0-6874: Develop Nondestructive Rapid Pavement Quality Assurance/Quality Control Evaluation Test Methods and Supporting Technology

Background

Attaining uniform construction of the required specification quality maximizes pavement life and minimizes life-cycle costs. Often, localized defects govern pavement life. To improve agencies' abilities to attain the most uniform level of quality construction, this project evaluated technologies for rapidly verifying attainment of specification and material requirements during flexible base construction, during asphalt mixture construction, and during concrete paving.

This project was conducted under a Phase I agreement to conduct proof-of-concept work on innovative technologies aimed at the goals of minimizing disruption to traffic, enhancing safety, and making agency practices best in class.

What the Researchers Did

This project used nondestructive test technologies to expedite test turnaround time, minimize disruption to traffic, and increase testing coverage to reduce contractor and agency risks.

For flexible base construction, researchers used ground-penetrating radar (GPR) with mechanics-based models to estimate the in-situ resilient modulus of flexible base course.

For asphalt mixture construction, researchers used real-time compaction monitoring from the breakdown roller with a compaction monitoring system (CMS) to estimate density in a quality control setting.

Also for asphalt mixture construction, researchers used GPR to measure the density of the completed asphalt mat after all finish rolling. This proof-of-concept effort used a GPR system custom tailored to the application, where the data are processed in real time for potential real-time density measurement.

For concrete mixtures, researchers used a curing effectiveness index (EI) concept along with GPR to select proper curing compound application rates and verify optimum curing of concrete in the field.

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Project Completed:
8-31-2016

What They Found

The findings from the proof of concept with mechanics-based models for flexible base suggest additional validation work should be performed, draft construction specification frameworks should be developed, and work extending the technology to stabilized materials should be performed.

The proof of concept with the CMS showed that the technology can accurately map roller passes to verify application of the prescribed rolling pattern and that the compaction index principle in the CMS does appear viable for measuring density in real time. These findings with the CMS open up the possibility of passive inspection, where technology can minimize the exposure of inspectors in the work zone while still achieving (and actually increasing) testing coverage. The findings with the CMS suggest that additional variables need exploration in the density prediction model to improve density prediction accuracy.

The proof of concept with GPR for asphalt mixture quality assurance showed good to excellent correlation with standard field compaction acceptance measurements, demonstrating the technology could potentially offer a solution for near-full-coverage quality assurance with minimum disruption to traffic. The findings using GPR for asphalt mixture quality assurance suggest additional work is needed to better identify when a new calibration procedure is required or identify how to adjust calibration curves to changes in the job-mix formula.

Results show EI is sensitive to the curing compound application rate, concrete mixture abrasion loss, and moisture loss. Laboratory EI curves along with expected field environmental conditions can be used to estimate the required curing compound application rate. GPR is a viable tool to verify attainment of the required minimum curing effectiveness in the field with near-full-coverage testing. Further work needed before transitioning the EI concept to stakeholders includes establishing more case studies, enabling real-time data processing of the GPR data in the field, and evaluating an automated system for GPR data collection in the field.

What This Means

Further development of these innovative technologies would offer significant benefits in assuring construction quality. Due to their nondestructive nature, test turnaround time is minimized, resulting in minimal disruption to traffic and improved work zone safety. Also due to their nondestructive nature, potential testing coverage is increased, resulting in reduced producer (contractor) and consumer (agency) risks. Each of these technologies if furthered and implemented would also significantly advance the state of the practice, consistent with the goal of making agency practices best in class. Additionally, if fully implemented, initial estimates suggest these technologies could save hundreds of millions of dollars over 10 years.

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Keyword: Research