Florida Department of Transportation Research

Quantifying the Duration of the Corrosion Propagation Stage in Stainless Steel Reinforcement

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Current Situation

Steel reinforcement makes concrete considerably stronger and makes possible many concrete bridges and other structures. Steel-reinforced concrete in warm, humid areas like Florida has a tendency for the steel reinforcement to corrode, which limits the service life of the structures. The situation is worse in coastal areas where concrete is exposed to sea water and its salt content. Many approaches have been taken to slow down the processes of water penetration into concrete and corrosion of steel reinforcement. The use of stainless steel is a possibility, which, although not impervious to corrosion, is much more resistant than standard carbon steel. Several investigations have found that when the extended service life and reduced maintenance are factored in for structures reinforced with stainless steel, their overall cost may be much lower than those made with carbon steel (CS).

Preventing corrosion damage to concrete structures can eliminate or delay expensive repairs.

Research Objectives

University of South Florida researchers examined corrosion initiation in stainless steel used in concrete structures, both through literature review and laboratory experiments.

Project Activities

Over time, water and salt penetrate concrete and contact steel reinforcement, but corrosion is not instantaneous. There is a delay between contact and corrosion initiation, and a further delay between this corrosion initiation and the active spread of corrosion, or corrosion propagation. The researchers compiled information on the few cases where stainless steel (SS) reinforcement had reached or finalized the corrosion propagation stage. They then conducted laboratory experiments for comparison with published results.

Lab experiments were conducted using a legacy specimen from another project and newly made beams and cylinders reinforced with either carbon steel or stainless steel. Specimens for compressive testing were prepared with a region of more porous concrete to simulate a common field condition like a crack, exposed rebar, or a poor patch repair. Experimental specimens were prepared with both CS and SS reinforcement.

Sensors tracked changes in the specimens' electrical properties from which corrosion activities could be determined. Corrosion was also simulated in finite element models. Correlating laboratory and simulation results also provided a check on the standard testing methods, and the researchers made recommendations for extending current test standards to include stainless steel. They also made recommendations for properly conducting electrochemical measurements, without which, corrosion rates might be underpredicted.

The corrosion parameters developed in the experimental phase of the project were used in a predictive model of life cycle deterioration for FDOT structures that could be used for cost-benefit analysis and optimization of the use of SS reinforcement. Results of this part of the project indicated that SS could be cost effective in certain applications.

Project Benefits

The data and methods produced in this project can provide a reliable and useful basis for incorporating SS in FDOT structural designs.

For more information, please see www.fdot.gov/research/.