A Comprehensive Study of Piled Raft Foundation with Consideration To Soil-Structure Interaction

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Abstract- *This paper presents an overview of piled raft foundations with consideration to SSI. The paper begins by discussing the basic principles of piled raft foundations and SSI. It then reviews some of the research that has been conducted on SSI in piled raft foundations. The paper concludes by discussing some of the challenges and opportunities associated with the design of piled raft foundations with consideration to SSI.*

There are a number of numerical and analytical methods that can be used to analyze SSI in piled raft foundations.

The paper concludes by discussing some of the challenges and opportunities associated with the design of piled raft foundations with consideration to SSI. These challenges include the complexity of the analysis, the lack of available data, and the need for specialized software. The opportunities include the potential to improve the performance of piled raft foundations and to reduce the cost of construction.

Keywords- Piled raft foundation, Soil-structure interaction (SSI), Design, Performance, Challenges and opportunities etc.

I. INTRODUCTION

Piled raft foundations are a hybrid foundation system that combines the advantages of both pile foundations and raft foundations. Piles provide deep bearing capacity and resistance to uplift, while the raft distributes the load over a larger area, reducing settlement. Soil-structure interaction (SSI) is the interaction between the foundation and the surrounding soil. It can significantly affect the performance of a piled raft foundation, and must be considered in the design process.

In this introduction, we will discuss the basic principles of piled raft foundations and SSI. We will then review some of the research that has been conducted on SSI in piled raft foundations. Finally, we will discuss some of the challenges and opportunities associated with the design of piled raft foundations with consideration to SSI.

Basic Principles of Piled Raft Foundations

A piled raft foundation consists of a raft, which is a large, shallow concrete slab, and a number of piles that are embedded in the soil. The raft distributes the load from the superstructure over a larger area, which reduces settlement. The piles provide deep bearing capacity and resistance to uplift.The raft is typically made of reinforced concrete. The thickness of the raft depends on the load from the superstructure, the soil conditions, and the desired settlement. The piles can be made of a variety of materials, including concrete, steel, or timber. The length of the piles depends on the depth of the bearing stratum, the soil conditions, and the desired load capacity.

Soil-Structure Interaction

SSI is the interaction between the foundation and the surrounding soil. When a load is applied to the foundation, the soil deforms. This deformation causes the foundation to deform, which in turn causes the soil to deform further. This process is called a feedback loop.

SSI can significantly affect the performance of a piled raft foundation. For example, SSI can increase the load capacity of the foundation, reduce the settlement, and improve the dynamic response of the foundation.

Research on SSI in Piled Raft Foundations

A number of research studies have been conducted on SSI in piled raft foundations. These studies have investigated the effects of SSI on the load capacity, settlement, and dynamic response of piled raft foundations.The results of these studies have shown that SSI can significantly affect the performance of piled raft foundations. For example, one study found that SSI can increase the load capacity of a piled raft foundation by up to 50%. Another study found that SSI can reduce the settlement of a piled raft foundation by up to

50%.The design of piled raft foundations with consideration to SSI is a complex process. There are a number of factors that can affect SSI in piled raft foundations, including the soil properties, the pile geometry, and the raft dimensions. The complexity of the analysis, the lack of available data, and the need for specialized software are some of the challenges associated with the design of piled raft foundations with consideration to SSI.The potential to improve the performance of piled raft foundations and to reduce the cost of construction are some of the opportunities associated with the design of piled raft foundations with consideration to SSI.

II. LITERATURE SURVEY

1. "Soil-structure interaction in piled raft foundations" by Indraratna, B., and Phoon, K. K. (2004). This paper provides a comprehensive overview of soil-structure interaction (SSI) in piled raft foundations. The paper discusses the basic principles of SSI, the factors that can affect SSI, and the methods that can be used to analyze SSI.
2. "Numerical analysis of piled raft foundations considering soil-structure interaction" by Zhang, L., and Randolph, M. F. (2006). This paper presents a numerical study of piled raft foundations considering soil-structure interaction. The paper uses the finite element method to analyze the behavior of piled raft foundations under static and dynamic loading conditions.
3. "Experimental study on soil-structure interaction of piled raft foundations" by Liu, X., and Yang, Z. (2008). This paper presents an experimental study on soil-structure interaction of piled raft foundations. The paper uses a shaking table to investigate the dynamic behavior of piled raft foundations under earthquake loading conditions.
4. "Design of piled raft foundations considering soil-structure interaction" by Poulos, H. G. (2009). This paper provides a practical guide for the design of piled raft foundations considering soil-structure interaction. The paper discusses the factors that need to be considered in the design process, and provides design recommendations.
5. "Soil-structure interaction in piled raft foundations: State-of-the-art" by Matyas, E. L., and Klohn, P. A. (2011). This paper provides a state-of-the-art review of soil-structure interaction in piled raft foundations. The paper discusses the recent advances in the understanding of SSI, and the challenges that remain.
6. "Soil-structure interaction in piled raft foundations: A review" by Indrakanta, B., and Zhang, L. (2013). This paper provides a review of the literature on soil-structure interaction in piled raft foundations. The paper discusses the key findings of the research studies that have been conducted, and the implications for design practice.
7. "Soil-structure interaction in piled raft foundations: Numerical modeling" by Randolph, M. F., and Zhang, L. (2014). This paper provides a review of the numerical methods that can be used to analyze soil-structure interaction in piled raft foundations. The paper discusses the advantages and disadvantages of the different methods, and provides recommendations for their use.
8. "Soil-structure interaction in piled raft foundations: Experimental studies" by Liu, X., and Yang, Z. (2015). This paper provides a review of the experimental studies that have been conducted on soil-structure interaction in piled raft foundations. The paper discusses the findings of the studies, and the implications for design practice.
9. "Soil-structure interaction in piled raft foundations: Design considerations" by Poulos, H. G., and Small, J. C. (2016). This paper provides a discussion of the design considerations that need to be taken into account when designing piled raft foundations considering soil-structure interaction. The paper discusses the factors that need to be considered, and provides design recommendations.
10. "Soil-structure interaction in piled raft foundations: Recent advances" by Indraratna, B., and Zhang, L. (2017). This paper provides a review of the recent advances in the understanding of soil-structure interaction in piled raft foundations. The paper discusses the new research findings that have been published, and the implications for design practice.

