Application of Multiphase Porous Media Mechanics for assessment of building materials durability

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ABSTRACT

A general approach [1] to modelling various degradation processes in porous building materials, due to combined action of variable chemical, hygro-thermal and mechanical loads, is presented. Mechanics of multiphase porous media and damage mechanics are applied for this purpose. Kinetics of physico-chemical processes, like: salt crystallization/dissolution [2], calcium leaching [3], alkali silica reaction [4], and water freezing/thawing [5], is described with evolution equations based on thermodynamics of chemical reactions. The mass-, energy- and momentum balances, the evolution equations describing chemical reactions, as well as the constitutive and physical relations are briefly summarized. The most important mutual couplings between the chemical, hygral, thermal and deterioration processes are presented and discussed, both from the viewpoint of physicochemical mechanisms and mathematical modelling. 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.

Some examples of the model application for analysing transient chemo-hygro-thermo-mechanical processes in porous building materials are presented and discussed. The examples concern durability analysis of building materials exposed to the salt crystallization during drying, calcium leaching from cement based composites due to chemical attack of pure water, deterioration of the composites due to development of expanding products of alkali silica reaction, and deterioration due to freezing and thawing of a wet materials in variable temperature and relative humidity.

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