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ANALYSIS OF PILED RAFT FOUNDATION USING PLAXIS 2D ON SOFT SOIL

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ABSTRACT

Recent years, a lot of urbanization is taking place as a result many high rise buildings are constructed and due to scarcity of land , structures are built on soft soils using pile foundation which becomes very costly. So apart from conventional method now geotechnical engineers are going for piled raft foundation in which load from super structure is shared by raft mainly and pile act as settlement reducers . Raft alone has adequate bearing capacity and reduces differential settlement but undergo excessive settlement so to overcome this problem piles along with raft are used as piled raft foundation to have adequate bearing capacity and reduce the settlement within allowable limits . It is also an economical method as compared to conventional pile foundation . In present paper experiment and numerical analysis is studied on plain raft and piled raft of different configurations namely with varying various parameters of pile and thus studying load settlement behaviour for different configuration of piled raft foundation experimentally and comparing them with numerical modeling using PLAXIS 2D . This study is useful to decide various parameters required to design piled raft foundation economically.

Keywords*: *Piled Raft Foundation, Settlement, Soft Soil, PLAXIS 2D.

I. INTRODUCTION

In recent years the use of piled raft foundation has become more popular as compared to conventional piled foundation. To carry the excessive loads that come from the superstructures like high-rise buildings, bridges, power plants or other civil structures and to prevent excessive settlements, piled foundations have been developed and widely used in recent decades. However, it is observed that the design of foundations considering only the pile or raft is not a feasible solution because of the load sharing mechanism of the pile-raft-soil. Therefore, the combination of two separate systems, namely "Piled Raft Foundations" has been developed .

A piled raft is a raft foundation that has piles to reduce the amount of settlement. The raft foundation and the piles would be designed to act together to ensure the required settlement is not exceeded. A major part of the bearing capacity comes from the raft rather than being dominated by the piles (as in a pile group).The piled raft minimizes both total and differential settlements of structure, and hence reduces the stresses and bending moments within the raft in an efficient and economical way. The load-bearing mechanism of the piled raft are characterized by complex soil-structure interaction between the elements of the foundation system, i.e., raft, piles and the subsoil.

The main objective of the present study is to:

1) Investigate the behavior of piled raft models on soft clay by varying different parameters of pile.

2) Study the Load Improvement Ratio and Settlement Ratio of model piled rafts.

3) Observe the load settlement behaviour of piled rafts using PLAXIS 2D.

II. LITERATURE REVIEW

Thakare.S.W and Pankaj Dhawale (2016), conducted laboratory study on model piled raft foundation to find the influence of configuration of piles and number of piles of on ultimate bearing capacity and settlement reduction. In this experimental study, three sets of model piled raft foundations were used consisting of 16, 24 and 32 number of piles having l/d ratio equal to 40. In each case, five different piles configurations were tested. Parameter of pile such as diameter, length, type of soil and raft size were kept constant. The results of the experimental study were presented and a result for an optimized configuration of piled raft was evaluated. The results of tests conducted on raft and piled raft foundation with different pile configurations were compared in terms of ultimate bearing capacity, load sharing ratio and settlement reduction ratio. It is concluded that the configurations of piles in a piled raft foundation has significant effect on ultimate bearing capacity, settlement reduction and load sharing ratio between the piles and raft.

Jaymin et al., (2016), conducted experiment which includes model test on unpiled raft, piled raft of different configuration such as (1×1), (2×2) and (3×3) pile groups. The piles used in the test were non-displacement piles. The results of the tests show that as the number of piles underneath the raft increases from 1 to 9 piles, the load improvement ratio increases by 30–40%, settlement reduction ratio increases by 18–90% and percentage of load carried by the raft decreases by 22–25%. Also load improvement ratio is slightly increases by 1.5–5% and the settlement reduction ratio decreases by 1.5–30% as the raft-soil stiffness ratio increases for the given number of piles, while the load carried by the raft slightly decreases by 1.5–4.5% as the raft-soil stiffness increases.

