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Probabilistic Analysis of Bearing Capacity of Strip Foundations Overlying Reinforced Embankments

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ABSTRACT

In cases where the soil underlying the foundation is loose and unable to carry the loads imposed by the structure, improving the soil by an appropriate approach is essential. The application of polymeric materials such as geogrids, in recent decades, has been of interest to engineers and researchers in order to increase the bearing capacity of soil foundations. Geogrid reinforcements allow for achieving an increased bearing capacity or a reduced layer thickness of soil improvements. The most significant factor used in the design of shallow foundations is the bearing capacity of the foundation along with its settlement. In geotechnical investigations, probabilistic analyses could be beneficial in the relevant problems. The Monte Carlo probabilistic simulation method is one of the most commonly used methods in solving geotechnical problems. Therefore, in the current research, a reasonable estimation of the bearing capacity of a strip foundation has been conducted by using a numerical model with the help of the discrete-element software FLAC3D in conjunction with the calculation of the probabilistic bearing capacity via the Monte Carlo simulation method and by considering the uncertainty of the soil internal friction angle and cohesion coefficients.

Keywords: Bearing capacity; strip foundation; reinforced embankment, numerical modeling, Monte Carlo

1. INTRODUCTION

On account of the weakness of soils against tensile stresses, designers have constantly been seeking the best solution to obviate this shortcoming. As a result, the tensile and shear strength of soils are expected to be improved by reinforcing the soil. Reinforced soil slopes are among the structures that benefit from this technique. With the advancements in polymer engineering & sciences in recent decades, geosynthetics – which possess superior advantages over other reinforcements – have been introduced as a suitable option to reinforce the soil. Alternatively, the application of a broad range of soils in combination with their easy execution technique has turned the reinforced soil into an economical option in civil projects [1]. Calculating the bearing capacity of strip foundations is an important and common task, the suitable estimate of which is requisite for a sound and safe design. The traditional techniques of calculation of the bearing capacity of foundations do not consider the uncertainty. One of the most substantial issues in the design and application of all types of foundations is to determine the bearing capacity, which was introduced, for the first time, by Terzaghi in 1948 [2], after which it was developed by other researchers throughout different periods of time. It has been nearly 40 years as of the recognition of the reinforcements as useful products in civil and geotechnical projects, during which they have been utilized in many projects, and their applications and production growth rate have been rapid [3-7]. Due to the recent advances in the polymer industry, the development of geosynthetics has also acquired a much faster rate. The term "geosynthetic" is used for a set of products that are generally applied in order to resolve the geotechnical problems [8]. Geosynthetics increase the bearing capacity of foundations, and protect retaining walls, asphalt pavements, drainage systems, hydraulic structures, etc. from erosion [9-12]. Most of the design methods of reinforced structures are based upon the limit equilibrium method by assuming the location and mechanism of failure. Moreover, it is assumed in this method that the failure mechanism is similar to the reinforced soil, which has been suggested by Terzaghi, as well as that the effect of the reinforcement is applied as a tensile strength in the design calculations. This idea has been employed by many researchers [13]. And Hull et al. [14], in the studies accomplished on reinforced embankments and slopes. These researchers utilized a simple computational method, and supposed that it is possible to consider the behavior of soils and reinforcements independently. However, there is an interaction between a soil and its reinforcement, and it appears that the failure mechanism of reinforced soils occurs gradually owing to the tensile properties of reinforcements. In a research which that was