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MULTIPHYSICS MODELING OF CONCRETE: IMPROVED DESCRIPTION OF THE HYGRO-MECHANICAL COUPLING OF SHRINKAGE AND CREEP

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Efficient design and dimensioning of concrete structures require appropriate consideration of the early-age behavior of concrete, as well as of its long-term response due to shrinkage and creep. A promising method in that respect, originally introduced by [1], is multiphase modeling of concrete based on the theory of partially saturated porous media, and accounting for the multiphysical properties of concrete in terms of hygral, thermal, chemical, and mechanical phenomena. In this context, the evolution of the material properties due to maturing is described based on the progress of the chemical process of hydration. Shrinkage is modeled according to the underlying hygral mechanism and thus based on desiccation, which is either caused by hydration or by drying in the classical sense. Creep is described based on the theory of viscoelasticity with theoretical foundation by the microprestress-solidification theory.

In order to ensure a holistic description of the actual material behavior, improved methods have recently been developed by the authors on the basis of the data set of a comprehensive experimental program. These model enhancements allow an improved description of autogenous shrinkage in the early concrete age [2], a better prediction of the long-term behavior of coupled shrinkage and creep [3], as well as a consideration of the change in internal relative humidity upon external loading and the closely related phenomenon of load-induced shrinkage [4]. The present contribution is focused on a hygro-mechanically coupled modeling approach for the moisture retention behavior. Due to the pronounced characteristics of the interaction between hygral and mechanical behavior, this coupling effect, introduced on the level of the hygral constitutive relation, significantly affects the model response for shrinkage and creep. It is shown that appropriate modeling of this coupling mechanism contributes to a more realistic description of the material behavior.

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