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Identification of ultrasonic waves in multiphase frozen soils using the theory of poroelastodynamics

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Abstract:

Characterization of permafrost soils plays an important role in the design and monitoring of structures built on foundation permafrost. The ultrasonic test is one of the promising methods in the characterization of physical (e.g., ice content, unfrozen water content and porosity) and mechanical properties (e.g., shear and compression wave velocity) of permafrost soils. In this paper, a three-phase (solid grain, pore-water and pore-ice) poroelastodynamic solver was developed to study ultrasonic wave propagation in frozen media. The spectral element method was developed to solve the three-phase poroelastodynamic model analytically. This meshless semi-analytical technique significantly reduces the computational costs by avoiding unnecessary calculations for the entire domain. The effects of solid grain, porosity and ice content on the phase velocities and wave propagation within soil specimen were investigated. Based on the numerical and experimental studies, it was shown that the developed multiphase poroelastodynamic solution describes successfully and efficiently the wave propagation within three-phase frozen soil specimens.

[1] Liu, H. and Maghoul, P. (2021). *Biot-Bažant abstract.*