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Modeling temperature-driven moisture flow in porous media

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Porous media flow is an important aspect of geomechanics and material behaviour of concrete under heating and drying. We will present a model for multiphase nonisothermal flow and its solution using the finite element method. In contrast to single phase models (e.g. [1]), which have to consider vaporization or condensation as a temperate dependency on the thermal capacity, the phase changes will be explicitly considered.

More complex models have been proposed (e.g. [3, 2]), which also capture the multiphase nature of the flow field. These models, however, also include the coupling to a mechanics field, with many of the constitutive relations of the flow field dependent on the specific damage formulation employed. The resulting complexity of the constitutive models leads to a high number of experiments and difficult calibration procedures to determine their parameters.

The simulation of the moisture distribution under fast and slow heating is presented. The constitutive relations employed here do not assume any particular damage-mechanical model and will therefore allow free choice when mechanical coupling is desired. The resulting pore pressure field is an important prerequisite for the modeling of concrete spalling. Suitable numerical methods to achieve optimal convergence will be discussed.

By using direct coupling between the parts of a multiphysics problem, the models for each part can be simplified, making calibration and sensitivity calculations easier. This is also important for more complicated problems, where the need for simpler material laws that handle coupled phenomena becomes more evident. In particular, this contribution is an essential step towards the modeling of concrete spalling.

References

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