Florida Department of Transportation Research

Durability Performance of Submerged Concrete Structures, Phase 2

October 2015

Project Number
BDV25-977-12

Project Manager
Paul Vinik
FDOT Materials Office

Principal Investigator
Alberto Sagüés
University of South Florida

Current Situation

Thousands of Florida bridges have steel-reinforced concrete piling foundations standing in salt water. Over time, chloride ions in the water can migrate through the concrete to attack the steel inside. The Florida Department of Transportation (FDOT) has implemented designs that better protect the steel. However, many structures were built before the new standards and, as such, are more susceptible to corrosion. Steel reinforcement has been studied extensively in the section of the pile just above the water line, the so-called splash-evaporation zone, where salt buildup is greatest. The portion of the structure below the water line has been less studied, but this area can still be a site of steel degradation.

This rebar taken from a piling shows corrosion's effect on reinforcing steel. Corrosion of the steel also damages the piling concrete by expanding and causing the piling concrete to crack.

Research Objectives

University of South Florida researchers examined a number of pilings that have recently been removed from service to investigate the condition of the steel reinforcement below the water line.

Project Activities

Assessments were conducted on several decommissioned pilings that were exposed for many years to an underwater environment. Studies were conducted on both complete piles as well as pile cores. Pilings were examined in detail to determine if and to what extent the steel reinforcement had been compromised. They were carefully inspected for visible corrosion indicators, such as spalling or cracking. Electrical potential and resistivity were measured over the length of the piles to provide insight into the condition of the reinforcement. In sections where higher electrical resistance indicated corrosion, the concrete was removed, and the steel rebar was visually inspected. In addition, concrete samples were pulverized to analyze the chloride content.

Data from piling investigations were used to develop computer models that predicted the expected service life of pilings. The model used a typical piling design, partly submerged, with a defined splash zone. Scenarios were based on both active and passive steel in the splash zone. Modeling was conducted in two stages. The stage 1 model demonstrated how corrosion in the submerged zone could be severe at specific locations while overall corrosion in the submerged zone was minor. The stage 2 model gave insights into corrosion progression over time and provided a quantitative assessment of the extent of corrosion control that could be expected with alternative protective measures.

Project Benefits

The insights and methods developed in this project can lead to better structural designs for Florida's harsh marine environments. This in turn can lead to longer service lives for bridge substructure components with lower maintenance costs.

For more information, please see dot.state.fl.us/research-center