Texas A&M Transportation Institute

Test Procedure for GPR for Asphalt Mixture Construction

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TEXAS A&M TRANSPORTATION INSTITUTE
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TEST PROCEDURE FOR GPR FOR ASPHALT MIXTURE CONSTRUCTION

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

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DRAFT Test Method for

Density Profile of Asphalt Mixtures Using Ground Penetrating Radar

TxDOT Designation: Tex-XXX-X

Draft Date: August 2019

1. SCOPE

1.1 Use this test method to obtain a density profile of an asphalt paving project using ground penetrating radar (GPR).

1.2 This method includes procedures for general system calibration, calibration of the GPR to the specific asphalt mixture, data collection, analysis procedures, and report summary.

2. APPARATUS

2.1 *Ground penetrating radar system* — A GPR system, comprised of antennas, signal processors, vehicle or cart mounting hardware, and software, capable of the following:

2.1.1 Collecting single- or multiple-channel GPR data using air-coupled antennas with central operating frequency between 1 and 3 GHz. The antennas must meet the performance specifications of Table 1.

Table 1— Performance summary table with required limits.

Measure Description	Required Limit
Short Term Dielectric Stability[1]	Max: 0.06
Long Term Dielectric Stability[2]	Max: 0.08
Antenna Dielectric Variation[3]	Max: 0.10

1 – Max difference between 50 scans sampled at 15 scans per second.
2 – Max difference between scans collected over 20 minutes at 15 scans per second.
3 - Multichannel systems only. Max difference among antennas from tests with 1,000 scans at 15 scans per second.

2.1.2 Recording position using GPS with an accuracy of ±15 ft or better and using a distance measuring instrument with a minimum operational tolerance of 0.5 ft/mile.

2.1.3 Measuring the surface dielectric constant in real time and recording the data at fixed longitudinal distance intervals as small as 0.5 ft at walking speeds and every 2 ft at driving speeds.

2.1.4 Providing software that:

- Displays readings in real time using a line graph or heat map format.
- Calculates recommended calibration core locations.
- Calculates summary data and creates reports according to Section 5 of this method.

3. PROCEDURE

3.1 *System Calibration* – Before collecting data, allow the GPR to warm up and then calibrate each antenna in the system with an air and metal plate calibration according to the manufacturer's recommendations. When using a multichannel system, use a fixed point or standard reference material to verify the antenna dielectric variation does not exceed 0.10. Repeat the calibration procedure if the antenna dielectric variated exceeds 0.10.

3.2 *Air Void Calibration:*

3.2.1 Each unique mix design requires an air void calibration.

NOTE — The calibration originating from another mix design is not valid. A new calibration may also be warranted with significant changes to the job mix formula (greater than ±0.3 percent change in asphalt content or change in aggregate source).

3.2.2 Under traffic control, collect a GPR profile on newly placed asphalt at least 500-ft long with a multichannel system, or 1,000-ft long with a single-channel system. Record measurements every 0.5 ft at a speed no faster than 10 mph. For multichannel systems, the antennas should be spaced at least 2-ft apart and at least 12 in. from the mat edge.

3.2.3 Identify nine calibration locations comprised of three high-, three moderate-, and three low-dielectric values. Note the dielectric, station, and lateral offset of each location.

NOTE —The difference between the highest and lowest average dielectric should be 0.75 or greater.

3.2.4 Return to each location and use the live dielectric measurement in time-mode to precisely find a location with a similar value as previously measured. Mark the location with minimal contamination to the surface (i.e., use paint marker or marking crayon).

NOTE — No data are actually recorded in this step.

3.2.5 With one designated antenna, perform a measurement directly over the marked location, moving the antenna ±2 to 3 in. to cover the diameter of a core sample (FIGURE 1). Record the average dielectric.

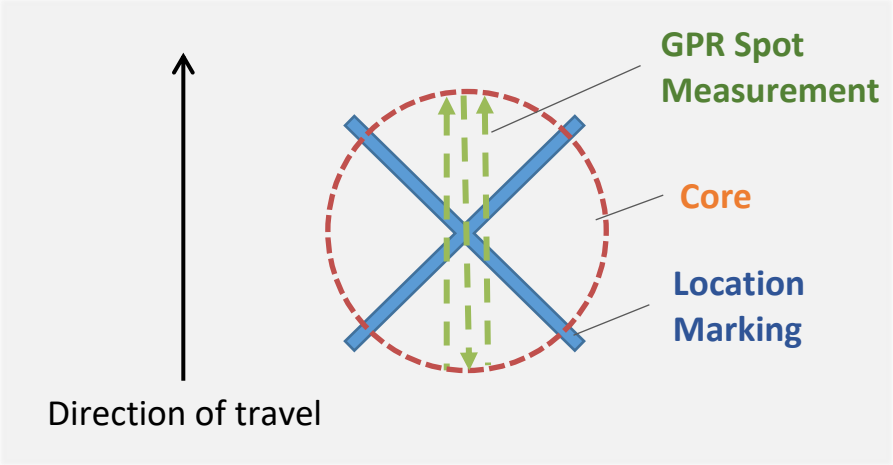

FIGURE 1 – Configuration for Spot Measurement.

