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Physics of shear-waves propagating in saturated and unsaturated soils: new potential for monitoring soil dynamics and stability

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Shear waves are uniquely informative because of their vector nature – with both polarization and propagation of shear waves being useful sources of information, their sensitivity to *in-situ* stress and grain-to-grain contact, and also because of the low velocity of shear waves in relatively soft formations - offering short wavelength and hence high resolution. Decimetre-scale resolution found in shear-wave reflection data in soft soil has resulted in new application possibilities. Medium anisotropy extracted from multi-component shear-wave data has provided information on natural symmetries in small-strain rigidity and/or stress in the shallow subsurface, which are caused by factors that are of great interest to the engineers. AVO response of shear waves at near-surface soil-layer boundaries has also proven to be useful for extracting local information in the subsoil.

In the present research we have looked at the sensitivity of shear-wave velocity and the underlying physics in both saturated and unsaturated near-surface soils, and if these can practically be used for monitoring soil dynamics and soil stability. Time-lapse changes in shear-wave velocity could be used to monitor changes in *in-situ* stress in the saturated sands. More recently, we have developed methodologies to invert time-lapse shear-wave velocity information together with geo-electrical information to obtain *in-situ* values of water saturation and suction in different partially saturated soil units. Incorporation of this information in a spatially varying sense is imperative in order to make assessment of stability of unsaturated soil slopes subjected to rainfall, modelling flooding and sediment flows due to increased surface runoff and erosion, sustainable agriculture through in-situ water moisture monitoring, and modelling pollutant transport through soils.