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PROCEEDINGS

Hierarchical Multiscale Modeling of Thaw-Induced Landslides in Permafrost

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ABSTRACT

With global warming, thaw-induced landslides occur more frequently in permafrost, which not only threaten the safety of infrastructures as general geohazards but also worsen global warming due to carbon release. This work presents a novel computational framework to model thaw-induced landslides from a multiscale perspective. The proposed approach can capture the thermal-mechanical (TM) response of frozen soils at the particulate scale by using discrete element method (DEM). The micromechanics-based TM model is superior to capturing the sudden crash of soil skeletons caused by thaw-induced cementation loss between soil grains. The DEM-simulated TM response is then homogenized and directly fed into an upper continuum-scale initial and boundary value problem, i.e., thaw-induced landslide. The mesh-free material point method (MPM) is employed to solve the TM response at the upper continuum scale. The coupled multiscale framework, coined as DEMPM, is highly parallelized by using a thread-block-wise parallelization scheme on graphics processing units (GPUs), thereby capable of handling engineering-scale simulations of landslides. Numerical simulations are showcased to demonstrate the efficacy of the proposed framework.

KEYWORDS

Multiscale modeling; MPM; DEM; thermal-mechanical coupling; landslide

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