The Effect of Structural Skirts on Bearing Capacity of Shallow Circular Foundations

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Abstract

Skirts are used to improve the bearing capacity of shallow footings on sandy soil by constraining the soil beneath and containing the plastic flow of soil. They are used as an alternative to deep foundations in soils with low strength at the surface. As there has been available little work studying the performance of skirted foundation, we are performing a series of numerical analysis using PLAXIS 2D software on circular footings of different skirt lengths. The aim of this article is to shed some lights on the effects of skirts on the bearing capacity of shallow footings. The effects of skirt length and the relative density of sand on the ultimate load attained were investigated. From the numerical analysis, it was found that skirts improve appreciably the sustainability of shallow footings to applied load as they increase the ultimate load of shallow footings by some up to 2.5 times for the current study conditions and variables. The performance of skirted footing depends upon the relative density of sand and on the skirt length to footing diameter ratio. Skirts are more beneficial in case of footings on loose sand than in case of medium and dense sand.

Keywords: Skirt, Foundations, Bearing Capacity, Circular Footing

1. INTRODUCTION

Bearing capacity is the prime importance for the stability of structures. It depends largely on the type of soil. If the soil is confined, as in the case of footings / rafts surrounded by sheet-pile walls, the bearing capacity is enhanced enormously. In the case of skirted foundations on sand, the same principle of confinement is applied whereby the sandy material is enclosed locally under the individual footing for a certain depth by skirt. Skirt is nothing but an enclosure which can withstand considerable hoop stress and confines the soil within it. Skirts forms closed space in which soil is restrained laterally. It works as a unit with the skirt to transfer superstructure loads to the soil at the level of the skirt tip. The skirt may be of any shape but generally the shape of the skirt is kept same as that of the footing. Several investigators have reported that confining the soil by using horizontal soil reinforcement increases the bearing capacity of the supporting soils (Binquet and Lee 1975; Mahmoud and Abdrabbo 1989; Mandal and Manjunath 1995; Das et al. 1994 etc.).

As an advancement soil reinforcement is not only placed horizontally but also can be placed vertically to resist the lateral deformations of the soil. Dash et al.(2001a) conducted a load test for a strip footing on homogeneous dense sand beds (relative density of 70%), and found an 8 fold increase in bearing capacity could be achieved with the provision of geocell in the foundation sand. Dash et al.(2001b) conducted the model test results on a circular footing supported on a dense sand layer (relative density of 70%) overlying a soft clay bed show about a six-fold increase in bearing capacity with the provision of geocell in the overlying sand layer. The higher performance improvement due to geocell in the sand bed compared with that in the soft clay bed is attributed to the mobilization of higher passive force at the geocell walls and frictional resistance at the geogrid-soil surface. In order to investigate the effect of confinement on bearing capacity and settlement characteristics of circular footing, the cells were instrumented in the laboratory. It was made of mild steel plate having a thickness of 0.94 mm and having different diameters. The cells were open at both the ends. It was modeled as a circular footing supported on a silty soil, which is surrounded by a mild steel cell having same soil outside. The tests were performed first without cells (unconfined case) below the footing and then with cells (confined case) and the results for bearing capacity and settlement corresponding to a constant pressure intensity of 100 kPa are compared. In cases where structures are very sensitive to settlement, soil confinement can be used to obtain the same allowable bearing capacity at a much lower settlement. Sawwaf and Nazer (2005) studied the effect of confinement on the bearing capacity of sand and