Numerical simulation of the effect of particle size distribution and boundary conditions on the behavior of stone columns using DEM

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Engkish Extended Abstract

Summary

In this study, using the DEM (which exhibits suitable abilities to simulate the mechanical behavior of discrete media), the bearing capacity of a stone column has been modeled. The results showed that increasing the diameter of the stone column increases the bearing capacity and the trapped stone column has between 25 to 30% more bearing capacity than the floating stone column.

Introduction

It is necessary to study the actual behavior of stone columns in different boundary conditions and soils and against incoming loads. In this regard, researchers have used laboratory tools to study the performance of these columns. However, due to some limitations of laboratory methods, it is impossible to control all effective microstructural parameters in understanding stone column behavior. In this regard, some numerical studies based on the continuum mechanics were performed. Numerical modeling based on the mechanics of continuous media has provided valuable results on subsidence, lateral deformation, and stress-strain diagrams based on macroscopic behavior. However, stone columns are generally composed of washed sand materials and their behavioral nature is distinct sometimes their behavior depends on the performance of their particles in interaction with loose soil particles and it is not possible to accurately evaluate the performance of stone columns using finite element modeling. The discrete component method has been considered as the purpose of this research.

Methodology and Approaches

The dimensions of the model were selected due to the limited number of particles due to the increase in the time of analysis on the scale of the laboratory physical model. These dimensions are determined in such a way that, with a scale of 20 times, they are similar to real projects and represent the diameter of a column of 1 meter with a length of 6 meters in reality. To eliminate the effects of lateral borders on the results, the distance of the borders from the center of the stone column was considered to be 5 times the diameter of the column. A behavioral model with rolling resistance was used.

Results and Conclusions

The modeled stone column is a tall stone column. Because the soil around the stone column is loose, the failure of the stone column is in the form of lateral expansion, which in this form is the tendency of the main force chains. The tall stone column, without lateral restraint, which rests on the trapped end and the forces are transmitted along with them, acted like a tall and thin column, which if its axis exceeds the thinness of the column. The buckle follows it. Evaluation of the behavior of the stone column can be simulated with the DEM, and micro-mechanical evaluations, especially the buckling of force-carrying chains and the path of particles can be observed. Also, the reduction of particle size has limited effects on reducing the bearing capacity of the loose stone-soil column complex.