Towards multifield discrete element modeling of concrete structures

Christian Flack*, Dieter Dinkler†

*† Institute of Structural Analysis
TU Braunschweig
Beethovenstr. 51, 38106 Braunschweig, Germany
e-mail: c.flack@tu-bs.de, web page: https://www.tu-braunschweig.de/statik

ABSTRACT

Concrete structures are affected by many external and internal influences during their lifetime which can cause degradation of the material. Thus deep knowledge and subsequently mathematical modeling of the different underlying chemical and physical and especially mechanical processes is extremely important to realistically predict the behavior of materials and structures. Based on discrete element methods a modeling concept is presented which is capable of describing processes taking place in the microstructure. The solid skeleton is modeled by a three-dimensional bonded contact model [1], derived from the model of Cundall [2] for granular assemblies.

In order to model concrete on the mesoscale, different components have to be taken into account. The aggregates forming the solid skeleton are discretized with rigid spherical particles according to grading curves. To reduce computational cost, the cementitous phase is summarized by the bond model. The local contact parameters of the spring-damper systems can be adapted to equalize the global Young’s modulus and Poisson’s ratio at macro scale. A Voronoi tesselation is applied to create a discrete pore network for the description of transport phenomena. Heat conduction calculations are performed by a thermal link network connecting the particle centers.

During the whole lifetime the inner structure of concrete is highly dictated by chemical processes starting with the hydration process which is a very complex cooperation of chemical reactions. Especially these period is important for the developement of strength and durability of the whole structure. To deal with those kind of chemical reactions, a process zone is introduced, located between two particles. This zone is used to handle arbitrary chemical reactions. Needed information of concentrations of involved substances are provided by the aforementioned pore network. Changes in substrates’ concentrations lead to variations of the contact stiffnesses due to coupling of processes.

This way a microstructure-related chemo-thermo-mechanical model is developed which may be applied to macro-scale numerical analysis of constructions.

REFERENCES
