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Undrained shear behavior of saturated Ottawa Sand under anisotropic triaxial loading conditions to assess seismic strengthening

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In geotechnical laboratory testing, we simulate the effect of initial static shear stress on inclined grounds analogous to those found on submarine continental slopes by performing various triaxial experiments on anisotropically compacted samples. If such slopes are subjected to seismic shakings, as they are near subduction zones, the experiments must be carried out using dynamic triaxial systems. Under cyclic loading conditions, one typical response of fluid-saturated granular samples such as sands may be the loss of their fabrics. If pore pressure rises to nearly lithostatic levels, where the effective stress is zero and the sample flows, liquefaction is achieved. However, if the cyclic loading is only moderate in terms of either amplitude or duration, the sample may not fail and may dissipate some pore fluids, causing the grains to settle and contact forces to increase. This phenomenon, known as seismic strengthening, results in densification and strengthening of sediment after earthquake events that are not strong enough to cause failure.
In our study conducted on Ottawa Sand 20/30, we developed a testing procedure that utilizes load-controlled undrained cyclic triaxial tests in anisotropic conditions with different initial relative densities and mean effective stresses. We observe that anisotropy (the presence of initial static shear stress) results in dilatancy of the tested sand and is beneficial to liquefaction resistance, though this does not necessarily mean that the sample is very resistant to seismic shaking. If a significant cyclic amplitude brings the effective stress state close to the critical state, "strain failure" criterion can still be reached.
We also observe significant strengthening when cyclic loads do not lead to specimen failure and subsequent drainage allows excess pore pressure to fully dissipate. We aim to demonstrate the threshold between failure and strengthening under cyclic loadings, document the density increase after drainage, and eventually discover the trends of seismic strengthening for Ottawa Sand 20/30, one of the most well-studied sand standards available.

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