ABSTRACT

Harb Carraro, João Antonio. Ph.D., Purdue University, August, 2004. Mechanical behavior of silty and clayey sands. Major Professor: Rodrigo Salgado.

The static and dynamic behavior of a quartz sand containing various percentages of plastic and nonplastic fines is investigated systematically in the laboratory. A new specimen preparation technique for sands containing fines was developed; the technique is particularly suitable for elemental study of homogeneous specimens of sands with fines deposited in aquatic environments such as those found in alluvial deposits, hydraulic fills, tailings dams, and off-shore deposits. The fabric of sands containing fines was examined using the environmental scanning electron microscope (ESEM). An alternative method to evaluate the minimum density of clean, silty and clayey sands deposited through water is suggested. Static, monotonic, isotropically consolidated drained triaxial tests were performed to evaluate the stress-strain-volumetric response and determine the intrinsic variables of these non-textbook soils. Piezoceramic bender element instrumentation was developed and integrated into a conventional triaxial apparatus; shear-wave velocity measurements were made with this device to evaluate the small-strain stiffness properties of the sands tested at various states. The intrinsic variables that characterize critical state, dilatancy, and small-strain stiffness properties of clean, silty and clayey sands were determined allowing analyses of soil behavior to be carried out using an appropriate theoretical framework for granular soils. Undrained cyclic triaxial tests were carried out to investigate the effect of fines on the liquefaction resistance of sand. A new approach to evaluate the liquefaction initiation of sands is proposed based on a combination of analysis and laboratory testing. All aspects of the mechanical behavior investigated in this study (e.g. stress-strain-volumetric behavior, shear strength, stiffness at very small strains, and liquefaction resistance) are affected by both the amount and plasticity of the fines present in the sand. Micro-structural evaluation using the ESEM highlighted the

importance of soil fabric on overall soil response. The results of this research provide new insights into the evaluation of liquefaction initiation of sands containing fines; the results suggest that fines plasticity and penetration rate effects may be overlooked by current empirical relationships widely-used in practice.