U.S. Department of Transportation
Federal Highway Administration

Spotlight on Pavement Density: Minnesota Department of Transportation

Working with Dielectric Profiling Systems

MATC
MOBILE ASPHALT TECHNOLOGY CENTER

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This equipment and more are available on loan at the MATC. https://www.fhwa.dot.gov/pavement/asphalt/matc/equipment-loan-program.cfm

The dielectric profiling system series shares information on pavement testing programs.

To access the full series, visit https://www.fhwa.dot.gov/pavement/asphalt/matc/technical-documents.cfm

Background

The Minnesota Department of Transportation (MnDOT) began evaluating dielectric profiling systems (DPS) in 2016 as one of the agency's several efforts to explore new technology to improve compaction quality control (QC) and agency acceptance for asphalt pavement. DPS use ground-penetrating radar (GPR) technology to measure dielectric constant of hot-mix asphalt (HMA) pavement. The measured dielectric constant can be related to the density, a key indicator for pavement performance. MnDOT participated in the DPS Assistant Program under the second Strategic Highway Research Program (SHRP2) RO6C and has demonstrated that DPS can be used effectively to assess HMA compaction and uniformity.

MnDOT's goal for DPS is to obtain a more complete picture of in-place air voids in the newly placed asphalt mixture than through its current practice of cutting sample cores from random locations.

"We see DPS as the final piece of the puzzle of getting expanded assessment of our placed pavement," says Kyle Hoegh, a research scientist for MnDOT. Hoegh and Shongtao Dai, who both work in the MnDOT Office of Materials and Road Research, say studies show that DPS is an effective tool for QC and agency acceptance in asphalt pavement compaction. Once the DPS tool is implemented for future construction projects, the MnDOT team hopes to reduce the number of sample cores typically pulled per project.

DPS in Use

Currently, DPS data collection is typically accomplished by walking a cart behind a final rolling compactor. MnDOT received its first DPS unit in 2016 and expanded the program to three DPS pushcarts, applied to more than 20 highway projects. MnDOT also has borrowed a DPS device from the Federal Highway Administration through the Mobile Asphalt Technology Center.

Data from the DPS unit is used to supplement and compare to data from field-sampled cores and to existing pavement acceptance practices.

DPS unit. Source: MnDOT.

MnDOT reports that the DPS's three antennas accumulate extensive and continuous information on the pavement's compaction. This allows detection of air voids or other issues—such as irregularities on a day's paving job—right away, very quickly, and informing paving practices during the same work shift. With cores, the agency typically receives analysis results the next morning

Example Projects

MnDOT researchers operating the DPS alongside the paving contractor on some projects helped identify issues that did not otherwise show up through sample cores. On a project in 2020 to resurface 13 miles of Highway 251 from I-35 east to Highway 218 in Freeborn County, compaction levels assessed by the DPS were consistently at 94 to 97 percent relative density, which matched well with field core results.

For a nearly 1-mile section, however, the team noticed a significantly lower dielectric constant that corresponded to 91 to 94 percent relative density for a majority of the asphalt placed in that segment, with several locations as low as 88 percent. "But we couldn't figure out why," Hoegh says. The team showed results to the MnDOT Advanced Materials and Technology unit, which used Roller Pass Counts from rollers equipped with Intelligent Compaction technology to confirm the lower compaction was caused by reduced vibratory roller passes. The mat temperature prior to the breakdown roller passes was too low to get adequate density. One random core was taken for acceptance in that segment at a location where the density was good, and it did not identify the compaction issues, Hoegh says.

On an I-35 project in 2019, the contractor team asked the DPS team to help test the effectiveness of two different rolling techniques at the joint, Hoegh says. The DPS clearly showed that the crew's second technique performed better than the first one, a difference that was not clear from the conventional method of spot-checks through sample cores. This shows the potential of the use of DPS as a process improvement tool, as the almost 2 percent improvement in density of the second method of rolling at the joint for the remainder of the project translates to a significant improvement of pavement life.