Comparison of static and seismic bearing capacity of strip foundation using slip line method

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ABSTRACT

Determination of static and especially seismic bearing capacity of foundation using slip lines method is one the interested method in geotechnics project because of its simplicity. In slip lines method, the stress equilibrium equations on the characteristic lines are solved using the finite difference method. In this research, to determine the static and seismic bearing capacity of foundation two programs were codded in MATLAB. For seismic analysis horizontal and vertical seismic coefficient were inserted in equilibrium equations. Comparison of the results shows that the proposed model can predicts close bearing capacity with respect to the literature. The results of sensitivity analysis show that the horizontal seismic coefficient and internal friction angle are the most effective parameters on bearing capacity of the strip foundation. The results indicate that earthquakes have a negative effect on the bearing capacity, so increase in the horizontal coefficient of the earthquake decrease the bearing capacity of the strip foundation significantly.

Keywords: Bearing capacity, Strip foundations, Slip line method, Stress equilibrium equations

1. INTRODUCTION

The bearing capacity analysis of the shallow strip footing is a classical problem in soil mechanics, in which the strip footing is subjected to a centrally located vertical load that gradually increases and finally induces a symmetrical failure pattern in the neighborhood of the strip footing.

The methods for calculating the bearing capacity of the shallow strip footing can be classified into four categories: limit equilibrium method [1,2], numerical methods [3,4], limit analysis [5-7] and the method of characteristics [8-12].

The method of characteristics leads to an exact true limit load when the calculations of the three terms in the bearing capacity formula are consistent with one collapse mechanism and the soil satisfies the associated flow rule. Although, the method of characteristics avoids the assumption of arbitrary slip surfaces, and produces zones within which equilibrium and plastic yield are simultaneously satisfied for given boundary stresses [13].

Several researches have been proposed by slip line method for determining the static bearing capacity of strip footing in the literature. Among important contributions are the works of Jian-Ping Sun et al. [13] and Kumar [10]. Jian-Ping Sun et al. [13] investigated the influence of groundwater on the bearing capacity of the shallow strip footing. They show that when the groundwater effect is taken into account, the error induced by the superposition approximation can be reduced as compared with dry soil condition. Kumar [10] computed the bearing capacity factor N_γ for a rough strip footing by using the method of characteristics. The analysis was executed by considering a curved non-plastic wedge below the foundation base bounded by curved slip lines intersecting at an interior angle $(\pi/2 - \varphi)$ along the vertical axis of symmetry and being tangential to the base near the footing edges. The available N_γ values in the literature calculated with the consideration of a triangular trapped wedge below the footing base were found to be generally higher than the results obtained in his research.

Furthermore, the effect of seismic forces on the bearing capacity of foundations can be entered into method of characteristics. Among important contributions are the works of Kumar and Mohan Rao [14], Keshavarz and Jahanandish [15]. Kumar and Mohan Rao [14] examined the effect of horizontal earthquake body forces on the bearing capacity of foundations. They also investigated changes of the bearing capacity factors N_c, N_q and N_γ as a function of earthquake acceleration coefficient for different values of soil friction angle. Keshavarz and Jahanandish [15] analyzed the ultimate bearing capacity of strip foundations situated on reinforced soils. They considered earthquake effect using horizontal and vertical pseudo-static seismic coefficients.

The purpose of this paper is firstly to determine and comparison the bearing capacity of the shallow strip footing in both static and seismic case by the slip lines method, and then assessment most effective factors in the bearing capacity of the shallow strip footing based on a sensitivity analysis.