Technical University of Denmark

Popular science summary of the PhD thesis

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Title of the PhD thesis	Corrosion-induced Cracking in Reinforced Concrete Structures - a numerical study
PhD school/Department	DTU Byg

Science summary

The aim of this project was to improve predictions of service life of reinforced concrete structures - both when assessing the remaining service life of existing reinforced concrete structures and when designing new concrete structures.

Some models are currently available assisting this process. These models are basing the estimated service life on limit states specifying a given status of corrosion – typically requiring no corrosion - as reinforcement corrosion is one of the main deterioration mechanisms in reinforced concrete structures. However new knowledge has highlighted that the models underestimate the actual durability of the structures.

Based on an existing finite element model to predict corrosion damage, a new model was established. The modelling was focusing on implementing and investigating two phenomena; a) non-uniform precipitation of corrosion products along the circumference of the reinforcement and b) corrosion-induced multiple cracking in reinforced concrete structures. Describing a varying corrosion current density and applying a Smeared Crack Modelling approach the two phenomena were implemented in the modelling scheme. Modelled results were compared to theoretical results applying the original model as well as experimental observations from DTU and the literature. The model showed good results when comparing deformations, cracking pattern, and surface crack width. Further, it was shown that both the implemented phenomena (non-uniform precipitation of corrosion products along the circumference of the reinforcement and corrosion-induced multiple cracking) have a large effect on time-to surface crack width and the magnitude of the surface crack width. In fact, the influence of these phenomena overruled the influence of generally studied parameters such as water-to-cement ratio and cover layer.

Based on the study it is conceivable that the basis of an operational tool for service life predictions could be established. The such tool is applicable both in design and as a supplement to inspection and monitoring. Especially when considering condition assessments and assessment of remaining service life of existing structures this kind of model could be a useful tool. Using the observed conditions of the structure, along with known geometrical and material parameters as input, predictions regarding the condition of concrete and the state of the reinforcement (state of corrosion) are possible. Given the current condition of the structure, it is moreover possible to plan present and future precautions and/or recommendations regarding maintenance.