Tran-SET
Transportation Consortium of South-Central States

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Key Points

Project Number:
17CLSU08

Start Date:
05/01/2017

End Date:
10/31/2018

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Funds Requested to UTC:
$106,000

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

Total Project Cost:
$212,968

Self-Healing Microcapsules as Concrete Aggregates for Corrosion Inhibition in Reinforced Concrete

Brief Project Description

This project investigates the use of self-healing corrosion inhibiting additives provides a technology capable of influencing positive the surface properties and indirectly the transport properties, the rebar corrosion rate, and the mechanism of reaction at the steel/concrete interface.

Problem Statement

The use of self-healing corrosion inhibiting solutions provides a technology capable of influencing surface properties and indirectly the transport properties, the rebar corrosion rate, and the mechanism of reaction at the steel/concrete interface. Single and double walled self-healing microcapsules are materials that can be used to control and mitigate damage evolution processes in electrochemical systems such as reinforced concrete systems. These capsules are made of either urea formaldehyde in the case of single walled or urea formaldehyde and polyurethane in regard to double-walled microcapsules. The capsules house an anodic or cathodic corrosion inhibitor agent including calcium nitrate, sodium chromate, sodium hydroxide and sodium carbonate. The advantage of self-healing capsules lays in the fact that can be added during the mixing process or following the dry process in the concrete structures and work on preventing corrosion with no need for maintenance or repair.

Based on the above, we propose a composite material that can benefit greatly if a research project is undertaken to develop an effective control-mitigate-repair action technology for the corrosion dynamics in the corrosion-damaged reinforced concrete that relates the corrosion process with the corrosion precursors from the environment and inherent to the material with time. The desirable features of this self-healing material would include reinforced concrete samples that are exposed to corrosive environments simulating different environment locations of the Southern Region for validation of corrosion condition and control and in-depth corrosion condition assessment, and methodology for damaging, self - healing and validation for such process.

Objective

The main goal of this effort is to validate the performance of corrosion inhibiting self-healing microcapsules capable of enhancing durability and resiliency of RC structures. The proposed project has the following objectives:

- Optimize the design parameters needed to produce single and/or double-walled corrosion inhibiting self-healing microcapsules to be used in concrete structures.
- Design an electrochemical set up for qualitative/qualitative characterization of concrete materials with and without the embedded microcapsules.
- Perform method of advanced laboratory techniques based on electrochemical and transport phenomena principles.
- Validation of the methodology by testing several conditions and samples with different microcapsules concentrations and formulations.
- Validate the methodology with the existing standard to support the obtained results.
- Apply the methodology to the inhibition mechanism proposed.

Intended Implementation of Research

This research project will provide funding to graduate students at Texas A&M University and Louisiana State University. This will help recruit and train future leaders in Transportation. The research team will also prepare educational materials on the production and use of microcapsules containing multifunctional corrosion control properties to be incorporated in materials science courses at TAMU, 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 also be disseminated at national conferences such as NACE, TRB and ECS.

This project will offer summer internships; one for international graduate Latin student from Mexico and another for a student from SEC or other Institutions 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 internships for undergraduate students to work with the research team and learn about monitoring technologies in Transportation. In addition, seminars and webinars explaining the preservation of different assets and structures subject to environmental degradation will be offered to operators and companies interested in corrosion and reliability of reinforced concrete structures in Region 6.

This research project will create awareness of the benefits of self-healing property in concrete when exposed to corrosive environments in the region and produce knowledge on the subject, which may be implemented in courses in concrete materials at TAMU, LSU and other universities in Tran-SET university consortium. This proposal provides an ideal environment for the education and training of students at the graduate level in a highly interdisciplinary area that encompasses civil engineering, materials engineering, corrosion, and application to real-world durability and reliability of reinforced concrete structures.

Anticipated Impacts/Benefits of Implementation

In the proposed study, a new self-healing mechanism technology will be developed that may extend the service life of concrete structures.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/completed-research/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1466911)