechanical circulating system to stabilize temperature within the specimen tank.

5.3 *Impression Measurement System* - A LVDT device capable of measuring the depth of the impression of the wheel within 0.01 mm, over a minimum range of 20 mm. The system shall be mounted to measure the depth of the impression at the midpoint of the wheel's path on the slab. The impression shall be measured at least every 100 passes of the wheel. This system must be capable of measuring rut depth without stopping

the wheel. This measurement must be referenced to the number of wheel passes.

If the LVDT is temporarily not working, measurements may be taken through the center of the sample in the direction of the wheel path. Thirteen measurements shall be taken 1 inch apart every 1,000 passes. The rut will be the average of the thirteen measurements and shall be reported for every 1,000 passes.

5.4 *Wheel Pass Counter* - A non-contacting solenoid that counts each wheel pass over the slab. The signal from this counter shall be coupled to the wheel impression measurement, allowing for the rut depth to be expressed as a fraction of the wheel passes.

5.5 *Sample Mounting System* - A stainless steel tray that can be mounted rigidly to the machine. This mounting must restrict shifting of the sample to within 0.5 mm during testing. The system shall suspend the sample, allowing for free circulation of the water bath on all sides. The mounting system shall be designed to provide a minimum of 2 cm of free circulating water on all sides of the sample.

6. SAMPLE PREPARATION

6.1 Laboratory Produced Mix

6.1.1 *Mixing* - Materials mixed in the laboratory shall be brought to mixing temperature (Table 1) in a forced draft oven and mixed in a mechanical mixer for 3 to 5 minutes or until complete coating of the aggregates is achieved.

6.1.2 *Splitting* - Material mixed in the laboratory shall be placed in open pans. The amount (weight) of material is determined by calculating the number of grams of mix needed to attain an air void target of 6% (± 2%). To do this, multiply the volume of the sample (width x length x height) in cubic centimeters by the sample's maximum specific gravity, and then remove a percentage of the mix equal to the targeted air voids. The pans should contain less than 77 kg/m^2 (15.9 lb/ft^2) of material.

6.1.3 *Aging* - The mixed material shall be short-term aged by placing the open pans in a forced draft oven at the compaction temperature (Table 1) for 2 hours to age the material before compaction. If it is known that the material being designed will stay at elevated temperatures in the field for longer than 2 hours, then the aging time can be increased.

6.1.4 *Compacting* - Material shall be compacted into slabs. The slabs must be compacted to 6% ± 2% voids such that the void distribution is consistent throughout the sample. Samples shall be 12.5 in. (320 mm) long and 10.25 in. (260 mm) wide. A slab thickness of 1.5 in. (38 mm) to 4 in. (100 mm) can be used. The slab thickness shall be at least twice the maximum nominal aggregate size. Alternatively, Superpave gyratory samples may be used. They should be prepared as described in T 324-04. Compacted slabs shall be cooled at normal room temperature on a clean, flat surface until the sample is cool to the touch.

6.1.5 *Bulking* - The bulk specific gravity shall be performed in accordance with CP 44.

6.1.6 *Slab Mounting* - Use Plaster-of-Paris to rigidly mount the slab in the mounting trays. The plaster shall be mixed at approximately a 1:1 ratio of plaster to water. Pour the plaster to a height equal to that of the slab so that the air space between the slab and the tray is filled. The plaster layer underneath the slab shall not exceed 0.08 in. (2 mm). Allow the plaster to set for at least one hour.

6.2 Field Produced Mix

6.2.1 Field Loose Mix

6.2.1.1 *Splitting* - The mix received from the field shall be heated for 3 hours (± 0.5) in a forced draft oven at compaction temperature (Table 1) and then separated into pans for compaction. The amount of material is determined by calculating the number of grams of mix needed to attain an air void target of 6% ± 2%. To do this, multiply the volume of the sample (width x length x height) in cubic centimeters by the sample's maximum specific gravity, and then remove a percentage of the mix equal to the targeted air voids. The open pans should contain less than 77 kg/m^2 (15.9 lb/ft^2) of material.

