A multiscale model on chloride diffusion in concrete including chemical reaction and cracking effects

T. Wu* and L.De Lorenzis*

* Institute of Applied Mechanics

Technische Universität Braunschweig

Bienroder Weg 87, Gebäude 1411, 38106 Braunschweig

E-mail: t.wu@tu-braunschweig, l.delorenzis@tu-braunschweig.de

Web page: https://www.tu-braunschweig.de/iam

ABSTRACT

A variety of durability problems in cement and concrete are the result of the interaction of diffusion processes combined with chemical reactions. A prime example is the attack of chloride ions, which is known to initiate corrosion of the steel reinforcement. Diffuse microcracks as well as discrete macrocracks play a significant role in this process, since they provide preferential ingress paths for chloride ions.

The motivation of this work is to establish a multiscale model to investigate the influence of micro- and macrocracks on the diffusivity of chloride ions in concrete. The mesostructure of concrete consists of aggregates with a random distribution embedded in the cement paste as well as interface elements with zero-thickness representing the interfacial transition zone (ITZ) between cement paste and aggregates [1,2]. Real mesostructures obtained through computed tomography are also considered.

Diffused microcracks are described using a damage model for the cement paste, whereas for debonding at the ITZ a cohesive zone modeling approach is adopted [3]. Coupling between chloride diffusion, chemical reactions and the mechanical field is fully accounted for. Comparisons between numerical results and experiments are also illustrated.

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