Standard Practice for

Asphalt Surface Dielectric Profiling System Using Ground Penetrating Radar

AASHTO Designation: PP 98-20 (2021)[1]

First Published: 2020 **Reviewed but Not Updated: 2021**

Technical Subcommittee: 5c, Quality Assurance and Environmental

AASHTO

American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004

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1. SCOPE

1.1. This standard specifies the equipment and software requirements for a dielectric profiling system (DPS). Calibration and verification procedures are also detailed.

1.2. A DPS uses ground penetrating radar (GPR) technology to continuously measure asphalt compaction quality up to highway speeds. The DPS system reports the asphalt surface dielectric constant which is strongly correlated to asphalt air void content (FHWA/TX-92/1233-1). As the dielectric constant increases, air void content decreases.

1.3. A DPS may be a single- or multi-channel system and may be cart or vehicle-mounted.

2. REFERENCED STANDARDS

2.1. *AASHTO Standards*:

- M 146, Terms Relating to Subgrade, Soil–Aggregate, and Fill Materials
- R 37, Application of Ground Penetrating Radar (GPR) to Highways
- PP 80, Continuous Thermal Profile of Asphalt Mixture Construction
- PP 81, Intelligent Compaction Technology for Embankment and Asphalt Pavement Applications

2.2. *ASTM Standards*:

- D150, Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
- D2520, Standard Test Methods for Complex Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials at Microwave Frequencies and Temperatures to 1650°C
- D4748, Standard Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar
- D6087, Standard Test Method for Evaluating Asphalt-Covered Concrete Bridge Decks Using Ground Penetrating Radar
- D6429, Standard Guide for Selecting Surface Geophysical Methods
- D6432, Standard Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation

2.3. *Federal Highway Administration*:

- TTI with FHWA. Implementation of the Texas Ground Penetrating Radar System. FHWA/TX-92/1233-1. Texas Transportation Institute with the Federal Highway Administration, U.S. Department of Transportation, Washington, DC,1992.
- Sebesta, S., T. Saarenketo, and T. Scullion. Using Infrared and High-Speed Ground Penetrating Radar for Uniformity Measurements on New HMA Layers. SHRP 2 Project R06(C) Final Report S2-R06C-RR-1. Federal Highway Administration, U.S. Department of Transportation, Washington, DC, 2013.

3. SUMMARY OF METHOD

3.1. This specification describes the hardware and software requirements and calibration procedures for a DPS.

4. TERMINOLOGY

4.1. Definitions shall be in accordance with the terms and symbols given in terminologies and definitions from R 37, PP 80, PP 81, and ASTM D6432.

4.2. *Definitions Specific to This Standard*:

4.2.1. *dielectric constant*—The measured dielectric property of the finished asphalt pavement surface. The surface dielectric constant is calculated using Equation 1 (S2-R06C-RR-1):

$$e_r = \left[\frac{1 + \left(\frac{A_0}{A_i} \right)}{1 - \left(\frac{A_0}{A_i} \right)} \right]^2 \qquad (1)$$

where:

e_r = dielectric constant,
A_0 = amplitude of the reflection at the air/asphalt interface
A_i = initial antenna amplitude. (May be measured with a metal plate calibration.)

4.2.2. *dielectric profile*—The surface dielectric readings and associated stationing, offset, GNSS coordinates, and time stamps.

4.2.3. *dielectric profiling system (DPS)*—The specific arrangement of the GPR equipment used to measure the dielectric constant including the GPR antennas, radar control unit, and suitable data storage, calculation, and display devices.

4.2.4. *heat map plot*—A graphic display of data using color scales. These plots may display raw values or employ varying degrees of smoothing (adapted from PP 81).

5. HARDWARE REQUIREMENTS

5.1. *Dielectric Profiler System Overview*:

5.1.1. *The DPS consists of the following components (Figure 1)*:

5.1.1.1. *Vehicle or Cart*: