Lateral Spreading And Liquefaction Assessment Of Cohesionless Soils In The Free Field: An Investigation Using Centrifuge Testing

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ABSTRACT

Liquefaction of saturated sands and other granular soils due to earthquake loading has been a major cause of damage to constructed facilities. One of the major liquefaction induced types of ground failure is lateral spreading of mildly sloping ground. Evaluation of liquefaction susceptibility of soils is an important step in many geotechnical investigations in earthquake-prone regions. There is a need for better understanding of the complex behavior of saturated granular soil deposits under earthquake shaking. Centrifuge and full scale testing have proved to be valuable tools in evaluating this behavior and the consequences of liquefaction and lateral spreading. Centrifuge modeling is particularly useful due to its reliability, time and cost effectiveness when compared to full scale testing.

The work presented herein is a centrifuge study conducted at the Center for Earthquake Engineering Simulation (CEES) of Rensselaer Polytechnic Institute (RPI) to investigate liquefaction and lateral spreading phenomena under free field conditions. This study is mainly concerned with investigating the correlation between different liquefaction and lateral spreading parameters, and two soil mechanical properties; the constrained modulus (M), and the shear wave velocity (V_S). This is done in two steps: (i) the effect of relative density, soil permeability, and overconsolidation and pre-shaking history on the measured mechanical properties is investigated and quantified; and (ii) the correlation between M, V_S and different liquefaction and lateral spreading parameters (e.g. lateral ground deformation and generated excess pore pressure ratio) is then established for

different soil parameters and stress history conditions. The established correlations are compared against traditional methods used to assess liquefaction susceptibility of the soil in the field. Based on this study it is concluded that the mechanical soil properties have significant advantages over geometric properties of the soil such as relative density, when correlating with the liquefaction and lateral spreading response of the soil. The cases of liquefaction and no liquefaction compared very well with field liquefaction charts found in the literature and used by practitioners over the years. Comparison with other newly developed liquefaction charts based on the cyclic strain approach showed promise but revealed that further research is needed on the engineering implications for very stiff deposits. Finally, the correlation between soil liquefaction and lateral spreading parameters, on the one hand, and soil constrained modulus (M) on the other, was established and discussed in detail, confirming that M can be an alternative soil stiffness parameter to correlate with liquefaction and lateral spreading due to earthquake shaking.