8th National Congress on Civil Engineering, 7-8 May 2014
Babol Noshirvani University of Technology, Babol, Iran

Improvement of Load-Settlement Behaviour of Strip Footings Using Geogrid-Reinforced Granular Trench under Cyclic Loading

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Abstract

Increasing bearing capacity of shallow foundations has always been one of the issues which geotechnical engineers have dealt with for weak soils. One of the various ways of improving these types of soils is to use granular trench that is the plane strain form of stone columns. This experimental investigation was conducted by using a practical model on a strip foundation overlying on a geogrid-reinforced and unreinforced granular trench embedded with sand under combination of static and cyclic loading with over 10000 cycles loading and unloading.In this study, the effect of placement depth and number of layers for geo-grid materials, and also their optimum values under cyclic loading has been determined. The influence of different amplitude of cyclic loading on footing having various number of layers were tested. The results demonstrate that regardless of reinforcing conditions, with the increasing number of loading cycles, settlement increases as well. If geo-grid layers are used in granular trench, by adding the number of layers, settlement and optimum distance between layers would decrease. For low intensity of the amplitude of cyclic loading, reinforcing is not quite effective.

Keywords: Practical model, Strip foundation, Granular trench, Static and cyclic loading

1. Introduction

Increasing the bearing capacity and reduction of the settlement of shallow foundations overlying on soft soils has always been a substantial problem for geotechnical engineers. One of the various ways to fulfill this requirement is to use granular trench that is the plane strain form of stone column. Moreover, due to the limitations of using piles and deep foundations, it is necessary to use an applicable but may be a rather costly method to improve soft ground including soft clay, silty and loose sands that results in increasing the stiffness of soil bed and bearing capacity as well. This influence is due to the influence of strength and deformation characteristics of the replacement soil (Unnikrishnan et al., 2009).

Replacement of weak soil with another soil having better strength and deformation properties is a classically accepted solution from old time. However, due to severe environmental norms and ever increasing cost of material and transportation, the performance of the technique has been limited. Granular trench is used to adopt selective replacement of weak material at the place where it is most required. In addition to the influence of the better strength and deformation properties of the replacement material, the granular piles also provide their capacity from passive resistance resulting from bulging (Greenwood, 1970; Hughes et al., 1975; Barksdale and Bachus, 1983). The granular pile or stone column technique was adopted in European countries in the early 1960s and thereafter it has been used successfully.

An experimental investigation on unreinforced granular trench in sandy bed under static loading have been proposed by Damerchilou (2010) to determine the optimum length and width of the rectangular granular trench and bearing capacity ratio (BCR) of trench and another one on sandy soil by Unninkrishnan et al. (2009) has been carried out to investigate the shape effect of trench in which the results were compared to numerical analysis.

As the Unninkrishnan et al. (2009) stated: the performance improvement due to such granular trench or granular pile depends upon the effective confining stress provided by the surrounding soil. The stone column improves the foundation behavior mainly due to the higher stiffness of the column or granular trench compared to the soil. The ultimate bearing capacity increased with the increase of the depth of the granular