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Modeling the interactions of creep, shrinkage and damage in a multiphysics simulation of concrete

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The time dependent, mechanical behavior of concrete is affected by multiple phenomena like creep, shrinkage and damage propagation. The interactions of these processes are supposed to have significant influence on the materials response to external loading. For example it can be observed that the compressive strength of concrete rises with lowering the moisture content [Dahms, 1968].

Most of the constitutive models for finite element methods are designed with just a single phenomena in mind. In multiphysics simulations it is quiet common to use a linear superposition, i.e. additive decomposition of the total strain into elastic shrinkage, creep or thermal strains.

In this paper, the interactions of creep, shrinkage and damage models are investigated, in particular for cases where the assumption of linear superposition is questionable. A gradient enhanced damage model proposed by [Peerlings et al., 1996] is employed. Creep is modeled as a Kelvin chain as described in [Jirásek and Bažant, 2001]. Shrinkage is simulated by using two different approaches. The first model simulates shrinkage as an additional moisture dependent strain component. In the second model, shrinkage is simulated as a moisture dependent pore pressure applied to the solid bulk.

The impact of model interactions will be discussed with a focus on simulating the influence of the moisture content on the macroscopic strength. The model is validated by comparison to experimental data.

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