Nitin Nandwani et al., (2015), studied the use of piled raft foundations has become more popular in recent years, as the combined action of the raft and the piles can increase the bearing capacity, reduces settlement, and the piles can be arranged so as to reduce differential settlement in the raft. Piled raft foundation is a new concept in which the total load coming from the superstructure is partly shared by the raft through contact with soil and the remaining load is shared by piles through skin friction. A piled raft foundation is economical compared to the pile foundation. Because piles do not have to penetrate the full depth of clay layer but it can be terminated at higher elevations. Such piled raft foundation undergoes more settlement than the pile foundation and less settlement than the raft foundation. In this paper the study of different parameters like size of the raft, thickness of the raft, diameter of the piles, length of piles, spacing of piles etc., which affect the behavior of piled raft foundation. And its interdependency is also reviewed for G + 20 storey building. This study is useful to decide the various parameters required in the design of piled raft foundation and suggest the suitable combination of Pile Raft Foundation.

Paravita Sri Wulandari (2015), analyzed piled raft foundation using finite element method using plaxis 2D considering various number of piles .In this study, the uniformly distributed load of 60 kN/m² was applied to 21 m x 21 m raft with different numbers of piles. It was a model of industrial building built on soft soil. In the finite element analysis, the raft and the piles were modeled as plate elements. Based on the finite element analysis in this study, the addition of even small number of piles decreases the settlement of piled raft foundation. The addition of piles reduces the settlement, but after reaching certain number of piles, further increase in number of piles showed the settlement tends to be constant. For economic design, it is necessary to consider the optimum number of piles in piled raft foundation system based on the allowable settlements.

Rautet al.(2015), performed an experimental model to study the load sharing ratio behavior of piled raft foundation. The model tests were carried out on unpiled raft, piled raft having 4 piles and 16 piles. From the results of the study, it was concluded that the load sharing ratio of piled raft foundation depends on stiffness of pile and raft.

R.Radhika (2015), investigated the load settlement behaviour of unpiled and piled raft in soft clay by varying length of piles with three different configurations namely 1x1,2x2 and 3x3 with varying Slenderness Ratio of 23,27 and 30. The results proved that ultimate load has increased and the settlement has reduced which is expressed by Load Improvement Ratio (LIR) and Settlement Ratio (SR). experimental study showed that reduction in settlement takes place due to increase in length of pile as well as increase in number of piles. Among the tested models, the maximum length of pile of 180mm with piled raft of 3x3 group showed 67% increase in ultimate load and 83% reduction in settlement compared to that of same pile configuration with pile length of 140mm. The settlement values from experimental study was compared with numerical modeling using PLAXIS 2D .

Jaymin et al., (2014), conducted an experiment to study the behaviour of piled raft foundation system subjected to vertical load. The experiment includes model test on unpiled raft, raft supported by single pile, (2x2) and (3x3) pile groups. The model piles used in this test are non displacement piles. Model piles made of mild steel of diameter 10mm and length 200mm were used, having slenderness ratio (L/D) of 20. The raft was square made of mild steel plate with dimensions of 160mm x 160mm with thickness of 5mm, 10mm and 15mm. The results shows that as the number of piles beneath the raft increases, load improvement ratio and settlement reduction ratio increase and percentage of load carried by the raft decreases and there is a negligible effect on load improvement ratio and settlement reduction ratio with increase in raft thickness, while thickness of raft has very less effect on the load carried by the raft.

N.Venkateshwaran(2014), studied behaviour of piled raft foundation subjected to vertical loadings in sand .The experiment were conducted on model square raft of size 70 mm×70 mm with 6 mm thickness and piled raft of pile length of 180 mm with diameter 8 mm taking configuration of 1×1, 2×2,and 3×3 .The results showed that ultimate load increased from 234N for plain raft to 578N for piled raft of 3×3 configuration and settlement reduces from 7mm for plain raft to 2.02mm for same combination and concluded that with increase in area ratio , % reduction in settlement initially increases rapidly and there after becomes constant and similarly

load carrying capacity increases rapidly first and then increases gradually. Analysis of Plaxis 2D also compares well with the experimental values.

III. CONCLUSION

Based on present study following conclusions are drawn:

1. Piled raft foundation has significant advantages in comparison to conventional foundation for soft soils.
2. Increasing number of piles in piled raft foundation increases the ultimate bearing capacity and decreases the settlement.
3. Ultimate bearing capacity of Piled raft foundation will increase and the settlement is reduced as the diameter of Pile increases.
4. Addition of piles reduces the settlement, but after reaching certain number of piles, increase in number of piles shows that the settlement tends to be constant.
5. Experimental study shows that with increase in length and number of piles, Load Improvement Ratio (LIR) increases and Settlement Ratio (SR) reduces.
6. Piled raft foundation provide an economical foundation option when raft alone does not satisfy the design requirements.

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