Tran-SET
Transportation Consortium of South-Central States

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Key Points

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18CLSU02

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Lead Institution:
Louisiana State University

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$64,455

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

Total Project Cost:
$128,930

Self-Healing Concrete using Encapsulated Bacterial Spores in a Simulated Hot Subtropical Climate

Brief Project Description

This study aims to develop an encapsulation procedure that will allow for testing two bacterial strains at varying dosages (by weight of cement) in concrete. The effects of encapsulated bacteria will be evaluated with respect to the crack-sealing efficiency observed, the effects on the intrinsic mechanical properties, as well as the self-healing processes over time after inducing damage. The concrete specimens will be cured in wet-dry cycles to determine their feasibility in Region 6.

Problem Statement

Reinforced concrete's susceptibility to cracking can significantly reduce the structure's durability due to the ingress of corrosive agents. Currently, several techniques are being used for cracksealing but with the current funding limitations, it is especially harder to afford the costly and labor-intensive maintenance and repair services needed to extend a structure's service life. In order to address this problem economically, researchers have proposed self-healing concrete materials.

Bacterial concrete has become one of the most promising self-healing alternatives due to its capability to seal crack widths up to 1 mm by reacting directly with the cementitious matrix to form calcium carbonate. It is developed by adding alkali-resistant bacterial spores, which do not impose hazards to human health, in the concrete mixing process. Furthermore, bacterial induced calcium carbonate precipitation is directly compatible with Portland cement materials. Based on this mechanism, it is expected that the proposed self-healing concrete will promote economic benefits by increasing durability in concrete, while minimizing the need of maintenance and repair.

Objectives

The study's main objective is to evaluate the performance of two bacterial strains for self-healing concrete applications and its effect on concrete properties and crack-sealing in wetdry cycles.

Intended Implementation of Research

Workforce Development

This study will provide funding for two graduate students at Louisiana State University and will assist in training future leaders in transportation. The research findings will be summarized in the form of seminars and YouTube videos for dissemination to DOTs and to the transportation industry. Results of this work will also be disseminated in national conferences and journal publications.

Education

The research team will produce educational materials on the use of bacterial spores for self-healing concrete which can be incorporated in transportation courses at Louisiana State University, and disseminate it through other universities in Region 6. In addition, the research findings will be published online to offer guides on using bacterial spores in concrete materials.

Outreach

This project will offer at least one summer internship, preferably from students in community colleges to support the Tran-SET's goals to engage more students in careers in transportation.

Anticipated Impacts/Benefits of Implementation

It is expected that self-healing concrete through microencapsulated bacteria will increase the durability of concrete structures and reduce maintenance and repair costs.

This study aims to apply state-of-the art research and test its feasibility for applications in regional climate conditions. If successful, this study will move to implementation through field testing in actual hot-humid conditions, where it will be tested for its mechanical properties as a concrete pavement mix and evaluated for its corrosion resistance as well. Its main benefits are economic and environmental, where the autonomous healing mechanism will save maintenance costs, and protect the steel reinforcement from corrosion caused by harmful agents seeping through microcracks.

Weblinks:

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

https://rip.trb.org/View/1491307