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An Experimental Study of Load-Settlement Characteristics of Single Pile, Pile Group, Unpiled Raft and Piled Raft System in Fine Sandy Soil

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Abstract - *When raft foundation alone does not satisfy the design criteria, it may be possible to increase the performance of the raft by the addition of piles. Piled Raft carries both the advantages of rigid pile groups and flexible unpiled raft. Present research work aims to study load-settlement characteristics response of pile-raft system embedded in uniform fine sand using physical model approach. In this study, piled raft foundations which are subjected to static vertical compression load in uniform fine sand has been taken into account. The load settlement curve for each tests have been plotted to calculate ultimate bearing capacity. The behavior of piled raft system was compared with responses of flexible unpiled raft, single pile, rigid pile groups. The results show that the effectiveness of the L/D ratio and number of piles used with and without raft in the uniform sand. Significant increase in load bearing capacity is achieved when we increase the length of pile and also when we provide piled raft in place of only pile foundation.*

Key Words: **L/D ratio, piled raft, pile group, single pile, unpiled raft**

1.INTRODUCTION

In the design of foundations, shallow foundation is the first option where the top soil has sufficient bearing strength to carry the superstructure load without any significant total and differential settlements to prevent damage of infrastructure and superstructure. The piled raft foundation system has recently been widely used for many countries to support different types of structures like bridges, buildings and industrial plants in different types of soil.

A raft foundation is a large slab supporting a number of columns and walls under the entire structure or a large part of the structure. A raft is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each other. Rafts are generally considered only as a "cap" which structurally connects the heads of the piles. However, the positive contribution of rafts to the load/settlement behavior is disregarded. As structural elements, rafts are mostly in contact with the soil, therefore has/have a capacity to transfer the load comes from the superstructure to the soil beneath. Considering this load sharing, the total length of the piles may be significantly decreased. So, piled raft foundations become an alternative to the piled foundations or foundations with "settlement reducing piles" for an economic/feasible design.

Piled raft foundations consist of three elements; piles, raft and the subsoil. Therefore, it is essential to mention the behavior of piled raft foundations starting from the single piles, pile groups and the raft only. In this study, piled raft foundations with friction piles, which are subjected to static vertical compression load in uniform fine sand soil has been taken into account.

2. EXPERIMENTAL STUDY

Limited research has been done to develop simple models for analyzing the behavior of piled raft foundation in cohesion less soil. In this paper, a laboratory study has been conducted on model systems. Laboratory tests were performed on models of unpeeled raft, single pile and piled raft to examine the settlement behavior of axially loaded pile raft system.

2.1 Experimental Setup

To carry out the compression test on pile-raft system, the compressive load was applied by the use of proving ring and two dial gauges has been set on either side of the tank has been used for measuring the displacements The laboratory model test set up has been presented in Figure 1. This mechanical jack was fixed at the inner side of the top section at equal distance from both extreme ends of loading frame. In compression test, proving ring of 1 tonne capacity was used to measure compressive load. The test was performed on uniform fine sand. Height of soil sample in the tank was 420mm.

Fig - 1 : Experimental Setup for Model Study

The pile-raft model system is fabricated using aluminium material for the slenderness ratio L/D of 10 and 13 with suitable scale factor. The dimensions of raft are 160 mm * 160 mm with thickness as 8mm. Aluminium plates with fixed

thickness of 8 mm served as model rafts. The outer diameter of pile is 19mm and inner diameter is 16mm with varying length of 190 mm and 250 mm. The modulus of elasticity and poison's ratio of the aluminium pipe were 70 GPa and 0.33 respectively. Top head of each pile was threaded to connect the pile to the cap to ensure a fixation between the pile and the cap. The centre to centre distance between the pile in pile group were twice the diameter of the pile. The tests were done using tank having 500 mm inside diameter and 500 mm height. The average relative density of sand kept up throughout all the tests is 70%. The test was performed on uniform fine sand. Height of soil sample in the tank was 420mm.

2.2 Properties of material

Properties of the material used for the research work is given below.

