Water-induced failure mechanics for concrete: Micro-mechanical model, experimental observation and phase-field coupling

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ABSTRACT

A micro-mechanical framework for modeling water-induced damage mechanism of concrete is outlined within this work. Concrete has a highly heterogeneous micro-structure and its composite behavior is very complex. Due to that a various effects must be considered for analyzing failure response at the micro scale, e.g. modeling the solid skeleton, fluid bulk phases and their interaction. For obtaining a deeper understanding of water influence on the concrete at the micro-level, a micro computed tomography (micro-CT) scan has been performed at the *Institute of Building Materials Science* (IfB) to illustrate the micro-structure geometry and concrete content, which are required to build up the constitutive model and design the numerical simulation, in line with [1]. To this end, a micro-mechanical model is developed for the coupled problem of fluid-saturated heterogeneous porous media at fracture. The modeling of microscopic cracks in porous heterogeneous media can be achieved in a convenient way by recently developed continuum phase field approaches to fracture, which are based on the regularization of sharp crack discontinuities, as outlined in [2, 3, 4]. This avoids the use of complex discretization methods for crack discontinuities, and can account for complex crack patterns. The numerical examples proposed in this work stem out from the DFG Priority Program SPP 2020 "Cyclic Damage Processes in High-Performance Concretes in the Experimental Virtual Lab".

Keywords: SPP 2020; Phase-Field Modeling; Porous Media; Coupled Problems; Concrete.

REFERENCES

[1] M. Hain and P. Wriggers. Numerical homogenization of hardened cement paste. *Computational Mechanics*, 42:197–212, 2008.

[2] C. Miehe, S. Mauthe and S. Teichtmeister. Minimization principles for the coupled problem of Darcy-Biot-type fluid transport in porous media linked to phase field modeling of fracture. *Journal of the Mechanics and Physics of Solids*, 82, 186–217, 2015.

[3] F. Aldakheel, B. Hudobivnik, A. Hussein and P. Wriggers. Phase-field modeling of brittle fracture using an efficient virtual element scheme. *Computer Methods in Applied Mechanics and Engineering*, 341:443–466, 2018.

[4] Y. Heider, S. Reiche, P. Siebert and B. Markert. Modeling of hydraulic fracturing using a porous-media phase-field approach with reference to experimental data. *Engineering Fracture Mechanics*, 202:116–134, 2018.