WSDOT T 738

In-Place Density of Asphalt Mixtures Using the Nuclear Moisture-Density Gauge

Scope

This test method describes the procedure for using a nuclear moisture gauge to determine the in-place density of asphalt mixtures, the correction of the gauge reading by correlation core, and the calculation of the percentage of compaction for asphalt mixtures.

Apparatus

- Nuclear density gauge with the factory matched standard reference block.
- Drive pin, guide, scraper plate, and hammer for testing in direct transmission mode.
- Transport case for properly shipping and housing the gauge and tools.
- Operator manual for the specific make and model of gauge.
- Radioactive materials information and calibration packet containing:
  - Daily Standard Count Log
  - Factory and Laboratory Calibration Data Sheet
  - Density Standard Decay Sheet
  - Leak Test Certificate
  - Shippers Declaration for Dangerous Goods
  - Procedure Memo for Storing, Transporting, and Handling Nuclear Testing Equipment
  - Other radioactive materials documentation as required by local regulatory requirements.

Radiation Safety

This method does not purport to address the safety concerns, if any, associated with its use. This test method involves potentially hazardous materials. Take proper precautions when utilizing the nuclear gauge, radioactive materials can be hazardous to the health of the user. Users of this gauge must become familiar with the applicable safety procedures and governmental regulations. All operators will be trained in radiation safety prior to operating nuclear density gauges. The use of personal monitoring devices such as a thermoluminescent dosimeter or film badge is required by WSDOT.

Calibration

Perform calibrations in accordance with the manufacturer’s operators manual.

Standardization (Standard Count)

1. Turn the gauge on and allow it to stabilize for 10-20 minutes prior to taking a Standard (extra carriage return) Count. Do not turn the gauge off during the work period.
2. Prior to any correlation of the nuclear gauge, perform a Stat Test in accordance with the gauge's operator manual.
   a. If the gauge passes the Stat Test, perform a Standard Count.
   b. If the gauge fails the Stat Test, run a second Stat Test. If the gauge fails the second Stat Test, it should be repaired or recalibrated.
3. Take a Standard Count at the start of each day's work and prior to testing whenever the gauge has been turned off during the work period. Daily variations in Standard Count shall not exceed the acceptable limits established by the manufacturer of the gauge. Compare the daily standard count to the average of the last four counts to ensure acceptable limits are not exceeded.
4. Compare the daily Standard Count to the Density Standard Decay Sheet (Note 2) to ensure the standard count falls within acceptable limits.
   a. If the acceptable limits in Standard Count are exceeded after repeating the Standard Count procedure or if the daily Standard Count is outside the range of the Standard Decay Sheet, the gauge should be repaired and or recalibrated.
5. Record the Standard Count for both density and moisture in the Daily Standard Count Log.
6. The gauge operator manual has instructions for taking a Standard Count.

   Note 2: The Density Standard Decay Sheet is found in the calibration documentation packet. This sheet shows the anticipated standard count range based on the calculated decay rate of the gauges radioactive source over the passage of time.

Test Site Location

1. Select a test location(s) randomly and in accordance with WSDOT Test Method T 716. Test sites should be relatively smooth and flat and meet the following conditions:
   a. At least 33 ft (10 m) away from other sources of radioactivity
   b. At least 10 ft (3 m) away from large objects (i.e., vehicles)
   c. No closer than 24 in (600 mm) to any vertical mass, or less than 6 in (152.0 mm) from a vertical pavement edge

Overview

There are two approved methods for determining in-place density of asphalt mixes:

- Direct Transmission Mode – When the lift thickness is 0.15 foot or greater.

  If a density lot is started in this mode it must continue in this mode until the pavement thickness falls below 0.15 feet. At that time, the mode of testing will change to Thin Layer Mode and the gauge must be correlated in thin layer mode prior to resuming testing.
- Thin Layer Mode – When the lift thickness is 0.10 foot or greater. Only gauges with two sets of photon detectors (i.e., Troxler 3450) operating in "Thin Layer Mode" will be allowed.

  If a density lot is started in thin layer mode, it must remain in thin layer mode until the lot is completed.

