Colorado Procedure L 5112

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 has been designed 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 55 Reducing Field Samples of Hot-Mix Bituminous Pavements to Testing Size

CP-L 5116 Linear Kneading Compaction of Bituminous Mixtures

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 40E to 50EC. 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 ± 0.5EC over a range of 25E to 70EC. 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.

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. If the air voids from the resulting compacted slab are measured at greater than 8% or less than 4%, adjust the mix weight for future slabs containing the same mix. The pans should contain less than 77 kg/m2 (15.9 lb/ft2) 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 using the Linear Kneading Compactor (refer to CP-L 5116) and 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. 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 1:1ratio 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 at least one hour to set.

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 2 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. If the air voids from the compacted slab are measured at greater than 8% or less than 4%, adjust the mix weight for future slabs containing the same mix. The open pans should contain less than 77 kg/m2 (15.9 lb/ft2) of material.

6.2.1.2 *Compacting* - The material shall be covered and heated for 4 hours in a forced draft oven at the compaction temperature (Table 1) prior to compacting. Material shall be compacted into slabs using the Linear Kneading Compactor (refer to CP-L 5116) and 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. 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. *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 at least one hour to set.

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 at least one hour to set.

Table 1

Asphalt Grade	Mixing Temperature	Compaction Temperature
PG 58-22	154EC(310EF)	138EC (280EF)
PG 58-28	154EC(310EF)	138EC (280EF)
PG 58-34	154EC(310EF)	138EC (280EF)
PG 64-22	163EC(325EF)	149EC (300EF)
PG 64-28	163EC(325EF)	149EC (300EF)
PG 70-28	163EC(325EF)	149EC (300EF)
PG 76-28	163EC(325EF)	149EC (300EF)

± 2.8E **C (5**E**F)**

7. PRE-TEST PROCEDURE

7.1 Be sure the red emergency button is depressed (machine disabled) and the main power supply is off. Choose the appropriate spacers for the tray(s) being used and place them over the threaded guides in the wheel-tracking machine. The spacers needed for the sample trays are as follows (may vary by machine):

Short Tray -	short, medium and tall spacers
Medium Tray -	tall spacer only
Tall Tray -	no spacers

7.2 Mount the sample trays on top of the spacers and secure them using the securing nuts. The securing nuts shall be tightened to approximately 10 ft-lbs. with the hand wrench.

7.3 Begin the computer testing software by typing **"HAM"**or **"VF 2002_P"** at the DOS prompt Continue through the first three windows by entering **"CONTINUE" and "START TEST"** until a screen appears that requests the testing information. Enter the test information as follows:

TEMPERATURE	**As specified**
NAME (Field Sheet #)	**1-8 characters***
NO. OF PASSES	**20,000**
NO. OF PREPASSES	**10**
CYCLE STORING	**50**
VARIABLE	**no**
MAXIMUM IMPRESSION	**20**
HOLD TEMPERATURE	**no**

* (The "NAME" **must** have a .DAT extension)

The test temperature is based on the high temperature of the asphalt grade and shall be determined as follows:

SHRP High Temp	Test Temp
52	**40EC**
58	**45EC**
64	**50EC**
70	**55EC**

7.4 Be sure the drain valve(s) for the front and back tanks are closed. Fill the wheel-tracking device with hot water until water overflows from the front tank into the back tank and the float device in the back tank floats to a horizontal position. The water temperature may vary and should be adjusted if necessary.

7.5 Turn on the main power supply and reset the emergency button to restore power to the wheel-tracking device. **Hit "CONTINUE"** to begin the process of bringing the water to test temperature. Once the water reaches the test temperature, the device will display the time that the water has been held at test temperature.

8. TEST PROCEDURE

8.1 When the water has been at test temperature for 30 minutes, lower the wheels onto the slabs. Check that the micro control unit's LVDT readout reads between 10 mm and 18 mm. To adjust the LVDT height, loosen the two screws on the LVDT mount with an Allen wrench, and then sliding it up or down to the desired height.

8.2 Press"ENTER" on the keyboard to begin the test. If the wheels do not begin to move, check the printer to ensure that it is "on-line."

8.3 The wheel-tracking device will shut off when 20,000 cycles have occurred. The device will also shut off if the average LVDT displacement (read from the micro-control unit, not the screen) is 40.90 mm or greater for either side of the test. Note that the screen readout subtracts the initial LVDT reading (Section 8.1) from the total displacement. If one side passes 20 mm before the end of the test, it will be necessary to raise the wheel off of the sample so that the other side may finish testing. **However,** the machine software requires that both wheels must be down at the end of the test in order to save the data. If it is necessary to prematurely shut down testing for both specimens, hit "E" on the keyboard or follow the software's instructions.

8.4 At the end of the test, go through the screens entering "END" until the DOS "C:\" prompt appears. Copy the test data onto a 3 1/2 " floppy disk with either one of the following commands:
c (filename) (no extension is necessary), or
copy (filename).* b:

Take the printer off-line and advance the final page of the document. Put the printer back to the on-line position.

9. POST-TEST PROCEDURE

9.1 Depress the red emergency button and turn off the main power supply. To drain the baths, open the valve(s) beneath the tanks. Raise the wheels and remove the rutted specimens and the spacers.

9.2 Clean the water baths, heating coils, wheels, and temperature probe with water and green scouring pads (and, optionally,140 solvent). Use a wet-dry vacuum to remove particles that have settled onto the bottom of the baths. Clean the filter element and spacers after every test.

9.3 To clean the rutted specimens from the trays, remove the bolts on the trays and use a chisel and hammer to pry the rutted slabs away from the bottom of the tray.

9.4 Clean the tray with water, a green scrub pad, and 140 solvent.

10. REPORT

10.1 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

11. MAINTENANCE

11.1 All of the grease fittings (8) shall be greased with fresh grease every 20 tests (not to exceed 2 months).

12. CALIBRATION / EQUIPMENT VERIFICATION

12.1 Verify that the water bath temperature is within 0.5EC of the temperature readout on the micro control unit every 6 months.

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