

Pavement**March 2026****Project Title:** Real-Time Monitoring of Concrete Strength to Determine Optimal Traffic Opening Time [TPF-5(471)]**Task Number:** 4012**Start Date:** June 1, 2021**Completion Date:** December 31, 2025**Task Manager:**Vipul Chitnis
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Real-Time Monitoring of Concrete Strength to Determine Optimal Traffic Opening Time [TPF-5(471)]

Develop a non-destructive, field-ready method to monitor early-age concrete strength.

WHAT WAS THE NEED?

Accelerated construction schedules often subject young concrete to early loading, risking premature failures and reducing the lifespan of pavements and bridges. Current methods for determining traffic opening times, such as maturity testing and flexural beam testing, are inefficient, costly, and time-consuming.

Supported by the Indiana Department of Transportation (Lead Organization), this study developed a non-destructive method using an electromechanical impedance (EMI) sensing approach that demonstrated reliable early-age strength monitoring (4–8 hours) and offered a simpler, faster alternative to conventional testing.

WHAT WAS OUR GOAL?

The research aimed to create and deploy a wireless, field-ready EMI-based sensing system capable of measuring real-time concrete strength and to produce American Association of State Highway and Transportation Officials (AASHTO)-ready specifications and guidance for optimal opening, maintenance, and repair scheduling.

WHAT DID WE DO?

- Developed multiple generations of a compact, battery-powered datalogger sensor system that can convert EMI signals into strength predictions.
- Developed field protocols to assess in-situ concrete strength, stiffness, and hydration behavior.
- Conducted field implementation and training in participating states.
- Compared sensor readings to cylinder breaks, cores, and maturity data, validating the sensing approach.



DRISI provides solutions and knowledge that improves California's transportation system.

- Developed AASHTO-ready specifications for the smart sensing method.

WHAT WAS THE OUTCOME?

The project demonstrated that the REBEL sensor system can accurately measure in-place concrete strength with results comparable to cylinder breaks and maturity testing, while also detecting differences in curing conditions confirming its sensitivity and accuracy. The team successfully deployed more than 800 sensors across over 100 projects, showing improved reliability, reduced data variability, and consistent field performance. Improved system features including antenna strength, battery efficiency, dashboards, and machine learning robustness to support real-world adoption. Early variability issues from hand-made sensors were identified, prompting efforts to standardize manufacturing through industry partnerships to ensure consistent quality.

WHAT IS THE BENEFIT?

The system provides the California Department of Transportation (Caltrans) with real-time, in-place concrete strength data that enables engineers and project managers to open pavements precisely when they reach the required strength, reducing construction delays and avoiding overly conservative closures. By directly measuring actual field conditions the technology improves durability and safety while lowering the risk of premature failures, generating meaningful savings across Caltrans projects. Because the system has been successfully deployed across many state Departments of Transportation, it offers a scalable and standardized approach that Caltrans can readily incorporate into its construction and materials workflows. Ultimately, faster and safer project delivery translates to fewer traffic impacts for the traveling public and improved long-term performance of California's highway infrastructure.

LEARN MORE

The final report will be forthcoming.

IMAGES



Image 1: Hardware of REBEL concrete strength monitoring system.



Image 2: Dashboard of REBEL concrete strength monitoring system.