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Research Results

TPF-5(368): Performance-Engineered Concrete Paving Mixtures

Development and deployment of concrete pavement technologies, specifications, and test methods to help state agencies improve pavement durability.

Pavement

JUNE 2025

Project Title: TPF-5(368): Performance-Engineered Concrete Paving Mixtures

Task Number: 3129

Start Date: October 1, 2017

Completion Date: March 31, 2023

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WHAT WAS THE NEED?

State transportation agencies and concrete pavement professionals have traditionally accepted concrete based on properties such as strength, slump, and air content. These measurements, however, have shown very limited correlation to long-term pavement performance. Recent advancements in concrete testing technologies have produced methods that better predict pavement durability. To improve the outcome, there was a need to adopt performance-based specifications using these advanced testing technologies.

WHAT WAS OUR GOAL?

The objective of this project was to focus on the deployment of performance-engineered mixtures (PEM). This involved building on the foundational work completed by the Federal Highway Administration (FHWA) and PEM champion states. The focus on implementation, education, training, and adoption of specification language to increase the likelihood of achieving durable pavement performance in the field.

WHAT DID WE DO?

The project developed standardized specifications and test methods linking concrete acceptance to critical performance parameters, including strength, shrinkage, freeze-thaw durability, transport properties, aggregate stability, and workability. Major activities included:

- Partnering with 19 state agencies, industry, and associations to support specification adoption.
- Conducting shadow testing with agencies and the FHWA Mobile Concrete Technology Center alongside traditional

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quality control procedures.
- Delivering 82 workshops, webinars, and regional state–industry meetings to promote adoption, gather feedback, and build local expertise.
- Developing a PEM website providing program resources, test method summaries, instructional videos, specification tables, and project reports.
- Supporting refinement of test devices and procedures, such as the Vibrating Kelly Ball and Phoenix moisture measurement device, to enhance field usability and reliability.
- Collecting and analyzing extensive field data from shadow projects and long-term pavement performance sites to correlate early-age properties with long-term outcomes.

WHAT WAS THE OUTCOME?

The project established a comprehensive framework for PEM with clear, measurable outcomes:

- Improved, performance-based specifications were adopted by multiple states, tailored to individual agency needs.
- PEM concepts, specifications, and test methods were successfully transferred to transportation agencies, contractors, and researchers through coordinated education, training, and technical assistance.
- Test methods that better predict pavement durability and sustainability were validated and refined, enabling agencies to set specification limits with greater confidence.
- Sustainability benefits were demonstrated, including longer-lasting pavements with reduced environmental impact and lifecycle costs.
- Strong collaboration between agencies and contractors during shadow projects led to ongoing use of PEM approaches in practice.

WHAT IS THE BENEFIT?

Performance-engineered mixtures deliver more durable, reliable, and sustainable pavements, enabling transportation agencies to reduce maintenance needs, lower costs, and minimize traffic disruptions while improving safety and service for road users. The benefits extend throughout the pavement lifecycle and to all stakeholders, from engineers and contractors to agencies and the traveling public. The project's implementation, education, and outreach efforts built a strong foundation for continued PEM use and future advancements in concrete paving practices.

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