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Technical note

Laboratory model studies on unreinforced and geogrid-reinforced sand bed over stone column-improved soft clay

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A B S T R A C T

Results from a series of laboratory model tests on unreinforced and geogrid-reinforced sand bed resting on stone column-improved soft clay have been presented. The diameter of stone column and footing has been taken as 50 mm and 100 mm, respectively for all the model tests carried out. Load was applied to the soil bed through the footing until the total settlement reached at least 20% of footing diameter. As compared to unimproved soft clay, the increase in load-carrying capacity under different improved ground conditions has been observed. Influences of the thickness of unreinforced as well as geogrid-reinforced sand bed and the size of geogrid reinforcement on the performance of stone column-improved soft clay bed have also been investigated. Significant improvement in load-carrying capacity of soft soil is observed due to the placement of sand bed over stone column-improved soft clay. The inclusion of geogrid layer within sand bed further increases the load-carrying capacity and decreases the settlement of the soil. Due to the placement of sand bed, the bulge diameter of stone column reduces while the depth of bulge increases. Further reduction in the bulge diameter and increase in bulge depth are observed due to application of geogrid layer. The optimum thickness of unreinforced sand bed is twice the optimum thickness of geogrid-reinforced sand bed. Under specific material properties and test conditions, it is further observed that the optimum diameter of geogrid layer is thrice the diameter of footing.

1. Introduction

Stone column, one of the most commonly used soil improvement technique, has been utilized worldwide to increase the bearing capacity of soft soils and reduce the settlement of superstructures constructed on them. Several researches have been carried out to study the behaviour of stone column-reinforced ground over the past three decades (Madhav and Vitkar, 1978; Balaam and Booker, 1981; Alamgir et al., 1996; Poorooshasb and Meyerhof, 1997; Lee and Pande, 1998; Muir-Wood et al., 2000; Ambily and Gandhi, 2007; Elshazly et al., 2007; Krishna et al., 2007; Black et al., 2007; Madhav et al., 2008; Bouassida et al., 2009). Horizontal geosynthetic reinforcement sheets can be used in the granular columns to increase the load-carrying capacity as well as decrease the bulging of the columns (Madhav et al., 1994; Sharma et al., 2004; Wu and Hong, 2008). Geosynthetic encasement can also be used to extend the use of stone columns for extremely soft soil condition (Murugesan and Rajagopal, 2006; Murugesan and Rajagopal, 2007; Gniel and Bouazza, 2009; Wu and Hong, 2009; Lo et al., 2010).

A granular layer of sand or gravel, 0.3 m or more in thickness, is usually placed over the top of the stone columns to provide a drainage path and distribute the stresses coming from the superstructures (Mitchell, 1981). Shahu et al. (2000) developed a simple theoretical approach to analyze the granular pile-reinforced soft ground with granular mat placed on the top. Deb (2008) developed a mechanical model for predicting the behaviour of stone column-improved soft ground with granular bed placed over the stone columns. It has been observed that the presence of granular bed on top of stone column-reinforced ground reduces the stress concentration near top of the columns. The granular bed also helps to reduce the maximum as well as differential settlement and increase the load-carrying capacity of the stone column-improved soft soil.

The granular bed can be further reinforced with geogrid to enhance the load-carrying capacity and reduce the settlement of the stone column-improved soft clay. Han and Gabr (2002) performed a numerical analysis of geosynthetic-reinforced and pile-supported

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