



Project Summary Report 0-4577-S

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Project 0-4577: Further Development of NDT Devices to Identify Segregation in HMA

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New Technologies for Assessing Quality of HMA Overlays

PROJECT SUMMARY REPORT

Improved methods for evaluating the quality and uniformity of hot-mix asphalt (HMA) overlays have become available over the past few years. Non-nuclear density gauges introduced to market provide rapid alternatives to nuclear gauges for field measurements of pavement density. Additionally, developed infrared imaging and ground-penetrating radar (GPR) technologies can provide rapid assessment of a project for segregation, uniformity, and overall quality, as illustrated through previous Texas Department of Transportation (TxDOT) Project 0-4126. This current project 0-4577 focused on evaluation of available non-nuclear

density gauges and further refinement of infrared imaging and GPR for use in evaluating HMA overlays.

What We Did...

Texas Transportation Institute (TTI) researchers began this project by evaluating two non-nuclear density gauges. The research team evaluated the ruggedness and repeatability of each device. By testing field projects and correlating to field cores, the TTI team analyzed the accuracy of each gauge and the potential use of each gauge for Tex-207-F Part V, Determining Mat Segregation Using a Density Testing Gauge. A nuclear density gauge provided traditional field density measurements for comparison.

In addition to the work with the density gauges, the research team developed a new infrared device for thermal imaging of HMA during the placement process. Finally, the research team conducted verification tests of previously recommended criteria for detecting segregation and also developed a new GPR system for rapid collection of data over a paving project.

What We Found...

Both non-nuclear devices provided satisfactory repeatability, with standard deviations of repeat readings under 0.5 lb/ft³. The presence of moisture influenced the readings on both gauges; additional moisture resulted in an increase in the measured



density. However, the impact of moisture did not become significant until the surface appeared visibly wet. At times all the gauges exhibited bias in the field, and due to the sporadic nature of observed mean errors, gauge bias could not be estimated. *Assuming each gauge is unbiased*, the following levels of accuracy were indicated from the projects tested:

- Pavetracker: $\pm 5.7 \text{ lb/ft}^3$
- PQI: $\pm 2.6 \text{ lb/ft}^3$
- Troxler 3450: $\pm 4.1 \text{ lb/ft}^3$

Based upon these observations, the PQI provides the most reliable estimate of differential density. The Pavetracker version evaluated should not be used for TxDOT operations. However, since the time of evaluation, Troxler purchased the Pavetracker device and now markets a reportedly improved version.

With the full coverage devices, the research team found that the new infrared sensor bar, shown in [Figure 1](#), provided a much-improved method to collect and analyze thermal imaging data of HMA paving projects as



Figure 1. A New Infrared Sensor Bar Provides Improved Data Collection.

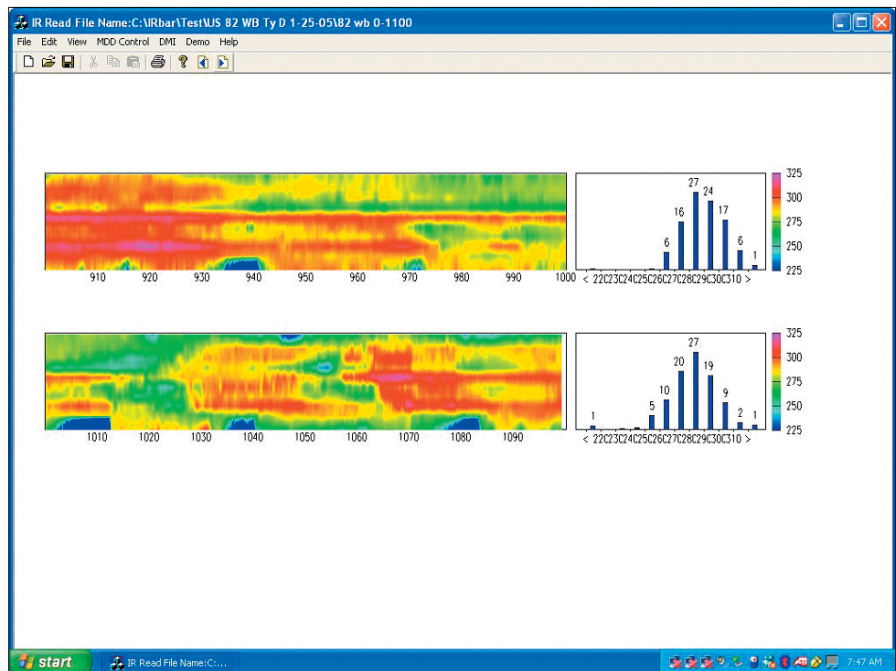


Figure 2. Real-Time Thermal Imaging Data of Paving Project.

compared to infrared cameras. TTI's thermal system, called *Pave-IR*, can display data in real time, as shown in

[Figure 2](#), and provides for additional evaluation of the data after collection.





Figure 3. One-Pass GPR Data Collection System.

Verification tests conducted in this project matched well with previously recommended criteria for detecting segregation. With thermal imaging, locations with temperature differentials greater than 25 °F should be inspected for segregation. With GPR, recommendations differ according to mix type:

- Coarse-graded mixes: locations not within ± 0.8 of the mean dielectric value should be inspected for segregation.

- Dense-graded mixes: locations not within ± 0.4 of the mean dielectric value should be inspected for segregation.

Given the positive results with using GPR for evaluating paving projects, TTI developed a system capable of obtaining data over both wheel paths and the centerline in one pass. [Figure 3](#) shows this system.

The Researchers Recommend...

Based upon results with the density gauges, the PQI should be considered acceptable for use in TxDOT's density profile procedure. The new Troxler Pavetracker and Pavetracker Plus were not available during the performance of this project. TxDOT should conduct testing with these new Troxler gauges before allowing their use.

The Pave-IR system should be further developed and refined to attach directly to a paver. Such a system could be used to test and certify an operation early in the placement process, such as during the first lot, to provide opportunity for corrective action before substantial amounts of HMA get placed. GPR should be used for a final quality assurance check on the previously certified placement operation. Conducted after all rolling ceases, the GPR survey provides for a uniformity check of the final product.



For More Details...

This research is documented in:

Report 0-4577-1: Evaluation of Non-nuclear Density Gauges for HMAC: Year 1 Report

Report 0-4577-2: New Infrared and Radar Systems for Detecting Segregation in Hot-Mix Asphalt Overlays

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