Florida Department of Transportation Research

A Comparison of Service Life Models for Concrete Corrosion Durability

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Current Situation

Corrosion, especially in marine environments, is a serious issue for structures like bridges, as it can lead to cracking, weakening, and eventual failure. Florida, with its many concrete bridges and high exposure to chloride from seawater, needs accurate models to estimate the service life of these structures and ensure they remain safe. With the ability to predict how long concrete structures, particularly reinforced concrete (RC) structures, can last before corrosion initiates, the Florida Department of Transportation (FDOT) would be better equipped to mitigate structural failures.

Concrete corrosion, as shown here, imapacts the service life of critical transportation facilities like bridges.

Research Objectives

The objective of this project was to evaluate and compare different models used to predict the service life of concrete structures under the risk of chloride-induced corrosion and identify the most suitable model for FDOT. The project also sought to recommend appropriate input parameters for the selected model, considering Florida's unique environmental conditions and materials commonly used in the State's infrastructure.

Project Activities

The research team comprehensively reviewed empirical, stochastic, and mechanistic models for concrete corrosion durability. They focused particularly on two mechanistic models: Life-365, a deterministic model, and fib Bulletin 34, a probabilistic model. A fib, or focused ion beam, is a technology commonly used for surface or topographical imaging. Each model was assessed for its ability to account for key factors that affect corrosion, such as chloride diffusion into concrete, the quality and thickness of the concrete cover, and temperature conditions.

Through sensitivity analyses, the team determined the key input parameters for Florida's environmental conditions, such as chloride concentration and the aging of the concrete. These analyses helped identify the factors that have the most significant impact on a structure's service life. The project also included full factorial statistical experiments to assess the reliability of each model under various conditions, emphasizing the importance of accounting for uncertainties when predicting the lifespan of concrete structures.

Project Conclusions and Benefits

Based on the results of the comparison, the fib Bulletin 34 is the model for predicting the service life of concrete structures in Florida, as it is better equipped to handle uncertainties in data, such as variations in material quality or environmental conditions. However, Life-365 remains a viable option for more straightforward applications where field data is reliable. By adopting fib Bulletin 34, FDOT can better estimate the remaining life of infrastructure, optimize maintenance schedules, and reduce maintenance costs. This ultimately will enhance the safety and durability of concrete structures exposed to corrosive environments.

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