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EFFECTS OF EMBEDDED COLUMNS ON MITIGATION OF LIQUEFACTION-INDUCED LATERAL SPREADING BY SHAKING TABLE TESTS

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Introduction

Deep soil mixing (DSM) has been used to improve ground and mitigate liquefaction for many years. The original idea was to bond entire sand particles with each other by uniform mixing of the entire soil with grouting agent. Later, improvements of grid or wall type and columnar type were attempted to decrease the construction costs.

In case of grid or wall type the rigidity of the improved grid constrains the shear deformation of sand inside the grid (or between parallel walls), and consequently the generated pore pressure during strong motion is reduced considerably. During the 1995 Kobe earthquake performance of the grid-type mitigation was verified as using this measure, subsoil liquefaction was prevented and an overlying water-front building was protected from seismic damage [1, 2].

Among various DSM improvement types the columnar type was considered less effective than other options in liquefaction mitigation despite its lower installation cost [3]. However, conducting shaking model tests, Yasuda et al. [4] and Tanaka et al. [5] showed that columns can mitigate the onset of liquefaction by constraining the shear deformation of soil.

Based on recent studies, changing the configuration of deep mixed soil columns could have positive effects on the behavior of quay walls subjected to liquefied soil pressure [6].This study was carried out to investigate the effects of some important parameters on the performance of soil deep mixing in controlling the lateral spreading of liquefied slope. The effective factors studied herein are pattern of embedded columns and length of improvement.

Configuration of Underground Columns

Three configurations of columns are presented in Figure 1. The irregular, square and triangular configurations are shown in Figures 1(a), (b) and (c). Irregular pattern indicates a 2 by 2 square grid with a spacing of "d" that is shifted either by 2d or d/2 distance in X and Y directions, respectively.

Arrows in these figures demonstrate the passages of liquefied subsoil through column spaces. The square and triangular configurations provide straight flow passages where ground flow is easier in contrast to irregular pattern. This lack of free space in the irregular configuration is expected to restrain cyclic shear deformation and probability liquefaction during shaking.

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