6.2.1.2 *Compacting* – The material shall be heated for 3 hours in a forced draft oven at the compaction temperature (Table 1) prior to compacting. Material shall be compacted into slabs. The slabs must be compacted to 6% ± 2% voids such that the void distribution is consistent throughout the sample. Samples shall be 12.5 in. (320 mm) long and 10.25 in. (260 mm) wide. A slab thickness of 1.5 in. (38 mm) to 4 in. (100 mm) may be used. The slab thickness shall be at least twice the maximum nominal aggregate size. Alternatively, Superpave gyratory samples may be used. They should be prepared as described in T 324-04. Compacted slabs shall be cooled at

normal room temperature on a clean, flat surface until the sample is cool to the touch.

6.2.1.3 *Bulking* - The bulk specific gravity shall be performed in accordance with CP 44.

6.2.1.4 *Slab Mounting* - Use Plaster-of-Paris to rigidly mount the slab in the mounting trays. The plaster shall be mixed at approximately a 1:1 ratio of plaster to water. Pour the plaster to a height equal to that of the slab so that the air space between the slab and the mold is filled. The plaster layer underneath the slab shall not exceed 0.08 in. (2 mm). Allow the plaster to set for at least one hour.

6.2.2 **Field Compacted Core / Slab**

6.2.2.1 *Cutting* - Field cores or field slabs shall consist of wet saw-cut compacted samples taken from asphalt pavements. Field cores shall be 10 in. in diameter. Field slabs shall be wet saw-cut to approximately 10.25 in. (260 mm) wide and 12.5 in. (320 mm) long. A slab thickness of 1.5 in. (38 mm) to 4 in. (100 mm) may be used. The height of a field core or field slab is typically 1.5 in. (138 mm), but may be adjusted to fit the specimen mounting system by wet saw cutting.

6.2.2.2 *Bulking* - The bulk specific gravity is typically not performed on cores/slabs, however, it can be performed in accordance with CP 44.

6.2.2.3 *Core/Slab Mounting* - Use Plaster-of-Paris to rigidly mount the core/slab in the mounting trays. The plaster shall be mixed at approximately a 1:1 ratio of plaster to water. Pour the plaster to a height equal to that of the core/slab so that the air space between the core/slab and the mold is filled. The plaster layer underneath the slab shall not exceed 0.08 in. (2 mm). Allow the plaster to set for at least one hour.

Table 1

Asphalt Grade	Mixing Temperature	Compaction Temperature
PG 58-28	154° C (310° F)	138° C (280° F)
PG 58-34	154° C (310° F)	138° C (280° F)
PG 64-22	163° C (325° F)	149° C (300° F)
PG 64-28	163° C (325° F)	149° C (300° F)
PG 70-28	163° C (325° F)	149° C (300° F)
PG 76-28	163° C (325° F)	149° C (300° F)
	± 2.8° C (5°F)	

7. PRE-TEST PROCEDURE

7.1 The test temperature should be selected as follows:

SHRP High Temp PG	Test Temp
58	45° C
64	50° C
70	55° C
76	55° C

7.2 Fill the wheel-tracking device with hot water.

8. TEST PROCEDURE

8.1 When the water has been at test temperature for 30 minutes, lower the wheels onto the slabs.

8.2 Begin the test.

8.3 The wheel-tracking device will shut off when 10,000 cycles have occurred.

9. REPORT

9.1 The report shall include the following parameters:

Number of passes
Maximum impression
Test temperature
Sample(s) air voids
Creep slope
Strip slope
Stripping inflection point

Note 1: Maximum Rut depth greater than 4mm before 10,000 passes is a failure.

The regression table on the PMW Wheel tracker software program is used to calculate the Stripping Inflection Point (SIP). The low creep / high creep and the low strip / high strip data are inputted manually into the software where the SIP is calculated.

10. CALIBRATION / EQUIPMENT VERIFICATION

10.1 Verify that the water bath temperature is within 0.5°C of the temperature readout on the micro control unit every 6 months.

10.2 Verify that the LVDT height is within 0.05 mm between the three (10, 20, and 30 mm) calibration blocks.

{This page was intentionally left blank.}