A Probabilistic Framework for Predicting Corrosion Propagation Rate in Reinforced Concrete Structures

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Chloride induced corrosion is one of the main causes for premature deterioration and failure of Reinforced Concrete (RC) structures. Once the critical chloride concentration is exceeded at the rebar level, the structure becomes susceptible to corrosion initiation. Corrosion propagates progressively, degrades the resistance capacity of the structure and decreases the design safety margin. Proper gauging of the corrosion propagation rate is highly critical as it allows for estimating the remaining service life of the structure.

There exist many empirical models for predicting the corrosion propagation rate in the literature. However, these models are limited by their ability to quantify the uncertainties in the corrosion propagation process. These uncertainties can be attributed to several sources including mathematical modelling simplifications, non-homogeneity of concrete and consequently the stochastic nature of the modelling parameters, and uncertain environmental conditions that might either slow or accelerate the corrosion propagation process. Knowing the importance of predicting the remaining capacity of the structure to achieve timely maintenance and to avoid the risk of brittle and catastrophic failures, this study aims at developing a framework that can accurately predict the corrosion propagation rate.

The proposed methodology uses the Ensemble Kalman Filter (EnKF) to probabilistically calibrate the governing parameters of the corrosion propagation model. The calibration process is based on monitoring measurable aspects of corrosion, namely deflection and crack width opening with the aim to minimize the difference between observed and predicted data in a probabilistic framework. The updated model permits timely maintenance before the corroded RC structure becomes unsafe and engenders capital losses.

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