9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology (IUT), Isfahan, Iran

Effect of the Seepage Flow on the Bearing Capacity of Strip Foundations by the Method of Stress Characteristics

Mehdi Veiskarami[1] and Jyant Kumar[2]

1- Assist. Professor, Civil Engineering Department, The University of Guilan, Iran
2- Assoc. Professor, Civil Engineering Department, Indian Institute of Science (IISc), Bangalore, India

Corresponding Author's Email: mveiskarami@gmail.com

Abstract

Groundwater flow can introduce an unbalanced force which reduces the bearing capacity of the foundation. The hydraulic gradient can exceed some critical value beyond which, soil completely loses the shear strength. In this research, the bearing capacity of shallow foundations subjected to seepage force has been investigated. A boundary value problem in soil plasticity was solved by numerical method and the limit load on the foundation was found. The plasticity equations were solved by the method of stress characteristics. The results showed that, under general assumptions, there is a critical seepage gradient beyond which, a general instability would occur. This latter can be well observed by plotting the variation of the dimensionless bearing capacity factor against the dimensionless groundwater flow and by analytical approach.

Keywords: Computational Modeling, Stress Characteristics, Foundations, Plasticity, Seepage.

1. INTRODUCTION

The bearing capacity of foundations was first suggested by the well-known triple-N equation of Karl Terzaghi (1943) for a typical foundation resting over the ground [1]. Later on, several modifications to this equation for inclination of the load, ground, footing base and so on, have been made [2-4] and many researchers investigated different effects on the bearing capacity factors, like the effect of foundation size, shape, base roughness, soil non-homogeneity, seismic loads and stress level [5-13].

Among many factors affecting the bearing capacity of foundations, there are several cases in which, design and construction of foundations over ground underlain by water flow is inevitable. Ground water flow can be resulted from transient and seasonal underground streams or steady-state seepage. The seepage force acts like a body force and hence, in seeking for the ultimate load on a foundation, the presence of this force defines an asymmetric boundary value problem. The method of stress characteristics has been known as one of the standard methods in soil plasticity problems [6,7,9,10,12,14,15]. This method has been widely developed and applied to many cases, among them applications to the ultimate bearing capacity of foundations can be pointed. Lately, Computation of the bearing capacity for unsaturated soils and development of the plasticity equations along the stress characteristics directions has been reported very recently by Veiskarami, *et al.* (2009) and Jahanandish *et al*. (2010) [13,16].

In this paper, the bearing capacity factor, N_γ, has been computed numerically for foundations subject to groundwater flow. The problem has been defined as a boundary value problem in which, an admissible failure mechanism is found. The method of stress characteristics has been employed to solve this boundary value problem. The study is limited to strip foundations and horizontal flow of water. Both smooth base and rough base foundations are analyzed.

2. DEFINITION OF THE PROBLEM

As stated before, seeking for the ultimate load on the foundation in presence of the seepage, can be reduced to a boundary value problem in which, the water flow, in general sense, introduces a seepage force the soil body. When the ultimate load is reached and plastic zones are formed, there would be two different regions identifiable in either side of the foundation: a strong side in which, the seepage force acts as a resisting (passive) force and the weak side in which, the seepage force acts as an unbalancing (active) force.