LAB STUDIES OF ACOUSTIC BEHAVIORS OF UNSATURATED SOILS

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Abstract: Soils are unconsolidated granular materials, consisting of solid particles, water and air. Their mechanical and dynamic behaviors are determined by the discrete nature of the media as well as external and inter-particle forces. For unsaturated soils, two factors significantly affect soils acoustic/seismic responses: external pressure and internal water potential/soil suction. In triaxial cell tests, unsaturated soils were subjected to predefined stress paths to undergo stages of normal consolidation, unload-reload cycles, and failure. The stress deformation curve and stress-P-wave velocity were measured and compared. The study revealed that soil’s dynamic response to external pressure are similar to those of the load-deformation behaviors and demonstrated that acoustic velocity can be used to monitor the state of stress of soils. In a long term field soil survey, the P-wave velocities were found to be correlated with water potential as expressed as a power-law relationship. The above phenomena can be understood by using the Terzaghi’ s the principle of effective stress. The measured results were in good agreement with Brutsaert theory. The effective stress concept can also be applied to explain the observations in a lab test aiming at study of soil pipeflow in which soil internal erosion processes were monitored and interpreted by the temporal evolution of the P-wave velocity. In addition to above linear acoustic behaviors, soils, like other earth materials, exhibit astonishing non-classical nonlinear behaviors such as end-point memory, hysteresis, strain –dependent shear modulus, resonant frequency shift, and phase shift, harmonics generation, etc. A nonlinear acoustic study of a soil as a function of water content showed that the nonlinear acoustic parameter are much sensitive to the variations of soil water content than that of the acoustic velocity.

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