SIMULATION OF CHLORIDE MIGRATION IN CONCRETE

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Abstract

In a large extent, durability and service life of reinforced concrete structures is influenced by penetration of deicing salts to the steel reinforcement. The steel corrosion is induced by a raising chloride concentration and possibly can lead to concrete cover spalling due to volumetric changes of oxides formed at the steel surface. Therefore, a critical concentration of chlorides is monitored and investigated by numerical simulations in service life assessments. Concrete is also a heterogeneous composite whose microstructure is characterized with fully or partially saturated porous system. Water in pores allows ionic species to be dissolved and transported in pores due to different mechanisms such as ion diffusion driven by concentration gradient or by convection. The convection can be caused either by physical phenomena (pressure gradient driven) or by electromotive phenomena when charged particles are driven by the electrical potential gradient. This contribution is devoted to the numerical solution of the diffusion-convection problem applied to chloride migration. The solution is implemented into an in-house open-source FEM software. Two kinds of tests are simulated, namely (i) chloride penetration and (ii) chloride extraction. In both cases, chlorides can migrate due to diffusion or convection which is, in our case, caused by an externally applied electrical field. The electrical field accelerates the chloride migration by multiple times compared to natural diffusion and can be used for repairing the concrete in a reasonable time frame (several days). Numerical simulation were compared with experimental results conducted on a small scale lab samples and mutual comparisons of chloride profiles after penetration and after extraction were performed. Also, numerical stability of the solution and some other phenomena related to chemical activity of the ions species (chloride binding) are discussed in the paper.

References

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