3.2.6 Obtain cores directly over each marked location.

NOTE — The center of the core must be within ±1.5 in. of the center of the marking.

3.2.7 Measure the bulk specific gravity and air void content of each core in accordance with Tex-207-F Part I or Part VI and Tex-227-F.

3.2.8 Plot the dielectrics *(x-axis) vs* voids (y-axis) data and calculate the calibration parameters *a* and *b* for the following non-linear (exponential) regression equation.

$$Voids = a * exp^{(b*Diel)}$$ Equation (1)

3.3 *Data Collection:*

3.3.1 Position the antenna/s over the desired profile line/s as shown in FIGURE 2. Options include:

- Left half of the mat.
- Right half of the mat.
- Center of the mat where the rollers overlap.
- Confined joint (3–6 in. from the joint).
- Unconfined joint (12–15 in. from the thickest part of the of the edge).

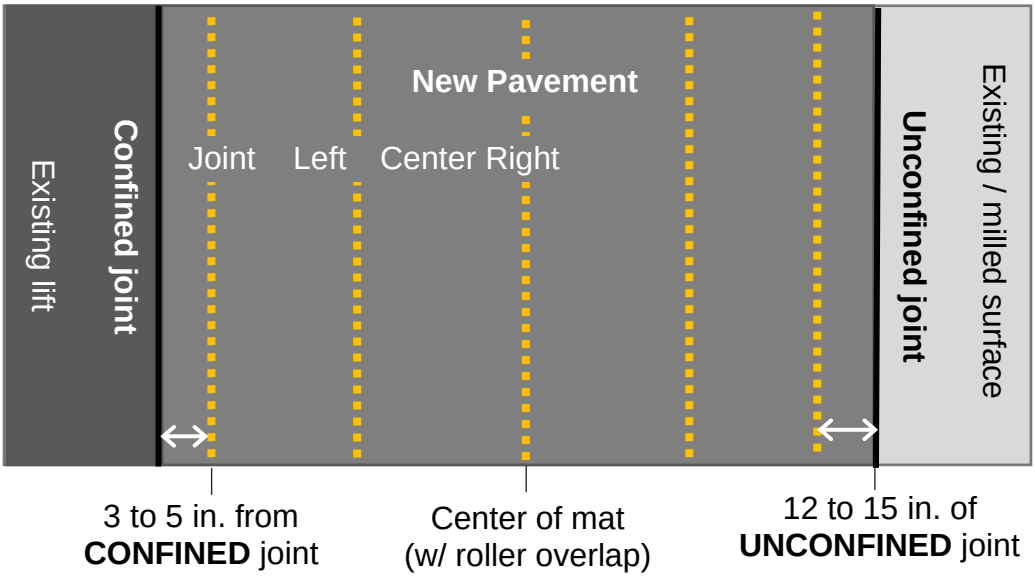

FIGURE 2 – Profiles Recommended for Testing.

NOTE — Do not test within 12 in. of the unconfined joint before the adjoining lift is constructed. The pavement edge drop-off will interfere with the GPR signal. After the adjoining lift is placed, the joint can be tested with a profile 3–6 in. from the joint.

NOTE — Mounted green lasers may be used as a guide to maintain a consistent lateral position. This is especially important for joint profiles.

3.3.2 Provide appropriate project and location details as prompted by the GPR software.

3.3.3 Collect the desired profile length of data in distance-mode at the speed and data density recommended by the GPR manufacturer.

3.3.4 Note any surface anomalies during the profile (i.e., surface water from rollers, metal bridge joints, bridge decks, and utility covers).

4. CALCULATIONS

4.1 Perform the following using the GPR software.

4.1.1 Query data for the desired analysis length, typically corresponding to one sublot.

4.1.2 Compute the air void contents from the dielectric data based on Equation 1.

4.1.3 Process the data with a 10-ft moving average filter.

4.1.4 Calculate a histogram of the overall air void contents for profiles within the mat. A separate histogram shall be calculated for joint profiles.

5. REPORT

5.1 *Table of Summary Data:*

5.1.1 Populate a table with the following data.

- Median void content.
- Average void content.
- Standard deviation void content.

5.2 *Heat Maps of Air Void Contents:*

5.2.1 Provide a heat map of air void contents (10-ft moving average) for the desired analysis length or station limits using the GPR software filter (e.g., FIGURE 3).

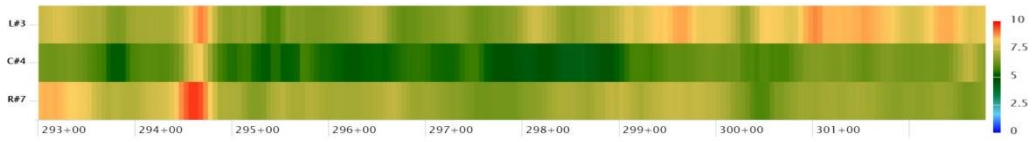

FIGURE 3 – Heat Map.