Table -1: Properties of Material

Specific Gravity, G	2.68
Cohesion, c	0
Angle of Internal Friction, φ	39°
Classification of Sand	SP (as per ISSCS)

3. RESULTS

Following are the results obtained from the laboratory model tests for unpiled raft, single pile, pile group and piled raft foundation system.

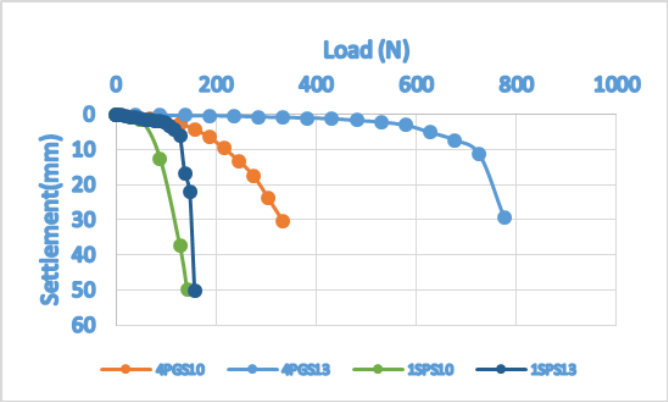

Chart -1: Load- Settlement Curve for single pile and pile group

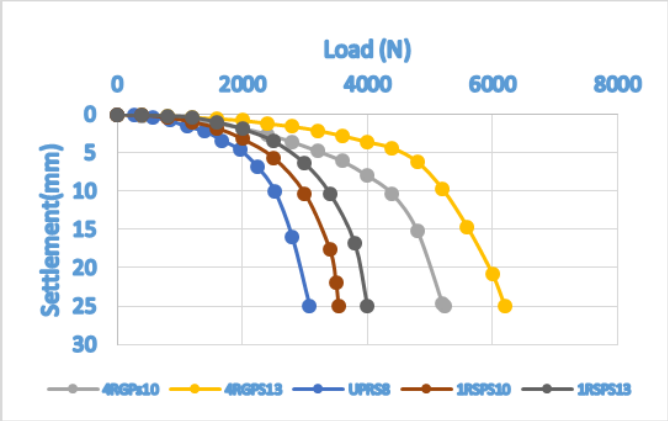

Chart -2: Load- Settlement Curve for Unpiled Raft and Piled Raft

4. CONCLUSIONS

In the present study, the behaviour of piled raft foundation system has been studied and the influence of the important factors like pile length and number of piles. These parameters have been considered to develop an economical and effective design methodology. A series of experiments has been conducted on model piled rafts, pile groups, and unpiled raft in cohesionless soil in the laboratory. The aim of the experimental program is to study the behaviour of foundation system subjected to vertical load. The following conclusions are concluded from the model test:

- It has also been noticed, as the length of pile increases, the magnitude of compressive load increases for corresponding settlement. From the results it is evident that pile with higher slenderness ratio is more effective than pile with smaller slenderness ratio when embedded in medium dense uniform fine sand.
- The ultimate load carrying capacity of a pile group increases 110 % in uniform fine sand as going from L/d ratio of 10 to 13
- The ultimate load carrying capacity of a single pile increases about 10% in uniform fine sand as going from l/d ratio of 10 to 13.
- Pile slenderness ratio has a considerable effect on the vertical load carrying capacity of pile and pile group.
- The ultimate load carrying capacity increases 5.8 times in uniform sand when we go for group of pile 4 instead of single pile at the slenderness ratio of 13.
- The ultimate load carrying capacity increases 2.51 times in uniform sand when we go for group of pile 4 instead of single pile at the slenderness ratio of 10.

- The ultimate load carrying capacity increases 1.56 times in uniform sand when we go for (Raft + group of pile 4) instead of (Raft + single pile) at the slenderness ratio of 13.

- The ultimate load carrying capacity increases 1.47 times in uniform sand when we go for (Raft + group of pile 4) instead of (Raft + single pile) at the slenderness ratio of 10.

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