Characterizing corrosion control and prevention methods for RC elements based on hybrid protection mechanism

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$ 230,000

Developing an innovative, sustainable, and eco-friendly integral corrosion control technology

A team comprised by TAMU and UTSA proposes a study that will include integration from the civil engineering, materials sciences and corrosion science technical communities to characterize and select the corrosion and mitigation methods for reinforced concrete (RC) elements regarding the corrosion of steel used in transportation applications. The project includes: (1) Characterizing RC elements with either or a combination of three different corrosion control methods, and evaluate their performance to understand their influence on corrosion and its rates; and (2) Identifying the most suitable and efficacy corrosion control strategy and quantify the uncertainties associated with methods for testing and monitoring corrosion of steel in RC elements. A collaborative research study is proposed to investigate the medium and long-term durability of RC system by using different control actions and optimize the materials design for transportation infrastructure in Region 6. As a part of the integral study, performance tests under corrosive environment are to be conducted on different control action systems over different periods of time. Both material characterization studies related to laboratory and field conditions will be carried out as a part of this effort. Field conditions will illustrate and correlate the results founded in laboratory scale conditions. It is apparent that DOT can benefit greatly if a research project is undertaken to develop effective corrosion control methods. The proposed study and the design guidelines for Hybrid or integrated systems would be beneficial to all state DOTs within the Tran-SET membership, as it will provide new approach for eco-friendly and corrosion resistant materials used for transportation infrastructure in Region 6. The proposed research with Hybrid protection mechanisms (HPM), should provide a sustainable and alternative technology applicable to the existing RC infrastructures to increase their life cycle.

Problem Statement

This RC structures are frequently exposed to aggressive/corrosive environments that can promote deterioration of their structural properties and shortening of their service life. Chlorideinduced corrosion of reinforcing steel in concrete represents one of the most severe and common forms of RC degradation. The high alkaline pH of concrete leads to the formation of a passive film on the reinforcing steel. Diffusion and accumulation of chloride ions within the concrete matrix promotes breakdown of the ferrous passive film and initiation of localized corrosion at the steel surface. This passive film breakdown process requires a critical chloride concentration, commonly known as “threshold” chloride concentration. In the case where a sacrificial inorganic layer such as Zinc is applied on the rebar, corrosion initiation could be defined as the failure of the Zn layer at a certain location. The localized attack can be influenced, as mentioned previously, by the chloride content, but also by other parameters such as temperature, corrosion products thickness, etc. Previous works and efforts have been mostly focused in the threshold chloride concentration at the steel/concrete interface. The literature on galvanized steel is limited; however, it is known that the threshold chloride concentration for this material is greater than for bare steel. Furthermore, the addition of a physical barrier will add another approach to the corrosion control actions used in the RC elements and infrastructure in general. There have been attempts in which either one of the corrosion control action have been used but not as integration or balance between them at the same time.

Objectives

The main objective of this study is to develop an innovative, sustainable, and eco-friendly integral corrosion control technology, based on inorganic sacrificial coating on rebar, organic physical barrier epoxy and BPT (a green synthesized organic compound) additions that will have a simultaneous or synergetic action. That is to provide a barrier to corrosion species, while protecting the reinforcing steel through sacrificial cathodic protection and corrosion inhibitors. It is expected that this research project will contribute

to the infrastructure integrity, durability and sustainability.

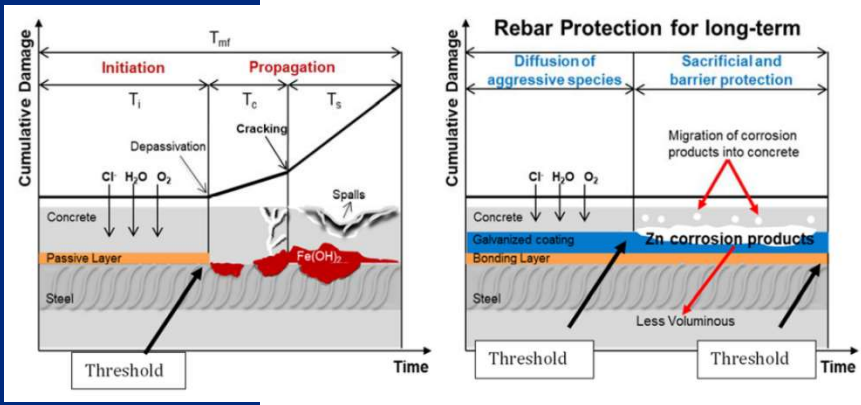

Figure 1. Performance evolution for traditional rebar (left) and galvanized rebar (right)

Intended Implementation of Research

The outcome of this research will lead to a comprehensive report that will provide design methods and guidance for utilization of rebar corrosion control actions and green inhibitors in RC, capable of long-term performance in marine or harsh corrosive environment. Workforce development will also take place through the series of the outreach activities targeting broader audience of corrosion, civil and materials engineers, and potential industrial partners with the goal of increasing their awareness on importance of developing new technologies for eco-friendly and durable transportation infrastructure. The information will also be disseminated in various venues including technical publications, and conference presentations. Research team will also disseminate research findings at American Ceramics Society (ACerS), American Cement Institute and the National Association of Corrosion Engineers (NACE). Result of this project will be also presented in at least two papers published in the peer review journals.

Anticipated Impacts/Benefits of Implementation

One of the missions of the Department of Transportation (DOT) is to preserve critical concrete structures and systems such as components for bridges and achieve or exceed the minimum design life using cost-effective preservation protocols during the operation (load) stages. The proposed research will develop an efficient and robust framework for corrosion damage management in RC elements to greatly improve the durability. This will help preserve an important class of physical assets, RC bridges against corrosion-induced damages. This research will serve the important mission: to take care of current infrastructure by providing comprehensive tools for preserving concrete structures. This will also help extend the reliability of these concrete structures.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.