Geotechnical Aspects of the Response of Pile-Supported Wharves in Liquefiable Soils

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Abstract

Commonly used soil improvement methods can have adverse affects on the surrounding infrastructure and less intrusive methods may be required. Research performed under the Grand Challenge project has investigated two liquefaction mitigation techniques—prefabricated vertical drains (PVD) and colloidal silica grout—that are well suited for remediating hydraulic fills prone to liquefaction at port facilities.

A series of centrifuge test demonstrated that PVDs were effective in dissipating the excess pore water pressures both during and after shaking and reducing the associated deformations. There was a 30-60% improvement in the horizontal deformations and a 20-60% improvement in the vertical settlements. The impact of the PVDs on the excess pore water pressure response was sensitive to the characteristics of the input motion. The dynamic behavior of colloidal silica soils was also studied through centrifuge model tests. The results indicate that treatment with colloidal silica gel reduces pore pressure response and reduces the shear strains induced when subjected to large dynamic loads.

Implementation of performance-based design procedures for pile-supported waterfront structures involves estimation of the dynamic wharf response for hazard scenarios that include liquefaction of the backfill. As part of this research, a macroelement has been developed for soil-structure interaction analyses of piles in liquefiable soils, which captures efficiently the fundamental mechanisms of saturated granular soil behavior. The mechanical model comprises a nonlinear Winkler-type model that accounts for soil resistance acting along the circumference of the pile, and a coupled viscous damper that simulates changes in radiation damping with increasing material non-linearity.