

## **An EnKF Approach for Structural Health Monitoring of Reinforced Concrete Structures under Corrosion**

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Chloride induced corrosion is a leading cause for reinforced concrete deterioration and catastrophic structural failures. The reliability of these structures is based on the chloride content at the reinforcement level as compared to the critical threshold needed to breakdown the passive protective film around the reinforcement. This paper presents a robust non-destructive Structural Health Monitoring methodology to evaluate the current state of the structure and predict its expected service life span. The presented methodology relies on measuring chloride content at certain locations using embedded sensors and a Finite Element predictive chloride ingress model. The Ensemble Kalman Filter (EnKF) is employed to calibrate the predictive model and minimize the mismatch between the forecasted and measured data. Based on the calibrated parameters, a First Order Reliability method (FORM) and Monte-Carlo simulations are used to predict the remaining service life of the structure relying on the improved state vector and calibrated parameters. The power of this monitoring framework lies in its ability to accurately draw the chloride profile as it propagates with time, leading to an efficient maintenance scheme and thus enhancing the sustainability of reinforced concrete structures.

### **REFERENCES**

- [1] G. Saad and R. Ghanem, Robust Structural Health Monitoring Using a Polynomial Chaos based Sequential Data Assimilation Technique, Chapter 12, *Computational Methods in Stochastic Dynamics*, M. Papadrakis et al. (eds.), Vol. 2, Computational Methods in Applied Sciences 26, Springer Science + Business Media Dordrecht 2013
- [2] B. Saassouh, and Z. Lounis, Probabilistic modeling of chloride-induced corrosion in concrete structures using first- and second-order reliability methods, *Cement & Concrete Composites*, Vol. 34, pp. 1082–1093, 2012.