VERMONT
AGENCY OF TRANSPORTATION

FACT SHEET

Development of Cost-Effective Rapid-Setting Concrete for Improved Bridge Joint Performance

PROJECT TITLE

Development of Cost-Effective Rapid-Setting Concrete for Improved Bridge Joint Performance

STUDY TIMELINE

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Accelerated Bridge Construction, Rapid Setting Concrete, Laboratory Testing, Durability.

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Introduction or Problem Statement

Vermont Agency of Transportation (VTrans) was an early adopter of the accelerated bridge construction (ABC) approach and has led the nation in using ABC to successfully deliver bridge construction and reconstruction projects. While ABC projects enjoy high material quality due to a large fraction of precast and prefabricated elements, connections between these elements must be placed in-situ, these are often treated as a "weak-link" due to potential risk for inferior performance. VTrans has adopted the use of rapid-setting concrete (RSC) for construction of connections between precast elements in ABC (see figure below showing an example of connection on a VTrans ABC project), which follows the current state of practice. Current VTrans practice dictates use of a membrane and overlay on ABC projects due to concerns of poor durability of RSC in ABC connections. Durability concerns that have prevented use of bare decks have not been studied or evaluated. This study will comprehensively assess durability of RSC used by VTrans for ABC connections and explore options of standardized mix designs to lower costs.

VTrans ABC connections (in red boxes) ready for RSC placement.

Methodology

This research study will focus on extensive laboratory evaluation of currently used RSC by VTrans to assess durability of these materials as well as to assess their structural performance. Testing will include strength (compressive and flexural), elastic modulus, chloride permeability, and bond capacity measurements for several RSC materials that have been used on VTrans ABC projects from last three years. These tests will be condcuted on control specimen as well as those with laboratory imposed freeze-thaw cycling. Limited evalauaion will also be cndcuted on materials extracted from existing ABC connecitons for measurement of chloride ion penetration.

On the basis of experimental results of the RSC that have been used by VTrans, a second experiment will be developed that will assess various RSC mixture proportions. A partial factorial experimental design will be employed. The objective of this effort will be to assess suitability of stnadardized RSC designs that can be adopted by VTrans as part of standard material specifications.

Next Steps

This project is in its initial stages and at present research team is conducting a literature review as well as working towards identifying first set of RSC mixtures for laboratory characterization.

Potential Impacts and VTrans Benefits

This research provides several potential benefits to VTrans that will improve the performance of bridges in the state as well as decreasing both initial and life cycle costs. The initial costs of ABC projects will be reduced via development of RSC mix design(s) that are less prone to variability in properties; therefore, requiring less quality control tests. The life cycle costs of ABC projects will be reduced by assessing the durability of RSC materials as well as the durability of structural connections made with RSC materials via laboratory and in-situ tests. Also, the improved and more cost-effective RSC material specifications will allow for an increased number of ABC projects as the structural performance will not be compromised; this has the potential to limit traffic disruption and overall construction time. The project outcomes have the significant potential to reduce the initial project costs and maintenance costs per ABC projects and provide VTrans with the means to repair or replace more structurally deficient bridges with a limited budget. This will increase the overall condition of bridges across the state. The benefits of the project can be quantified from multiple perspectives:

- Initial project cost savings can be directly calculated using information on the cost of testing requirements within current quality assurance process.
- Potential initial project cost savings can be directly calculated by eliminating the need for membrane and pavement on ABC projects.
- Life cycle cost savings can be determined based on the expected improvements in performance and durability using the improved RSC designs, no future maintenance of membrane and pavements which have a lower design life and are prone to maintenance issues, and an increased resiliency in ABC projects.
- The decrease in traffic disruption for projects using ABC and RSC materials as compared to traditional construction can be determined; and,
- Contributions to sustainability aspects can be quantified, including reduction in carbon footprint.

In addition to direct outcomes with respect to RSC for ABC connections, this project will also generate tangible outcomes that will have benefits to VTrans, examples include (a) RSC design effort can be easily translated to specify rapid repair and patching materials for bridges and other concrete infrastructure elements; and (b) instrumentation and monitoring of demonstration bridge in future will help develop procedures and datasets that can be used for load testing and structural evaluation of other VTrans bridges.