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Thesis

Initial Stress State and Stress History Effects on Liquefaction Susceptibility of Sands

Abstract

An experimental study of the effects of stress state and history on the cyclic liquefaction potential of sands under undrained loading is presented. The primary objective was to determine the dependency of the widely used correction factors Kσ and Kα on state variables and particle shape, especially OCR. Cyclic resistance of semi-angular Fraser River sand and sub-rounded Silica sand were evaluated at various stress/density states and at several OCR values.

Cyclic resistance increases significantly with increasing OCR in both sands under most conditions. At a given initial state, the correction factor Kσ is not dependent on the type of the sand, but the Kα correction factor is highly dependent on the sand. The effect of over consolidation on Kσ and Kα factors under simple shear stress condition was assessed for both sands. While the Kσ correction that is applied to account for the overburden stress does not show significant differences between normally and over consolidated states, the Kα is critically influenced by over consolidation. These results indicate that the current practice of accounting for the effects of stress level and density without regard to the particle shape, or OCR may lead to unsafe designs.

Rotation of principal stresses profoundly influence liquefaction resistance, and the lowest resistance is observed when the major principal stress was inclined at (rotated between) about 45° to 60° to vertical, and not when the inclination is 90°. The alignment of the plane of maximum shear stress along the weak bedding plane is primarily responsible for this response. This suggests that simple shear test can be a useful tool not only when characterizing liquefaction susceptibility due to vertically propagating s-waves, but also in cases involving surface waves that have both dilatational and shear components.

Degree

M.A.Sc.

Completion

2011

Supervisor

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