Florida Department of Transportation Research

Effects of Service Life of Aluminized Steel Corrugated Pipe with Visible and Not Visible Coating Deficiencies within the Lock System

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Current Situation

Corrugated steel pipe (CSP) is widely employed for both wet and dry uses, including culverts, drainage, or service access tunnels. CSP offers strength and ease of fabrication, and at a fraction of the weight of concrete pipe, it is also easier to transport and handle. However, CSP is steel and is therefore subject to rust and corrosion. For this reason, pipes are coated protectively with either zinc (galvanized) or aluminum (aluminized). In use, CSP is constantly exposed, inside and outside, to water and dissolved materials like chlorides or sulfates that can promote corrosion, and failures do occur. If corrosion occurs, it is usually in the lower part of the pipe, which is exposed more regularly, if not continuously, to water. Corrosion has also been observed at the lock-seam where the pipe is formed from a sheet of corrugated steel by a folded overlap of metal. The tight fold can conceivably cause stresses or breaks in the protective coating, and the small space inside the fold can be problematic.

Sheet steel glistens as it is withdrawn from an 840°F bath of liquid zinc metal.

Research Objectives

University of South Florida researchers investigated the electrochemical behavior of aluminized and galvanized steel to examine corrosion activity at coating deficiencies induced in lock-seams during the fabrication of aluminized and galvanized CSP.

Project Activities

The literature review revealed a number of service life models and mechanisms of corrosion applied to both aluminized and galvanized CSP (ACSP and GCSP). Service life models tended to be empirical, based on field data collected over many years in specific locations. As such, they did not provide general or widely applicable data. Also, the models found did not consider chloride and sulfate. These observations showed that a Florida-specific model was needed.

Samples of ACSP and GCSP were acquired from four manufacturers. Samples of the flat sheet from which the CSP was made were also acquired. Examination of lock-seams on all samples showed defects in the form of breaks, delamination, or shards, likely the result of manufacturing processes. Generally, GCSP lock-seams showed fewer defects than ACSP. Defects were typically on the order of 1 mm, a useful measurement in a service life model.

Lock-seams and flat sheet samples were tested in the lab and in computer simulation. Tests were conducted on as-received materials and materials with artificial defects applied. Lab tests included weeks to months of immersion in solutions resembling Florida natural waters. Tests in electrical cells were used to determine potentiodynamic behavior, a standard type of corrosion testing. Where potentiodynamic tests examined overall sample behavior, a method called the scanning vibrating electrode technique (SVET) probed the electrical potential in the vicinity of a defect. Generally, these methods indicated a higher potential for corrosion near defects in ACSP. Computer simulations based on the laboratory findings generally confirmed those results. They also showed that the chemicals produced by ACSP corrosion can actually clog and seal the lock seam and prevent further corrosion at that site.

Project Benefits

The results of this project can lead to savings and longer service life of corrugated steel pipe installations through better product specifications and reduced maintenance and replacement.

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