Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices
FOP for AASHTO T 343

Scope

This procedure covers the in-place density determination of Hot Mix Asphalt (HMA) in accordance with AASHTO T343using an electronic surface contact device / gauge. This field operating procedure is derived from AASHTO T343. The gauge measures density and relative compaction of HMA pavements by measuring changes in the electromagnetic field resulting from the compaction process.

Apparatus

- electronic surface contact gauge shall meet the following requirements:
  - be housed in an enclosure of heavy-duty construction.
  - function in the temperature and moisture levels experienced during the placement of HMA pavements.
  - include the internal circuitry suitable for displaying individual measurements.
  - include a continuous measurement mode of operation.
  - provide power to the sensor which allows data acquisition, readout function, and calibration.

Calibration

Calibration of the gauge shall be performed as specified in the Idaho Transportation Departments Laboratory Operations Manual section 200.

Standardization

Standardize the gauge daily per the manufacturers instructions. Note: gauges are paired to the standardization (reference) blocks. Using only the standardization block paired with the gauge.

PQI 301. Establish initial reference reading with the standardization block after calibration. Calculate and record upper and lower limits. Record date. Record and compare daily readings to upper and lower limits. Remove gauge from service if values are not within limits

PQI 380. Record date. Record results (pass/fail). Remove failing gauge from service

Pavetracker. Record date. Remove gauge from service if it displays an error message.

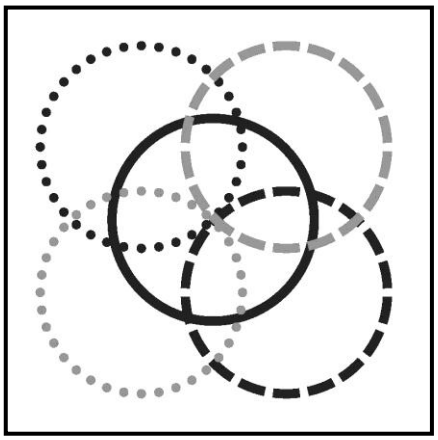
Correlation with Cores

Correlate the gauge for each Job Mix Formula (JMF) and each pavement lift. These correlation measurements / readings should be taken at the same temperature range as the acceptance tests.

1. Determine the number of cores required for correlation. Cores shall be located on the first day's paving or on the test strip. For projects with test strips locate the test sites in accordance with the IT125. Test sites shall be determined using random sampling practices.
2. Clear any existing correlations from the gauge.
3. Place the gauge on the HMA mat at the test sites and draw an outline around the base of the gauge. The mat shall have no noticeable moisture visible. The mat shall be flat, relatively smooth and clear of any loose particles.

4. Perform and record five (5) measurements as shown in diagram #1. Determine and record the average test site measurement / reading.

DIAGRAM # 1



5. Obtain a 6" core from of each test site in accordance with WAQTC TM 11. The core should be taken from approximately the center of the footprint.
5. Determine the density of the cores by the FOP for AASHTO T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens.
6. Calculate a correlation factor for the gauge reading as follows:
   a. Calculate the difference between the core density and the average gauge density at each test site to the nearest 0.1 lb/ft^3. Calculate the average difference and standard deviation of the differences for the entire data set to the nearest 0.1 lb/ft^3.
   b. If the standard deviation of the differences is equal to or less than 2.5 lb/ft^3, the correlation factor applied to the gauge reading shall be the average difference calculated above in 6.a.
   c. If the standard deviation of the differences is greater than 2.5 lb/ft^3, the test site with the greatest variation from the average difference shall be eliminated from the data set and the data set properties and correlation factor recalculated following 6.a and 6.b.
   d. If the standard deviation of the modified data set still exceeds the maximum specified in 5.b, additional test sites will be eliminated from the data set and the data set properties and correlation factor recalculated following 6.a and 6.b. If the data set consists of less than five (5) test sites, additional test sites shall be established.

