MODELING CHEMO-HYGRO-THERMO-MECHANICAL COUPLINGS IN CEMENTITIOUS MATERIALS

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ABSTRACT

A general approach to modeling chemical degradation processes in cementitious materials, due to combined action of variable hygral, thermal, chemical and mechanical loads, is presented. Mechanics of multiphase porous media and damage mechanics are applied for this purpose, and kinetics of chemical processes is described with evolution equations based on thermodynamics of chemical reactions.
The mass-, energy- and momentum balances, as well as the evolution equations, constitutive and physical relations are briefly summarized. The mutual couplings between the hygral, thermal, chemical and mechanical processes are presented and discussed.
Then, numerical methods used for solution of the model governing equations are presented. For this purpose the finite element method is applied for space discretization and the finite difference method for integration in the time domain.
Three examples of the model application for analyzing transient chemo-hygro-thermo-mechanical processes in cement based materials are presented and discussed. The first one deals with deformation of maturing concrete element exposed to drying and external load. The second one concerns the salt crystallization during drying of a concrete wall, and the third one describes calcium leaching from a concrete wall due to chemical attack of pure water at two different temperatures.

Keywords
Cementitious materials, numerical modeling, chemo-hygro-thermo-mechanical couplings.