World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:10, No:02, 2016

Predicting the Effect of Vibro Stone Column Installation on Performance of Reinforced Foundations

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Abstract : Soil improvement using vibro stone column techniques consists of two main parts: (1) the installed load bearing columns of well-compacted, coarse-grained material and (2) the improvements to the surrounding soil due to vibro compaction. Extensive research work has been carried out over the last 20 years to understand the improvement in the composite foundation performance due to the second part mentioned above. Nevertheless, few of these studies have tried to quantify some of the key design parameters, namely the changes in the stiffness and stress state of the treated soil, or have consider these parameters in the design and calculation process. Consequently, empirical and conservative design methods are still being used by ground improvement companies with a significant variety of results in engineering practice. Two-dimensional finite element study to develop an axisymmetric model of a single stone column reinforced foundation was performed using PLAXIS 2D AE to quantify the effect of the vibro installation of this column in soft saturated clay. Settlement and bearing performance were studied as an essential part of the design and calculation of the stone column foundation. Particular attention was paid to the large deformation in the soft clay around the installed column caused by the lateral expansion. So updated mesh advanced option was taken in the analysis. In this analysis, different degrees of stone column lateral expansions were simulated and numerically analyzed, and then the changes in the stress state, stiffness, settlement performance and bearing capacity were quantified. It was found that application of radial expansion will produce a horizontal stress in the soft clay mass that gradually decrease as the distance from the stone column axis increases. The excess pore pressure due to the undrained conditions starts to dissipate immediately after finishing the column installation, allowing the horizontal stress to relax. Changes in the coefficient of the lateral earth pressure K □, which is very important in representing the stress state, and the new stiffness distribution in the reinforced clay mass, were estimated. More encouraging results showed that increasing the expansion during column installation has a noticeable effect on improving the bearing capacity and reducing the settlement of reinforced ground, So, a design method should include this significant effect of the applied lateral displacement during the stone column instillation in simulation and numerical analysis design.

Keywords : bearing capacity, design, installation, numerical analysis, settlement, stone column
Conference Title : ICSMGE 2016 : International Conference on Soil Mechanics and Geotechnical Engineering
Conference Location : Paris, France
Conference Dates : February 22-23, 2016