IOWA STATE UNIVERSITY
Institute for Transportation

Investigation of Electromagnetic Gauges for Determination of In-Place Density of HMA Pavements, Phase II

tech transfer summary

Electromagnetic asphalt density gauges have the potential to facilitate more efficient quality control and quality assurance in Iowa.

Objectives

- Evaluate two electromagnetic gauges for their ability to determine the adjusted density (including corrections for surface moisture, temperature variation, and sensor impedance) of hot mix asphalt (HMA) pavements
- Determine whether the correction factor used for a specific mix on the first day of paving operations can be used on subsequent paving days under the same conditions
- Determine the most suitable adjustment method for determining pavement density

Problem Statement

Two electromagnetic density gauges are manufactured today: the Pavement Quality Indicator (PQI) 301 from TransTech and the PaveTracker 2701 from Troxler. Both gauges use similar technology to measure the HMA's dielectric constant—a conductivity indicator—and relate increases or decreases in dielectric constant to asphalt density changes.

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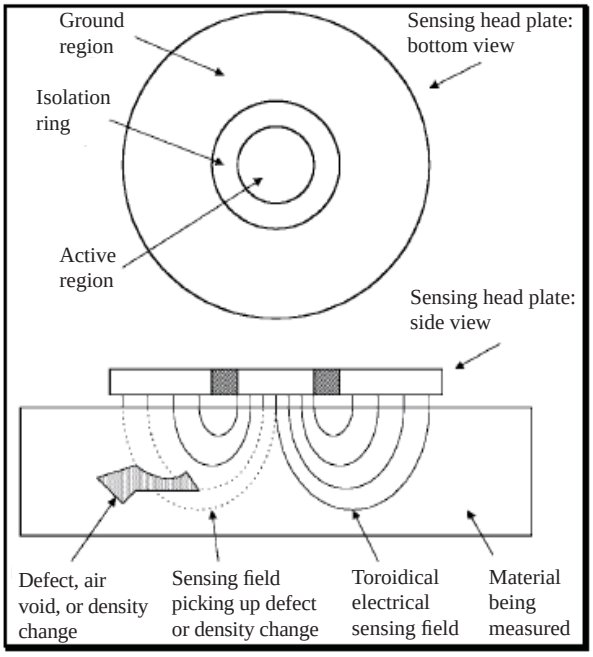

Operational theory schematic of PQI 301

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RESEARCH PROJECT TITLE
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SPONSORS
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For a relatively homogenous asphalt material, the dielectric constant increases as the asphalt is compacted. However, water on the surface and other variables can affect the dielectric constant and produce an incorrect density reading. In such cases, correction factors are needed to determine pavement density accurately.

In the previous phase of this research, both the PQI 301 and the PaveTracker 2701 were found to be accurate and precise compared to core testing done on a daily basis. Moreover, both gauges were determined to be adequate for quality control and quality assurance in Iowa.

Technology/Technique Description

To determine the ability of the PQI 301 and PaveTracker 2701 to measure adjusted asphalt density, field measurements were collected over three to five consecutive paving days at seven paving projects. For each day/lot, 20 randomly selected locations were tested with the gauges and 7 cores were taken.

To analyze the adjusted density measurements for both gauges, the statistically significant factors affecting density measurements were determined using the unadjusted density readings from the gauges. The core density residuals (actual core density minus the density predicted by the gauges) were then determined. For each core, a regression analysis was performed to compare the actual core density to each gauge's density readings.

Key Findings

- For both electromagnetic gauges, core density, traffic, and asphalt binder content were found to be statistically significant influences on density readings.
- For both electromagnetic gauges, core density residuals were normally distributed and centered at zero, which indicates that the density adjustment factors are consistent across different paving days.
- According to regression analyses, both gauges were determined to be inadequate for measuring adjusted asphalt density.
- For the PaveTracker 2701 readings, regression analysis showed that statistically one-third of the lots do not have an intercept (b) of 0 and two-thirds of the lots do not rule out a slope of 0.
- For the PQI 301 readings, regression analysis showed that statistically the 95% confidence interval rules out an intercept (b) of 0 for all seven projects, and six of the seven projects do not rule out a slope of 0.

Implementation Notes

- With the limited sample size, the adjusted density measurements for both electromagnetic gauges were determined to be inadequate for full quality control and quality assurance use.
- The PaveTracker 2701 was determined to measure adjusted density better than the PQI 301.
- Based on the results of this study, the PQI 301 gauge should not be used for quality control or quality assurance in Iowa.
- The PaveTracker 2701 can be used for quality control, but it provides no benefit for quality assurance. Because the gauge would need to be calibrated to core density every day, the gauge does not provide any additional efficiency for owner agencies.
- The PaveTracker 2701 may be applicable for quality assurance if the number of necessary core locations per day can be reduced and supplemented with additional PaveTracker 2701 readings. Further research on this topic is warranted.

PaveTracker 2701 (from http://www.troxlerwest.ca/)

PQI 301 (from http://www.transtechsys.com/)