Florida Department of Transportation Research

Concrete Pipe – Electrochemical Cell, Phase II

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Current Situation

Dry-cast reinforced concrete pipes are commonly used in sewer and stormwater applications. Dry-casting, in which moist concrete is compressed in molds, produces an extremely durable pipe when combined with reinforcing wire. However, years of continuous service in wet or humid environments can eventually affect the steel reinforcement. Corrosion weakens steel and causes it to expand. This expansion of corroded steel can cause cracks in the concrete pipe through which water can escape and also come into direct contact with the steel, accelerating the corrosion process and exacerbating the problem.

Reinforced concrete stormwater components await installation.

Research Objectives

The corrosion process occurs in well-defined phases and certain conditions are required for corrosion to be initiated. These conditions then have to be sustained for corrosion to grow and spread, leading to the weakening of the steel and resulting in an adverse impact on the concrete integrity.

In this project, Florida Atlantic University researchers sought to better understand the corrosion propagation of steel in dry-cast reinforced concrete pipes (RCP) when exposed to high moisture conditions and chlorides.

Project Activities

The researchers used electricity to accelerate the penetration of chloride ions through dry-cast concrete pipe sections, initiating corrosion in days to months, compared to the years this process would take in the field. The pipes in these experiments were made from various concrete formulations, most notably with and without fly ash. Once corrosion was initiated, the pipe sections were transferred to one of a variety of moist environments: immersion in water, highly humid atmospheres, or covered with wet sand. Corrosion of the steel in the pipe sections was continuously monitored using linear polarization resistance and electrochemical impedance spectroscopy. Values from these monitoring techniques were used to determine how much steel was lost over time.

Studies were also conducted on RCP both recently removed from service and pipes still in the field. Samples of RCP removed from service were taken to the laboratory and analyzed for their corrosion status both by electrical measurements and by direct examination after concrete had been removed. Field visits were also conducted to RCP still in service, some for up to 60 years. Evidence of corrosion was found, revealed by cracks or leakage of corrosion products or by electrical measurements.

Wet/dry cycles appeared to be important for the development of cracks in pipes that had been in long service and in which corrosion had taken a significant toll on the reinforcing steel.

Project Benefits

A more precise understanding of corrosion and cracking processes in reinforced concrete pipes will assist in maintenance planning and in design of more durable RCP.

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