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Scale Effects of Footings on Geocell Reinforced Sand Using Large-Scale Tests

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Abstract

The scale effect on bearing capacity of shallow footings supported by unreinforced granular soils has been evaluated extensively. However, the subject has not been addressed for shallow footings on geocell-reinforced granular soils. In this study, load-settlement characteristic of large square footings is investigated by performing large-scale loading tests on unreinforced and geocell-reinforced granular soils. The effects of footing width (B), soil relative density of soil (D_r), and reinforcement depth (u) have been investigated. The test results show that the scale effects exist in geocell-reinforced soils, like unreinforced soils, and the behavior of small-scale models of footings cannot be directly related to the behavior of full-scale footings due to the difference between initial conditions of tests and the initial state of mean stresses in the soil beneath the footings having different dimensions. Large footings create higher mean stresses in the soil, resulting in low soil friction angle and initial conditions of the test approach to the critical state lines. The results of tests indicate that model experiments should be conducted on low-density soil for better prediction of the behavior of full-scale footings, otherwise, the predicted behavior of full-scale footings does not seem conservative.

Keywords: Scale Effect; Geocell; Shallow Footing; Large-Scale; Sand.

1. Introduction

Geocell consisting of three-dimensional honeycomb-shaped structure has been of significant interest in recent years for geotechnical engineers due to its reasonable price, ease of use, good tensile strength, higher bending stiffness compared with planar geosynthetics, high durability and environmental considerations. The better performance of geocell than planar reinforcements (e.g. geogrid and geotextile) in increasing the bearing capacity and reducing the settlement of shallow footings is well known [6-10]. A numerical simulation of geocell-reinforced foundation beds using FLAC 3D was reported by Oliaei and Kouzegaran. In this study, a comparison was made between the performance of cellular geosynthetic reinforcement and a planar form with the same mass of used material [23]. Hegde and Sitharam have performed many numerical and experimental studies to investigate the behavior of the footings supported on geocell, geocell with additional basal geogrid reinforced soil and bed reinforced with the bamboo cells. They reported that planar geogrid at the base of the geocell layer increased the load carrying capacity significantly [16, 17 and 18]. Shadmand et al. [24] used geocell with an opening reinforcement as the bed for large scale footings for the first time. They showed that using geocell with opening like full geocell can improve load-settlement characteristics of footings. In 1963, De Beer showed that the bearing capacity coefficient (N_γ) was not only a function of the soil internal friction angle of the soil (Φ) but also the value of N_γ decreased with increasing the footing dimensions (B) in the granular soil.

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