Technische Universität Braunschweig

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MUSEN

Freezing-Induced damages in multiphase porous materials

multi-scale analysis supported by machine learning approaches

Lecture of

Dr. habil. Yousef Heider

Institute of General Mechanics
RWTH Aachen University

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Okerhochhaus, Pockelsstraße 3,
seminar room, ground floor

This research work presents a numerical study with reference to experimental data of the coupled inelastic thermo-hydro-mechanical (THM) processes that occur during soil freezing. In this, a distinction is made between two thermal states: (1) The thermal transient state, which is associated with ice penetration, small deformations, and insignificant water suction. (2) The thermal (quasi-) steady state, which has a much longer duration and is associated with significant ice lens formation due to water suction (micro-cryo-suction). In the continuum mechanical modeling, the fundamentals of macroscopic porous media mechanics are applied. The emerging cracks are modeled using the phase-field method (PFM), whereas a different phase-field approach is applied for modeling the pore-water freezing as a phase-change process. Several numerical examples will be presented and include qualitative and quantitative comparisons with experimental data. Besides, an overview of recent advancements in related multiscale porous media modeling will be presented. This will focus on the possible inclusion of machine learning to replace conventional material models for the THM processes. For instance, artificial neural networks (ANN) can be applied to replace the phenomenological retention curve, predict the anisotropic permeability, and replace the stress-strain material model.