

Effect of water transport on steel corrosion in the carbonated concrete

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Abstract:

Steel corrosion is one of the major degradation mechanisms of the reinforced concrete structures. It is generally agreed that carbonation-induced corrosion is commonly found in the atmospheric environment. Steel corrosion in carbonated concrete is closely related to water transport in concrete. Previous studies performed corrosion rate measurements of steel wires in thin carbonated mortar specimens that were equilibrated at given relative humidities and reported that corrosion rate increases with water content ¹. Therefore, the conclusion has been drawn that water content has the most pronounced effect on steel corrosion. However, it is still not clear how corrosion rate changes with the dynamic water transport.

In this study, the steel potential and water transport were both monitored during water penetration in the carbonated mortar. The corrosion rates of steel wire in the specimen before and after water penetration experiment were estimated by the linear polarization resistance technique. Experimental results showed that when water front reached the steel wire, the measured potential started to decrease sharply. The corrosion rate changed from a very low value ($<1 \mu\text{m}/\text{year}$) before water penetration to above $20 \mu\text{m}/\text{year}$ when the potential reached a plateau. A 2D continuous water transport model, developed based on Richards' equation and water vapor sorption property of the material, was used to simulate water transport ². Simulation results showed the decrease of potential has a good correlation with the increase of water content at the depth of steel wire. This study demonstrates that the corrosion rate of steel in carbonated concrete is significantly affected by the change of water content at the steel-concrete interface.

¹ Stefanoni, M., Angst, U.M. and Elsener, B., 2019. Kinetics of electrochemical dissolution of metals in porous media. *Nature materials*, 18(9), pp.942-947.

² Zhang, Z., Thiery, M. and Baroghel-Bouny, V., 2015. Numerical modelling of moisture transfers with hysteresis within cementitious materials: Verification and investigation of the effects of repeated wetting–drying boundary conditions. *Cement and Concrete Research*, 68, pp.10-23.