MECHANISM OF PERFORMANCE STONE COLUMN SUBJECT TO STRUCTURE ON DEEP LOOSE SATURATED SAND DEPOSITS

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ABSTRACT

This paper presents the fully coupled nonlinear effective stress dynamic analyses carried out on structures on deep loose saturated sand deposits to better understand the failure mechanisms of stone column (SC) and structure founded on loose sediment ground. Seismically induced settlement and lateral displacement of buildings with shallow foundations on liquefiable soils has resulted in significant damage in earthquakes. Each model was subjected the ground motion event obtained by scaling the amplitude of the El Centro (1940) earthquakes. The models included layers of loose sand thickness, and different surcharge on shallow foundation. This paper uses simplified conversion method to obtain the equivalent plane-strain model which the column width is matched based on the equivalence of column area and investigates its applicability to multicolumn reinforced ground. In a series of four separate numerical models, these models are studied first without, then with stone columns, as a free-field situation, and with a surface foundation surcharge. The underlying mechanism and effectiveness of the stone columns are discussed based on the recorded dynamic responses. Effect of the stone column (SC) on excess pore pressures and deformations is analyzed and compared. The numerical simulation demonstrate that stone columns cannot be an effective technique in the remediation of liquefaction induced settlement and lateral displacement of loose sand deposits particularly under shallow foundations, or surcharge larger than approximate 60 kPa.

INTRODUCTION

The economic construction method often involves structure onto loose or liquefiable deposits with little or no ground improvement. Hence in a seismic environment, these structures are potentially vulnerable to failure due to pore pressure generation effects of the underlying deposits.

During many large earthquakes, soil liquefaction results in ground failures in the form of sand boils, differential settlements, flow slides, lateral spreading, and loss of bearing capacity beneath buildings. Such ground failures have inflicted much damage to the built environment and caused significant loss of life. The risk of liquefaction and associated ground deformation can be reduced by various ground-improvement methods including densification, solidification (e.g., cementation), and gravel drains or stone columns Adalier Korhan and Elgamal Ahmed (2004).

Geotechnical earthquake engineers conduct extensive research to understand and characterize various SC and pile-pinning applications and to assess their effectiveness as liquefaction countermeasures, through