Experimental Study on Behavior of Piled-Raft Foundation: A Critical Review

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Abstract*-In the piled-raft foundation systems the load is assumed to be shared between the piles and raft. Therefore, this improves the ultimate load capacity and reduces settlements in a very economic way as compared with the traditional foundation concepts. Only limited research has been done on experimental Study on Behavior of piled-raft foundation, this paper presents a literature review on the experimental program is aimed to investigate the behavior of Piled- Raft Foundation.*

Keywords*-*Piled-Raft, PLAXIS 3D, finite element.

I. INTRODUCTION

Piled-Raft foundation is continuously being developed to achieve more economical foundation along with safety and serviceability of the structure. Piled-raft foundation has been applied to high-rise buildings all over the world and increasingly being recognized as economical foundation system. The piled-Raft foundation system provides a skilful geotechnical concept where in the applied load is transferred by means of a load sharing mechanism which is generated through a process of interaction between the pile, soil and Raft. They introduced factors reflecting the efficiency of interference for bearing capacity between footings. The concept of using piles as settlement reducers was first proposed by Burland et al. (1977). Several reports were published on the use of piles as settlement reducers. Clancy and Randolph (1993)compared the behavior of piled raft foundation system with that of the free standing pile group and un-piled raft, through model tests on Piled-Raft foundation. Agarwal (1970) investigated the interference effect for both strip and rectangular footings. According to Katzenbach et al. (1998) the loading transmitted to the soil by the raft can have a beneficial effect on the pile behavior in the Piled-Raft system. The pile foundations are normally used when constructing a tall building on a low bearing capacity soil. Mandolini and Viggiani (1997) presented an analysis to predict the settlement of piled raft foundations with the help of finite element method. Singh et al. (1973) reported experimental investigations on the interference effect of two adjacent footings subjected to axial load in cohesion less soil. Bajadet al.(2008) conducted 1 g model test on a piled raft foundation on soft clay with raft having different thicknesses on different combinations of piles, to study the effect of pile length and number of piles on load sharing between raft and the piles and settlement reduction. Horikoshi et al. (1996) performed a centrifuge test on piled raft foundation system on clayey soil, to study the settlement of piled raft foundation. According to Katzenbach et al.(1998) the loading transmitted to the soil by the raft can have a beneficial effect on the pile behavior in the piled raft system.

II. FINITE-ELEMENT METHOD

A numerical analysis has been carried out by using finite element software (PLAXIS 3-D). The aim is to optimally utilize the load-carrying capacity of both the raft and the pile group. Mohr- Coulomb model was used for defining the failure criterion for the soil media. Pile aspect ratio, number of piles, pile spacing and raft thickness were taken as variables of study. After the generation of model for all cases, the foundation system was simulated under a uniform vertical floor load on whole of raft and its behavior was observed. R. S. Bishtet al.(2012)presented that a 42 m x 42 m raft with 1m diameter piles were analyzed using a software PLAXIS-2D.P.Garg et al.They studied the clay soil was considered for the parametric study and analysis. It has been modeled using PLAXIS 3D foundation finite element program. The contact between the soil and pile is assumed to have some friction thereby representing the rough surface of the pile and would consider the pile contribution through skin friction in carrying the imposed load.

