Micro-Mechanical Simulation of Granular Soil Liquefaction

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Pore water pressure and flow velocities have a significant impact on the response of saturated granular soils to seismic loading. Large water pressure and flow velocities may lead to liquefaction and transition of soil from a solid state to a fluid-like suspension. The mechanisms of this transition are still not fully understood. A coupled continuum-discrete hydromechanical model is utilized to analyze the pore fluid flow and solid phase deformation of saturated granular soils when subjected to dynamic excitations. The fluid motion was idealized using averaged Navier-Stokes equations, and the discrete element method was employed to model the solid particles. The fluid-particle interactions were provided by established semi-empirical relationships. The conducted numerical simulations show that loose sandy soils exhibit a contractive response when subjected to cyclic loading. The resultant volumetric deformations are associated with an increase in pore water pressure. At large strains, the soil skeleton response is dilative and marked by instants of sharp decrease in pore pressure. The outcome of the conducted simulations is consistent with experimental observations, and sheds light on salient micros-scale mechanisms of soil liquefaction.