Florida Department of Transportation Research

NEXTGEN Concrete – Tests of the Future: Chloride and Sulfate Durability

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Project Number
BEE02

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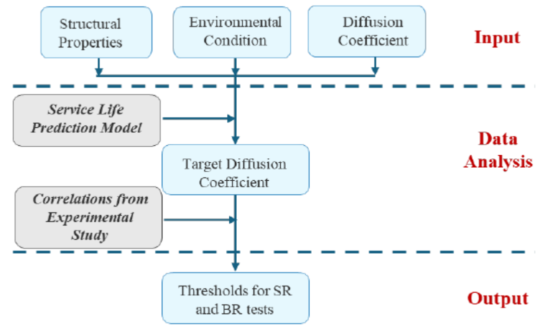
Background

The Florida Department of Transportation (FDOT) needs concrete mixes that will last for many decades in harsh service conditions, especially where salt, chlorides, and sulfates can penetrate and weaken concrete structures. Assessing a mix's resistance to shrinkage, creep, chloride ion penetration, and sulfate attack is vital to making durable designs, but existing tests and thresholds have not yet been fully established in ways that are simple, affordable, safe, quick, and repeatable for routine use on FDOT projects.

Because concrete with supplementary cementitious materials (SCMs) can take longer to develop resistance to harmful ion movement, there is a practical need to relate faster test results (28-day) to longer-term performance (56-day) and to define threshold values that reliably indicate durability for extremely aggressive environments.



Based on the correlation between concrete resistivity and chloride diffusion coefficient, a comprehensive approach for thresholds selection was developed and the appropriate thresholds were proposed, as shown here.

Research Objectives

The objective of this project was to determine appropriate screening thresholds for tests that assess concrete durability in extremely aggressive chloride and sulfate environments. Specifically, the research aimed to recommend threshold values for bulk and surface resistivity tests (based on AASHTO TP 119 and T 358) for chloride durability, and for a rapid sulfate electrochemical test for sulfate durability, while also developing prediction equations that relate 28-day test results to 56-day performance.

Project Activities

The Embry-Riddle Aeronautical University research team reviewed existing durability screening tests to identify those that could meet FDOT's criteria of simplicity, low cost, safety, speed, and repeatability. Based on these recommendations, FDOT selected the surface resistivity (SR) and bulk resistivity (BR) methods for chloride assessment and a rapid sulfate electrochemical test (modified ASTM C1202) for sulfate assessment. A comprehensive literature review was conducted, including review of state soil and water data and existing SR/BR literature.

The team then executed a testing plan on 31 approved concrete mix designs, measuring SR, BR, and rapid sulfate test results at both 28 and 56 days curing. They used these data to analyze correlations between resistivity, chloride diffusion, and sulfate expansion, and to develop predictive equations incorporating mix parameters such as water-to-cement ratio and SCM content.

Project Conclusions and Benefits

The project identified threshold values for SR and BR tests at 28 days linked to service life performance in extremely aggressive chloride environments for different structural elements, and a rapid sulfate test threshold corresponding to an 18-month expansion criterion, providing concrete criteria for mix screening. The research also developed equations that predict 56-day SR, BR, and sulfate test results from earlier 28-day data, helping FDOT efficiently assess concrete durability within project timelines.

By correlating resistivity to concrete diffusivity, the team connected practical field tests to fundamental durability parameters that affect long-term service life. These outcomes give FDOT a scientifically grounded basis to screen and approve concrete mixes that are more likely to resist chloride and sulfate attack, supporting longer-lasting infrastructure.