Procedure

Direct Transmission Mode

1. Maintaining maximum contact between the base of the gauge and the surface of the material under test is critical.
2. Use the guide and scraper plate as a template and drill a hole to a depth of at least ¼ in (7 mm) deeper than the measurement depth required for the gauge.
3. Place the gauge on the prepared surface so the source rod can enter the hole. Insert the probe in the hole and lower the source rod to the desired test depth using the handle and trigger mechanism. Ensure that the pavement depth is within 0.15' of the correlation depth. If the pavement depth not within 0.15' of the correlation depth an new correlation is required per SOP 730.
4. Position the gauge with the long axis of the gauge parallel to the direction of paving. Pull the gauge so that the probe is firmly against the side of the hole. Draw an outline around the entire gauge base for correlation coring, when applicable.

   WSDOT Note: For alignment purposes, the user may expose the source rod for a maximum of 10 seconds.
5. Take one 4-minute test and record the wet density (WD) reading.

Thin Layer Mode

1. Maintaining maximum contact between the base of the gauge and the surface of the material under test is critical.
2. A thin layer gauge (i.e., Troxler 4640) or a moisture density and thin layer gauge that has a thin layer mode setting (i.e., Troxler 3450) is required to perform this testing.
3. Ensure that the depth entered into the gauge matches the pavement depth and is within 0.08' of the correlation depth. If the pavement depth is not within than 0.08' of the correlation depth, a new correlation is required per SOP 730. Draw an outline around the entire gauge base for correlation coring.
4. Take test in accordance with manufacturer's recommendation except, WSDOT does not fill voids in asphalt with sand or cement.
5. Take one 4-minute test and record the density (D) reading.

Calculation of Percent of Compaction

The percent compaction is determined by comparing the in-place wet density (WD) or density (D), as determined by this method, to the Average Theoretical Maximum Density of the asphalt mix as determined by the WSDOT SOP 729.

The gauge operator will receive a new average Theoretical Maximum Density from the asphalt mix tester for each day of production a mix test is required. The gauge operator will continue to use the previous moving average until a new moving average is received. The gauge operator will then change the moving average value and calculate the percent compaction using the new moving average value. Density tests performed prior to the receipt of the new moving average will not be adjusted with the new moving average value.

Each gauge shall be correlated in accordance with WSDOT SOP 730. A correlation factor will be provided for each nuclear-moisture density gauge.

Use the following equations to calculate the percent of compaction:

1. Calculate the corrected gauge reading to the nearest tenth of a percent as follows:

   Corrected Gauge Reading = WD × CF or D × CF

   Where:
   WD = moisture density gauge wet density reading
   D = Asphalt Mix Density reading for thin layer mode gauge
   CF = gauge correlation factor (WSDOT SOP 730)

2. Calculate the percent compaction as follows.

$$\text{Percent Compaction} = \frac{\text{Corrected Gauge Reading}}{\text{Average Theoretical Maximum Density}} \times 100$$

Correlation With Cores

Refer to WSDOT SOP 730 for the procedure for correlation cores

Report

Report the results using one of the following:

- Materials Testing System (MATS)
- DOT Forms 350-092 and 350-157
- Form approved in writing by the State Materials Engineer

Report the percent compaction to the nearest tenth of a percent (0.1 percent).

Tester Qualification Practical Exam Checklist

In-Place Density of Asphalt Mixes Using the Nuclear Moisture-Density Gauge
FOP for WAQTC T 738

Participant Name _____ Exam Date _____

Procedure Element	Yes	No
1. The tester has a copy of the current procedure on hand?		
2. All equipment is functioning according to the test procedure, and if required, has thecurrent calibration/verification tags present?		
3. Gauge turned on?		
4. Gauge standardized and Standard Count recorded?		
5. Standard Count compared with Density Standard Decay sheet?		
6. Stat test run prior to correlation?		
7. Test location selected appropriately?		
8. Direct Transmission Mode:		
a. Hole made a minimum of ¼ inch deeper than measurement depth?		
b. Gauge placed parallel to direction of paving, probe extended, gauge pulled back so probe against hole?		
c. For alignment purposes did not expose the source rod for more than 10 seconds.		
d. One 4-minute test made?		
e. Wet density recorded?		
9. Thin Layer Gauge or Gauge in Thin Layer Mode:		
a. Gauge placed, probe extended to backscatter position?		
b. One 4-minute test made; gauge placed as described in the manufacturer recommendations?		
c. Density (D) recorded?		
10. All calculations performed correctly?		
11. Nuclear Gauge secured in a manner consistent with current DOH requirements?		

First Attempt: Pass Fail Second Attempt: Pass Fail

Signature of Examiner _____

Comments: