9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology (IUT), Isfahan, Iran

Numerical Evaluation of Soft Clay reinforced by Geosynthatic Encased Stone Column

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Abstract

One of the best improvement technique on soft clays is the installation of geosynthatic encased stone columns. A numerical analysis was carried out using Plaxis software and the effectiveness of geosynthetic in reducing the settlement of single foundation resting on a geosynthatic encased stone column was investigated through a parametric study. A drained analysis was carried out using Mohr-Coulomb's criterion for soft clay and stone. The geogrid element was used to model the geosynthetic and was modeled as linear elastic element. Based on the results of these analyses, warrping the stone column with geosynthetic, significantly reduces the lateral bulging, which occurs at top sections of ordinary stone column during loading, and increases the transfer of axial force to lower depths too. The role of encasement in reducting the settlement is superior for higher surface pressure. The adequate depth for encasing is lesser than the length of the column. Encasing beyond this depth does not effective in reducing settlement.

Keywords: Stone column, Geosynthetic encasement, Numerical analysis, Settlement reduction factor

1. Introduction

Some problematic soils like soft clay deposits, peat soils, recent fills, marine clays, etc. posses problems in construction because of low bearing capacity, high compressibility, tendency for lateral flow, etc. These grounds need treatment for the improvement in their engineering behavior as per the design requirements of the structure. One common approach for treatment of soft clay soils is the installation of stone columns. The beneficial effects of stone columns are increased stiffness, reduced settlements, increased time rate of settlements, increased shear strength and reduction of the liquefaction potential of soft ground (Barksdale and Bachus,1983). When the stone columns are installed in extremely soft soils, the lateral confinement offered by the surrounding soil may not be adequate to form the stone columns and the bulging of stone columns will be more leading to larger surface settlements rendering the efficacy of the stone columns to very low. This is a major limitation of stone column technique especially in very soft soils. One of the methods to improve the performance of the stone columns installed in such soils is wrapping the ordinary stone column by a suitable geosynthetic (geogrid or geotextile) in a tubular form. Expansion of stone materials and consequently lateral strain of the stone columns due to vertical loading, will induce a hoop tension force in the encasement and additional confining stress to the stones columns (Deshpande and Vyas, 1996).

Many of the researchers have investigated the behavior of ordinary stone columns by an experimental or numerical studies (e.g. Hughes and withers 1974; Balaam et al. 1978; Ambily and Grandhi 2007; Zahmatkesh and Choobbasti 2010 and Choobbasti et al. 2011). Recently, a number of the researchers have conducted an experimental study to investigate the influence of several factors on the behavior of the soft soils reinforced with geosynthetic encased stone columns. Murugesan and Rajagopal (2010) presented the results from a laboratory based studies on the performance of the encased stone columns. The laboratory studies consisted of load tests on stone columns with and without encasement in a clay bed formed in unit-cell tank. The influence of parameters such as the diameter of the stone column and stiffness of the geosynthetic encasement were investigated. The major conclusions drawn from this study are as follows: a) Pressure-settlement response of geosynthetic encased