COMPARING THE LIQUEFACTION BEHAVIOR OF CARBONATE AND SILICATE SANDS BY ENERGY APPROACH

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Many studies demonstrated that carbonate sands exhibit different behavior from silicate sands while experiencing monotonic and cyclic loadings. The reason for this discrepancy is related to different mineralogy, shape characterizations and microstructure of the carbonate and silicate sands. This paper is focused on the response of carbonate and silicate sands to cyclic loading. Excess pore pressure generation regime and shear induced dissipated energy required for onset of liquefaction (capacity energy) are two key parameters that were investigated in this study. For this purpose, some cyclic triaxial and hollow cylinder simple shear tests have been performed on carbonate sand (Hormuz Island sand) and silicate sand (Firoozkooh sand) with the same grains size distribution. The results show that capacity energy of carbonate sand is considerably higher than the silicate sand but the excess pore water pressure generation regime was the same at both sands.

INTRODUCTION

As a disastrous phenomenon, soil liquefaction is a popular topic in the geotechnical engineering studies. Proper determination of liquefaction resistance (CRR or Wliq) and earthquake-induced excess pore water pressure (PWP) is of great importance. Many laboratory studies and field investigations are carried out on the liquefaction behavior of silicate sands, but there are few concerning carbonated sands liquefaction behavior.

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EXPERIMENTAL PROCEDURE

Excess pore pressure generation regime and shear induced dissipated energy required for onset of liquefaction (capacity energy) are two key parameters that were investigated in this study. For this purpose, some cyclic triaxial and hollow cylinder simple shear tests have been performed on carbonate sand (Hormuz Island sand) and silicate sand (Firoozkooh sand) with the same grains size distribution. In following, experimental procedure will be described.

MATERIALS

Carbonate sand (Hormuz sand) was obtained from the northern shore of the Hormuz Island. Silicate sand (Firoozkooh sand) was obtained from Firoozkooh city in north of Iran. In order to eliminate the effect of soil particle gradation characteristics (D50,Cu and etc.) on the liquefaction behavior of tested soils, silicate sand was fabricated with the same grains size distribution as the carbonate sand.

TEST APPARATUS AND PROCEDURE

In this study, 10 stress-control cyclic simple shear tests with hollow torsional apparatus were performed on the Hormuz sand in three different relative density (D_r) and same effective confining pressure ($\sigma'\sigma'$). Liquefaction resistance of Hormuz sand was determined in three different relative density by strain-energy approach (W_{liq}). The tests with different CSR and same D_r and $\sigma'\sigma'$, resulted in the same capacity energy that indicates capacity energy is independent of stress-strain pass.

Three strain-control cyclic triaxial tests were performed on the Firoozkooh sand and capacity energy of the sand at three different relative densities was determined. As mentioned before, one of the advantages of strain energy approach is its independency from stress-strain pass; therefore, the capacity energy obtained from different test apparatus and stress-strain pass (stress-control or strain-control) can be directly compared.

RESULTS AND DISCUSSION

Comparing the capacity energy of Hormuz carbonate sand and Firoozkooh silicate sand demonstrates that liquefaction resistance of Hormuz carbonate sand is considerably higher than the silicate Firoozkooh sand. This is in agreement with the previous studies (Brandes, 2011; Shahnazari et al., 2016). The reason of greater liquefaction resistance of carbonate Hormuz sand is related to microstructure and shape characterization of sand grains.

Besides, excess pore water pressure generation of two tested sand was compared by normalized strain-energy method, and the results show that despite of differences in capacity energy, excess pore water pressure generation regime of both Hormuz carbonate sand and Firoozkooh silicate sand is the same. This conformity highlights the efficiency of normalized strain-energy method.

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