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Experimental and numerical investigation on circular footing subjected to incremental cyclic loads

S. N. Moghaddas Tafreshi[1,*], Gh. Tavakoli Mehrjardi[2], M. Ahmadi[3]

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Abstract

The results of laboratory model tests and numerical analysis on circular footings supported on sand bed under incremental cyclic loads are presented. The incremental values of intensity of cyclic loads (loading, unloading and reloading) were applied on the footing to evaluate the response of footing and also to obtain the value of elastic rebound of the footing corresponding to each cycle of load. The effect of sand relative density of 42%, 62%, and 72% and different circular footing area of 25, 50, and 100cm^2 were investigated on the value of coefficient of elastic uniform compression of sand (CEUC). The results show that the value of coefficient of elastic uniform compression of sand was increased by increasing the sand relative density while with increase the footing area the value of coefficient of elastic uniform compression of sand was decreases. The responses of footing and the quantitative variations of CEUC with footing area and soil relative density obtained from experimental results show a good consistency with the obtained numerical result using "FLAC-3D".

Keywords: Experimental model; Numerical model; Coefficient of elastic uniform compression; Circular footing; Footing area; Sand relative density

1. Introduction

Machine foundations require the special attention of a foundation engineer. In addition to static loads due to the weight of machine and the foundation, loads acting on such foundations are often dynamic in nature due to the action of the moving parts of the machine. While these dynamic loads are generally small, as compared to the static load, they are applied repetitively over a very large number of loading cycles. Therefore it is necessary that the soil behavior be elastic, or else deformation will increase with each cycle of loading until the unstable soil behavior develops.

Research into the behavior of soil and shallow foundations subjected to dynamic loads was initiated during the 1960s and 2000s. Both theoretical and experimental studies of the dynamic behavior of shallow foundations have been reported by several researchers out to understand the load-settlement relationship of footings and also the relationship between footing settlement and the number of load cycles [1-6]. Experimental observation of the load-settlement relationships of square surface foundations supported by sand and clay and subjected to transient loads were reported by [1, 7]. Raymond and Komos [2] conducted laboratory model tests on strip surface foundations supported by sand and subjected to cyclic loadings of low frequency to determine the relationship between foundation settlement and the number of load cycles. Das and Shin [5] reported the results of some laboratory model tests conducted to evaluate the permanent settlement of a surface strip foundation on a saturated clayey soil layer while being subjected to a combination of static and cyclic loading of low frequency. This investigation indicated that the initial rapid settlement due to cyclic load application takes place during the first ten cycles of loading, constituting about 60% to 80% of the total settlement and an equilibrium period is reached after about 15000 cycles.

Das [8] conducted a laboratory model tests for settlement of surface square foundation supported by a medium dense reinforced sand bed and subjected to cyclic loading of low frequency. His test results indicated that the geogrid reinforcement can act as a settlement retardant for dynamic loading conditions on the foundations. Raymond [9] investigated the performance of a thin layer of granular

* *Corresponding Author: nas_moghaddas@kntu.ac.ir*
[1] *Associate Professor, Department of civil Engineering, K.N. Toosi University of Technology*
[2] *Post Graduated Student, Department of civil Engineering, K.N. Toosi University of Technology*
[3] *M.Sc graduated, Department of civil Engineering, K.N. Toosi University of Technology*