Modeling of heat and mass transfer induced by high temperature in concrete.

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ABSTRACT

Concrete subject to high temperatures undergoes two main degradation mechanisms. The first one is related to the incompatibility of thermal deformations between aggregates and cement paste. The second one corresponds to the heat and mass transfer taking place in the concrete microstructure as the result of high temperatures, which causes water evaporation and pore pressure build up.

Previous work of the group was focusing on the first of those mechanisms [1, 2] by means of temperature-driven purely mechanical analysis of a meso-structural model which including cracking via zero-thickness interface elements [3, 4]. The material was considered as a two-phase composite with different thermal expansion laws for matrix and aggregates, whereby the mismatch generates cracking.

This paper is focusing on the on-going work to represent the second mechanism by means of a thermo-hygro-mechanical model to analyse the influence of heat and mass transfer induced by high temperature on the concrete damage. Temperature distributions are obtained from a separate thermal diffusion analysis, and only one unknown variable is considered to describe the water transfer process where the water dehydration is included. For temperatures below 374ºC the model is based on the Bazant & Thonguthai model [5], and for higher temperature an ideal gas in the porous material is considered. Simple academic examples for temperatures between 27 and 800ºC show the behaviour of the model developed exhibits the expected behaviour to then couple it with the meso-mechanical model.

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