III. EXPERIMENTAL PROGRAM

The objective of the experimental studies mentioned herein was to examine the validity of the available methods of analysis and computer programs to investigate the behaviors of the Piled-Raft foundation. The purpose of the work was to study the load-settlement behavior of Piled-Raft foundation system and load transfer mechanism between the raft and piles with different raft thicknesses and different pile group combinations. El-Garhy et al. (2013) they did series of laboratory tests were performed on models of single pile, un-piled raft and central piled raft. The experimental investigation consists of forty tests. One test was carried out on single pile, three tests were carried out on un-piled rafts and thirty six tests were carried out on central piled rafts. The dimensions of the model rafts were selected in such way that to ensure no effect of the boundary walls on the stresses in the soil, and the height of the soil was two times greater than the maximum pile length to ensure insignificant effect on the behavior of piles. Phung (2010) presented the data of three extensive series of large-scale field model tests performed on piled footings in non-cohesive soil in order to clarify the overall cap-soil-pile interaction and the load settlement behavior of piled footing. All the pile groups were square and consisted of five piles. In this paper, the behavior of piled raft is investigated through model tests on piled raft in loose sand. Model tests on single pile and un-piled raft are also carried out for the purpose of comparison. EI Garhy et al. (2013) performed experimental test on model piled raft foundation on sandy soil to investigate the behavior of raft on settlement reducing piles, due to influence of raft-soil stiffness. In this paper, the load-settlement behavior and the load sharing mechanism between the piles and raft is investigated through a model test on piled raft foundation system on sand. Wiesner and Brown (1980) studied four model of piled raft foundations in a large pot with an internal diameter of (590) mm and a depth of (480) mm filled with over consolidated clay. The main objective of this article is to study experimentally the load sharing mechanism between the raft and piles, as well as the load settlement behavior of the piled raft with different configurations. J. D Patilet al.(2014) investigated the load-settlement behavior of piled raft foundation system and load transfer mechanism between the raft and piles with various raft thicknesses and different pile combinations. Total twelve tests were conducted in the laboratory. Three tests were carried out on un-piled raft and nine tests were carried out on piled rafts. It can be noted that the load carrying capacity of the un-piled raft slightly Increase with the increase in raft thickness the load-settlement curves of un-piled raft and raft supported by 1, 4 and 9 piles for raft thicknesses 5mm, 10mm and 15mm, respectively. Lee et al. (2005) carried out an experimental test on piled raft foundation system in sandy soil, to investigate the behavior of piled raft foundation due to the effect of pile installation and interaction between the raft and piles. AL-Qaissyet al.(2013) presented that The settlement versus vertical load is plotted for both models. The load-settlement behavior of piled- raft, group piles, single pile and raft for the large model. From the behavior of the load-settlement relation of the piles in the present work, it is found that the tangent proposal can be adopted in specifying the ultimate piled raft capacity. The carrying capacity of the pile groups with different number, constant length, and diameter are shown. In addition, the total carrying capacity of the piles relative to the total applied load increases with the increasing number of piles in the group, whereas the pile group of (four piles) recorded a maximum value of carrying capacity. S. W. Thakareet al.(2016) pointed out that the model plate load tests were conducted on sand as per IS 1888:1982 to evaluate the ultimate bearing capacity. After the preparation of sand bed along with piled raft the load was applied on the raft in increments of one-tenth of estimated ultimate bearing capacity and the settlements were recorded. Each load increment was kept constant till the rate of settlement became less than 0.02 mm/min. The next increment of load was then applied and the settlement was measured. The test was continued till the failure of foundation or until settlement reached to 10 % of width of raft i.e. 15 mm.

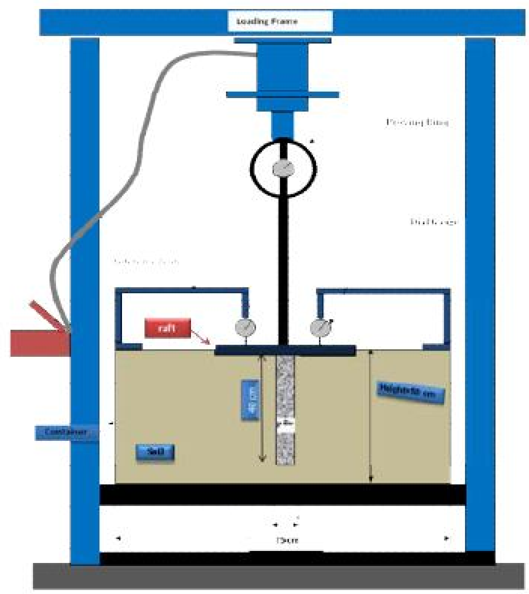

Fig 1. Experimental Model set up (AL-Qaissy et al. 2013)

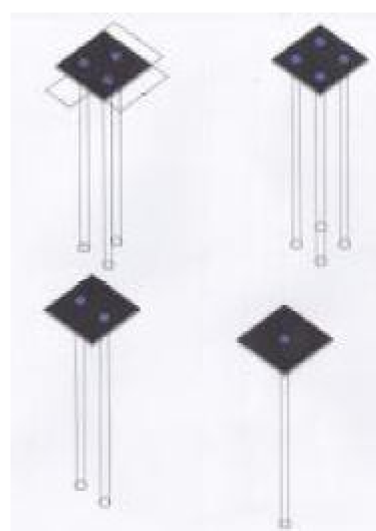

Fig. 2 Raft Size 15cm x 15 cm, L= 400 mm
Dia= 2.5 cm (AL-Qaissy et al. 2013)

IV. CONCLUDING REMARKS

Based on the published literature on the experimental investigation on behavior of piled-raft foundation, the following concluding remarks are made.

1. The addition of even a small number of piles below the central area of the raft increases the load bearing capacity of the piled raft, and this enhancement effect increases as the number of piles increases and as the slenderness ratio, L/D, of the piles increases.
2. The load carrying capacity of piled raft increases with raft thickness up to a limit and beyond it raft thickness does not have any appreciable effect on its carrying capacity.
3. The raft thickness has insignificant effect on the settlement and the loading sharing between piles and raft.
4. For the Piled-Raft models, the total carrying capacity of the model increased with increasing raft size and the number of piles in the group.
5. The change in configuration of piles over the raft area has also significant effect on settlement reduction ratio of the piled raft foundation.

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