ABSTRACT

Construction of any engineering structures on weak soil may lead to load-bearing capacity and excessive settlement failure. Soil reinforcement is a widely applied ground improvement technique that is often accomplished by the use of planar and/or 3D reinforcement in the foundation system.

This study deals with a series of laboratory load tests conducted to investigate the effect of various parameters such as footing shape, the relative density of sand subgrade, geocell geometric dimensions, and relative density of infill sand (in the geocells) on the performance of geocell-reinforced sand under static and repeated load. The laboratory physical model tests had been carried out in a steel tank of size, 1200 mm × 980 mm × 1010 mm (length × breadth × height). The effect of the shape of footings was assessed by using three different types of footings such as square (150 mm), rectangular (150 mm × 200mm), and strip footings (150 mm × 975 mm) supported on unreinforced and geocell-reinforced sand. Further, the response of square footing supported on geocell-reinforced sand beds under static and repeated loads was studied systematically by varying the relative density of sand subgrade (D_r), geocell placement depth from the base of the footing (u), the equivalent diameter of geocell pocket (d), the height of geocell reinforcement (h), the width of geocell reinforcement (b) and relative density of infill sand in the geocells ($D_{r,\ infill}$). The ultimate bearing capacity ($q_{ult.}$) obtained at the settlements equal to 10% of footing width (B) was used as the basis for calculating the magnitude of repeated loads. The influence of initial static load levels and the number of load cycles were also investigated to study the response of unreinforced and geocell-reinforced sand beds under repeated loads.

The results of the model load tests show that the inclusion of geocell reinforcement in a sandy soil bed enhanced the bearing capacity and reduced the settlement of the footing. The bearing capacity of geocell-reinforced sand was observed to be affected by the shape of the footing. A higher bearing capacity improvement factor (IF) was found for square and rectangular footing as compared to strip footing. The load-carrying capacity of the reinforced foundation bed was also found to be influenced by the relative density of sand subgrade, the depth of placement of the geocell reinforcement layer, the equivalent diameter of the geocell pocket, the height of the geocell reinforcement layer, the width of geocell layer and relative density of infill sand in geocells. Based on the analysis of the test data, the critical values of the sand-geocell reinforcement giving maximum beneficial effect were determined for both static and repeated loads. The heaving on the fill surface was found to reduce due to increased confinement provided by the geocell reinforcement to the infill sand. The reduction was relatively more for higher heights, smaller pocket sizes, and wider widths of geocell reinforcement. It was also found that for the application of the same initial static load intensity and the number of cycles, the amount of total settlement due to repeated loading decreased with the provision of a geocell layer. Further, for the same number of load cycles, the total settlement due to repeated load increased with increasing initial static load.

Multiple-variable regression analyses were performed on the experimental data to develop a regression model to predict the bearing capacity of the reinforced foundation bed as a function of various parameters that influence the bearing capacity. Finally, the developed equation is compared with existing theories.

Keywords: *Geocells, sand bed, bearing capacity, settlement, improvement factor, surface heaving, geocell geometric dimensions, relative density, multiple regression equation, static loading, repeated loading*