Numerical studies on unreinforced and geogrid-reinforced sand bed over stone columns-improved soft clay

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ABSTRACT

Results from a series of 3D numerical approach have been presented to study unreinforced and geogrid-reinforced sand bed resting on stone columns-improved soft clay. Influences of the thickness of unreinforced as well as geogrid-reinforced sand bed and the number of geogrid reinforcement on the performance of stone columns-improved soft clay bed have also been investigad. The inclution of geogrid layer within sand bed further decreases the settlement of soil and also decreases lateral deformation. Single layer reinforcement with stone columns is very effective to reduce the total settlement and bulging diameter.

Keywords: stone column, geogrid, sand bed

1. INTRODUCTION

One of the techniques extensively used in soft soils is the use of stone columns. The use of stone columns can accelerate the strength gain of the surrounding soft soil. It has been used to increase the bearing capacity of soft soils and reduce the settlement of superstructures constructed upon. Most of the works reported in the literature are developed for foundations either reinforced by stone columns or geosynthetic layers. Limited studies have been done on the combined use of geosynthetic reinforcement and stone columns. Han and Gabr [1] presented a numerical analysis of single layer geosynthetic-reinforced pile-supported earth platform over soft soil. Deb et al.[2] developed a lumped parameter model for single layer geosynthetic-reinforced granular fill-soft soil with stone columns. Thus it is necessary to study multilayer geosynthetic-reinforced granular fill resting over soft soil improved with stone columns. Horizantal geosynthetic reinforcement sheets can be used to in the granular columns to increase load carrying capacity and also decrease the bulging of the columns. A granular of sand is usually placed over the top of the stone columns to distribute the stresses coming from the superstructures. [3]

This paper presents the result of 3D numerical analyses of different aspects of the performance of reinforced sand bed using the finite element code ABAQUS.

1.1 Three dimensional numerical analyses

Finite element analyses were performed using the progam ABAQUS. As the zone of interest has two plans of symmetry, it was only necessary to numerically model the behavior of the system over a quarter of the domain. Figure.1 shows a typical finite-element mesh used in the analyses. In the present study, numerical analyses have been conducted on stone columns to study the effect of thickness of reinforced as well as unreinforced sand bed on settlement response and bulging diameter of stone columns. The optimum of reinforced and unreinforced sand bed has also been determined. In order to study the effect of thikness of sand bed on the behavior of a group of stone columns installed under a concrete foundation, a group of 9 stone columns having 800 mm diameter and arranged in a 2m c/c squar pattern was analysed. Thickness of the soft soil and length of the stone columns were assumed to be 5 m. A 60 KPa surcharge pressure was applied in 100 increments on the stone columns group through a linear elastic concrete foundation. The soft soil and the stone column material behaviors were simulated using the modified Cam Clay and mohr columb model respectively. The finite element mesh was developed using 8-node linear break elements for the stone columns, the concrete foundation and the soft soil. The geogrid was also modeled as linear elastic material using 3-node triangular membrane elements. Material properties selected in the analyses are presented in Table1. Thinckness of the geogrid is was assumed to be 2mm in all models.