DRISI
CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

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.

Pavement

November 2025

Project Title:
Real-Time Monitoring of Concrete Strength to Determine Optimal Traffic Opening Time [TPF-5(471)]

Task Number: 4012

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WHAT IS 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 promising non-destructive method using electromechanical impedance (EMI) sensors with piezoelectric technology. Lab-scale testing demonstrated reliable, early-age (4–8 hours) strength monitoring, offering a faster, simpler alternative to conventional approaches.

WHAT ARE WE DOING?

This pooled-fund study includes:

- Developing field protocols to assess in-situ concrete strength, stiffness, and hydration behavior.
- Creating a user-friendly graphical interface for data interpretation.
- Conducting field implementation and training in participating states.
- Providing guidelines and specifications for EMI sensor use based on national data.
- Developing American Association of State Highway and Transportation Officials (AASHTO)-ready specifications for the smart sensing method.

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WHAT IS OUR GOAL?

The goal of this study is to deliver a field-deployable, wireless EMI-based sensing system, implement it in participating states, and develop AASHTO specifications for its use.

WHAT IS THE BENEFIT?

This technology will give the California Department of Transportation (Caltrans) a reliable, efficient tool to determine optimal traffic opening times, reducing delays and cost overruns in concrete pavement construction.

WHAT IS THE PROGRESS TO DATE?

The research team has made the following progress:

- Over 800 REBEL Sensors have been used in 100+ projects, with improvements in LTE outage handling, battery efficiency, and dashboard tracking.
- Machine learning models and post-processing methods have been refined for more accurate and consistent concrete strength predictions, supported by a new diagnostic tool for better model performance.
- The software interface has been further enhanced, with the dashboard now displaying the unique mixture design of each blend.
- The battery performance of the datalogger was optimized to support data collection for 56 days.
- Sensor field testing was conducted in Iowa and Nebraska, specifically in the roller compacting concrete industry.
- The machine learning algorithm was improved to enhance accuracy and boost its performance.