Reliability Assessment of a Bridge Structure Subjected to Chloride Attack

Prediction of the service lifetime of concrete structures with respect to chloride ingress involves a number of parameters that are associated with large uncertainties. Hence, full-scale measurements are strongly in demand. This paper begins by summarizing statistical distributions based on measurements taken from the Gimsøystraumen Bridge in Norway. A large number of chloride profiles are available based on concrete coring samples, and for each of these profiles the diffusion coefficient and surface concentration (due to sea spray) are estimated. Extensive measurements of the concrete cover depth are also performed. The probability distributions are input into a prediction model for chloride concentration at the steel reinforcement. By also introducing the critical chloride concentration as a random variable, the probability of exceeding the critical threshold is determined as a function of time. To address chloride attack on the entire bridge, a system model with 90 components is introduced. Reliability updating based on observations at multiple sites along the bridge is also investigated. First-order reliability methods typically become inaccurate for large systems of this type, so an enhanced Monte Carlo simulation method is applied. It is shown that the corresponding computation time is significantly reduced compared to crude Monte Carlo methods.