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 new non-destructive field-testing method for monitoring the strength of concrete at early ages.

Pavement

NOVEMBER 2024

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:

Junxia Wu
Transportation Engineer
Junxia.Wu@dot.ca.gov

WHAT IS THE NEED?

Fast-paced construction schedules often expose concrete pavement and/or structures to undergo substantial loading conditions even at its early age, which causes pre-mature failure or a significant reduction in the life span of pavement and bridges. The current methods for determining traffic opening times can be inefficient and expensive, causing construction delays and cost overruns. For instance, maturity testing and flexural strength of concrete are two commonly used methods. The maturity test requires extensive calibrations of the maturity meter and trial batches for each different mix design, causing inefficiency and high costs. The flexural strength testing of concrete beams is very time consuming and often provides unreliable results due to the differences between laboratory and field conditions.

Through support from Indiana Department of Transportation (Lead Organization), the project team developed a non-destructive sensing method for in-situ monitoring of concrete strength at laboratory scale using electromechanical impedance method coupled with piezoelectric sensors. This method has proven to be feasible and reliable. Unlike conventional methods, this new method can evaluate the strength property of concrete at the very early age of 4-8 hours.

WHAT ARE WE DOING?

This pooled-fund study includes the following tasks:

1. To develop field testing protocols to assess in-situ properties of concrete including the strength gain, elastic modulus (stiffness), and hydration behavior at any time period of interest.

Caltrans

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

2. To develop a user-friendly graphical user interface (GUI) for data interpretation.
3. To implement the smart sensing methods in all participating states through field testing and train state engineers to effectively use the sensing methods.
4. To provide guidance and specifications for use of the EMI sensor and measurement system based on data gathered nationwide.
5. To develop AASHTO ready specifications for evaluating the concrete properties using the proposed smart sensing technology.

WHAT IS OUR GOAL?

The goal of this pooled-fund study is to develop the field-ready sensing method, implement it in all participating states and develop AASHTO ready specifications for using this method.

WHAT IS THE BENEFIT?

This study will provide the California Department of Transportation (Caltrans) with an effective tool for determining the optimal traffic opening times for concrete-pavement construction projects, thus, reducing construction delays and cost overruns.

WHAT IS THE PROGRESS TO DATE?

- The working stability and battery life of the datalogger have been further improved.
- The accuracy of the machine learning output has been increased, and a more robust model has been established.
- The sensor system has been deployed in additional states.
- The REBEL sensor system was deployed in the INDOT CR200 over the I-69 bridge, where the sensing strength matched the core drill strength, though the cylinder break strength showed a significant deviation.
- The REBEL sensor system was also deployed in Texas on a patching project with rapid-setting concrete, yielding promising results.