Transportation Consortium of South Central States

Evaluation of the Performance and Cost-Effectiveness of Engineered Cementitious Composites (ECC) Produced from Region 6 Local Materials

Key Points

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17CLSU05

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Lead Institution:
Louisiana State University

Funds Requested to UTC:
$60,000

Funding Source(s):
Tran-SET
Louisiana State University
Louisiana Transportation Research Center (LTRC)

Total Project Cost:
$131,613

Brief Project Description

This project will develop cost-effective engineered cementitious composite (ECC) materials with the use of locally available materials from Region 6. Furthermore, the fresh and hardened properties of the developed ECC mix designs will be evaluated.

Problem Statement

Reinforced concrete is a key material in US transportation infrastructure. Reinforced concrete structures durability largely depend on the permeability of the concrete, which protects the steel reinforcement from corrosion. Since concrete is a brittle material (strain capacity in tension of about 0.01%), it is prone to cracking, which increases permeability and thus negatively affects the durability of the structure. Experimental evidence suggests that 100 µm represents a crack width threshold above which water flow through cracks is appreciable and thus detrimental for concrete structures. Unfortunately, in practice, cracks in concrete structures can easily exceed 100 µm allowing for access to detrimental substances into the structure reducing the service life and creating the need for early repair.

In contrast with traditional concrete, ECC is a highly ductile cementitious composite material with intrinsic thigh crack width (usually below 100 µm) that produces an excellent concrete cover for reinforced concrete structures. Furthermore, several characteristics of ECC make it a suitable material for repair applications. For instance, ECC superior ductility can absorb interface incompatibilities between the ECC/concrete repaired system eliminating spalling and premature delamination. Moreover, ECC possess a significantly higher fatigue resistance as compared to commonly utilized repair materials such as polymer mortar. Specifically, in overlay repair applications primarily relevant to the transportation sector, delamination of concrete bridge overlays from substrate deck is one of the main causes of ultimate overlay failure, which could be addressed by the implementation of ECC materials.

For this reason, the implementation of ECC is presented as an innovative solution to address durability problems of current and future infrastructure in the region.

Objective

To address the problem statement, the main goal of this study is to develop and characterize cost-effective ECC materials implementing locally available ingredients by means of the following objectives:

- Develop ECC mix designs implementing locally available materials;
- Evaluate ECC mix designs mechanical properties (ultimate tensile strength and strain, flexural strength, compressive strength);
- Characterize ECC cracks (obtain crack width distribution);
- Identify key parameters affecting ECC properties;
- Perform a feasibility study for implementation.

Intended Implementation of Research

This research project will provide funding to one Ph.D. student at Louisiana State University. This will help recruit and train future leaders in the Transportation Sector. The research team will also prepare educational materials on the properties and design of ECC materials with local materials to be incorporated in transportation courses at LSU, and share it with other universities in Region 6. The educational materials will also be summarized in the form of YouTube videos for dissemination to DOT and the Transportation industry. Results of this work will be also disseminated at national conferences such as TRB and ASCE.

This project will offer two summer internships; one for a Native American student from Navajo Technical college and another for a student from BRCC to introduce them to research in Transportation. The developed educational materials prepared in this project will be shared with our partner community colleges to be used to recruit students to Transportation. The project will also offer 2 internships, one for a high school student and one for an undergraduate student to work with the research team and learn about emerging technologies in Transportation. In addition, seminars and webinars explaining the properties and design of ECC will be offered to concrete research institutes and companies interested in emerging innovative materials for the Transportation Sector in collaboration with the highway agencies in Region 6.

This research project will create awareness of novel ECC materials and of the vast possibilities of implementing these materials in the region transportation infrastructure. Furthermore, this project will produce knowledge about ECC, which may be implemented in courses in concrete materials at LSU and other universities in Tran-SET university consortium. Moreover, ECC mix designs produced in this project will serve as a base for further development on this subject in the region from which many future research projects may emerge.

Anticipated Impacts/Benefits of Implementation

The implementation of ECC materials is presented as an innovative solution to address durability issues of current and future infrastructure in the region. ECC materials have the potential to be successfully implemented as a more reliable repair alternative as well as for new construction providing structures with an enhanced service life as compared to structures repaired and build under current practices. It is expected that the development of ECC with local materials will serve as a base for further development on the subject. In addition, this investigation will help create awareness of this novel material in educational institutions and industry throughout the region.

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Weblinks:

http://transet.lsu.edu/research/research-in-progress/

https://rip.trb.org/View/1465718