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Backward Calculation for Bearing Capacity Estimation of Geogrid Reinforced Foundation by Finite Element Method

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Abstract

In this study a new numerical solution is developed to estimate the ultimate bearing capacity of reinforced soil foundations (RSF) with geogrid reinforcement considering a various soil types. The method is based on the classical bearing capacity theories of shallow foundations such as Terzaghi or Meyerhof theories, however is applicable to reinforced shallow foundations. In this finite element method, a model of unreinforced soil foundation was analyzed; using classical bearing capacity theories, under the ultimate load and the amount of footing settlement was calculated. Then, models of reinforced foundations were allowed to settle to this certain amount and the bearing capacity of reinforced soil foundations was back calculated. A ratio BCR was defined as the bearing capacity of a reinforced soil foundation to an unreinforced soil foundation. The number of reinforcement layers (N), the top layer spacing (u), and the vertical spacing of reinforcement (h) were investigated as three important parameters on BCR. It was concluded that applying reinforcement can considerably increase the bearing capacity of soil foundations up to a BCR of 2.598, for a settlement ratio of 9%. The results of the developed finite element method were compared to preexisting experimental data from laboratory model tests on reinforced soil. Good agreement between the prediction of this method and experimental data confirms the reliability of the new developed method

Keywords: Back calculation, Bearing capacity, reinforced foundation, Finite element method.

1. INTRODUCTION

Insufficient bearing capacity and excessive foundation settlement are the most prevalent problems that geotechnical engineers are confronted with them. Construction of shallow foundations on the top of an existing soil layer with a low bearing capacity can results in an abundant settlement of the foundation and even failure of the structure. A well known economical solution technique is reinforced soil foundation (RSF) in which the weak soil is replaced with stronger material in combination with geosynthetics. The role of artificial materials such as metal strips and geosynthetics in increasing the bearing capacity of soil foundations has been obviously known by geotechnical engineers for more than three decades.

The behavior of RSF considering various soil types has been investigated experimentally, numerically and analytically many researches so far. The bearing capacity of a sandy soil reinforced with metal strips has been studied initially by Binquet and Lee (1975a). Since then, several experimental studies are accomplished on the bearing capacity of reinforced soil foundations (Binquet and Lee, 1975a;Fra-gaszy and Lawton, 1984; Huang and Tatsuoka, 1990; Khing et al., 1993,1994; Yetimoglu et al., 1994; Shin and Das, 2000; Yoo, 2001; Dash et al., 2003; Michalowski, 2004; Sitharam and Sireesh, 2004; Patra et al., 2005, 2006; Basudhar, et al., 2007; El Sawwaf, 2007; Chen et al., 2007; Abu-Farsakh et al., 2008a; Somwanshi and Latha, 2009; M.H.A Mohamad, 2010). Many researchers endeavored to estimate the benefits of using RSFs through bearing capacity ratio (BCR), which is defined as a ratio of the bearing capacity of a reinforced to an unreinforced soil foundation. However some analytical solutions have been proposed already to evaluate the ultimate bearing capacity of footings (Binquet and Lee, 1975a,b; Michalowski, 2004; Wayne et al., 1998; Kumar and Saran, 2003), the problem is not widely investigated numerically and analytically compared with the high number of experimental researches.

In this study a new numerical solution is developed to estimate the ultimate bearing capacity of RSF with geogrid reinforcement covering any type of soil. Ultimate bearing capacity of a reinforced soil foundation is back calculated from the settlement of the foundation. While this settlement is calculated from the bearing capacity of an unreinforced soil foundation based on the classical theories of shallow foundations such as Terzaghie and Meyerhof theories. The main objective of this study is to introduce a new method for back calculation of bearing capacity of geogrid reinforced soil foundation. Furthermore, this study aims to