Core Correlation Example:

Core Density T 166:	Avg. Test site In-Place T343:	Difference:
144.9 lb/ft^3	142.1 lb/ft^3	2.8 lb/ft^3
142.8 lb/ft^3	140.9 lb/ft^3	1.9 lb/ft^3
143.1 lb/ft^3	140.7 lb/ft^3	2.4 lb/ft^3
140.7 lb/ft^3	138.9 lb/ft^3	1.8 lb/ft^3
145.1 lb/ft^3	143.6 lb/ft^3	1.5 lb/ft^3
144.2 lb/ft^3	142.4 lb/ft^3	1.8 lb/ft^3
143.8 lb/ft^3	141.3 lb/ft^3	2.5 lb/ft^3
	Average Difference:	**+ 2.1 lb/ft^3**
	Standard Deviation (n – 1):	0.47 lb/ft^3

7. Adjust the gauge, following the manufacturer's procedures, to account for the average difference. This will calibrate the instrument to the HMA mat by adding (or subtracting) the average difference.

Procedure

1. Select a test location(s) randomly and in accordance with ITD requirements. Ensure that the device is correlated in accordance with "Correlation with Cores Section". Locate the measurement area away from any known sources of electromagnetic interference such as overhead high-tension power lines or large metal objects. For best results avoid surfaces with large temperature extremes.
2. Brush the surface clear to remove any loose particles. The mat shall have no noticeable moisture visible. It shall be flat, relatively smooth and clear of any loose particles.
3. Place the gauge firmly on the test surface and trace an outline around the probe (base) of the unit.
4. Perform and record five (5) measurements as shown in diagram #1. Determine and record the average test site measurement / reading.

Calculation

Density measurements / readings from gauge: 142.9 lb/ft^3, 141.9 lb/ft^3, 142.6 lb/ft^3, 141.6 lb/ft^3, & 143.1 lb/ft^3

Avg. density: 142.4 lb/ft^3
Core Correction: +2.1 lb/ft^3

Avg. corrected Density: 144.5 lb/ft^3

Percent Compaction

Percent compaction is determined by comparing the average corrected test site density as determined by this procedure to the maximum density from AASHTO T 209.

G_{mm} and maximum density from the FOP for AASHTO T 209: G_{mm} = 2.466 = 153.5 lb/ft^3

$$\frac{\text{Corrected Reading}}{\text{Maximum Density}} \text{X100} = \% \text{ compaction} \qquad \frac{144.5}{153.5} X100 = 94.1\%$$

Report

Results shall be reported on standard forms approved by ITD. Include the following information:

- Location of test and thickness of layer tested.
- Visual description of material tested.
- Make, model and serial number of the density gauge.
- Density readings to 0.1 lb/ft^3.
- Average Density readings to 0.1 lb/ft^3.
- Core Correction to 0.1 lb/ft^3.
- Maximum density to 0.1 lb/ft^3.
- Percent compaction to 0.1%.
- Name and signature and STQP / WAQTC qualification number of the tester.

PERFORMANCE EXAM CHECKLIST

Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices

FOP for AASHTO T 343

Participant Name _____ Exam Date _____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. Gauge turned on?	_____	_____
2. Gauge calibrated using data from cores?	_____	_____
3. Test location selected away from any known sources of electromagnetic interference such as overhead high-tension power lines or large metal objects?	_____	_____
4. The HMA surface is free of moisture, relitively flat, and smooth?	_____	_____
5. Surface brushed clear of loose particles?	_____	_____
6. Gauge placed firmly on HMA surface?	_____	_____
7. Outline traced around base?	_____	_____
8. Five (5) measurements taken per diagram # 1 and recorded?	_____	_____
9. Average density calculated?	_____	_____
10. Compaction calculated to 0.1%?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

_____

_____

Examiner Signature _____WAQTC #:_____

Examiner Signature _____WAQTC #:_____