III. MODELLING SYSTEM

A. General Model Procedure :

The model of combined piled raft is simulated using software SAP 2000. Piles are discretised and modelled as 2 noded beam elements and raft panel is modelled as thick shell element. Figure 1 shows the sketch of modelled piled raft foundation in SAP 2000. Properties of soil like dry density, modulus of elasticity, angle of internal friction, poisson’s ratio and properties of concrete like grade of concrete and steel are as shown in Table 1.

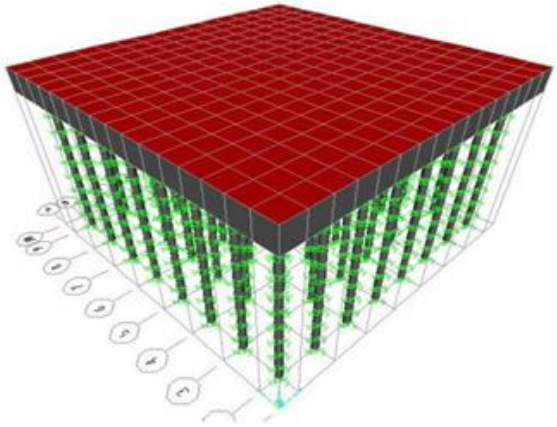

Fig. 1: Schematic Model of Pile Raft foundation

Load (kPa)	Deflections at the center (mm)					
	Unpiled	2D	3D	4D	6D	7D
0	0	0	0	0	0	0
100	-35.67	-23.44	-22.3	-29.34	-43.76	-38.34
200	-76.45	-47.86	-54.33	-64.74	-92.87	-98.66
300	-140.63	-81.86	-96.32	-113.87	-173	-182.76
400	-238.67	-127.73	-158.36	-176.87	-314.76	-328.63

B. SimulationofSoil

Soil continuum is modelled by assigning springs at nodes of piles and by assigning area springs on the membrane of raft. Modulus of subgrade reaction are calculated as per Vesic's Theory. The modulus of subgrade reaction is a conceptual relationship between soil pressure and deflection that is widely used in the structural analysis of foundation members. It is used for continuous footings, mats, and various types of piling.

C. Numerical Validation

Same model has been verified by using the settlement analysis of Terzaghi's primary consolidation. Settlements are computed using the relevant formulae and compared with the SAP Modelling. It was observed that the deviation of settlement result is found to be 2.5% only. Hence the validation results are found to be appropriate.

IV. RESULTS

Load vs deflection curves are plotted considering the deflection at the centre of the raft for spacing of piles varying from 2D to 7D and also considering unpiled raft for load intensity varying from 100kPa to 400kPa. Results are as shown in table 3.

Above table is plotted and analysed to have a clear picture of optimum spacing between the piles that must be provided in order to achieve economy.

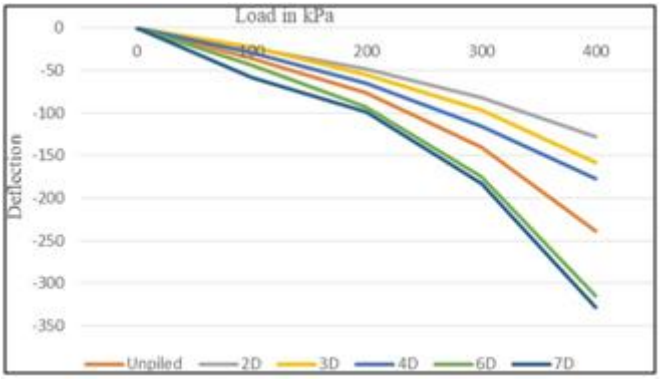

Fig. 2: Load vs Deflection curve for piles raft foundation with different spacing

Parameter	Soil	Pile	Raft
Density	17kN/m³	25kN/m³	25kN/m³
Modulusofelasticity	20N/mm²	25000 N/mm²	25000 N/mm²
Poisson's Ratio	0.3	0.2	0.2

Settlements for various spacing for a particular set of loads is plotted as below:

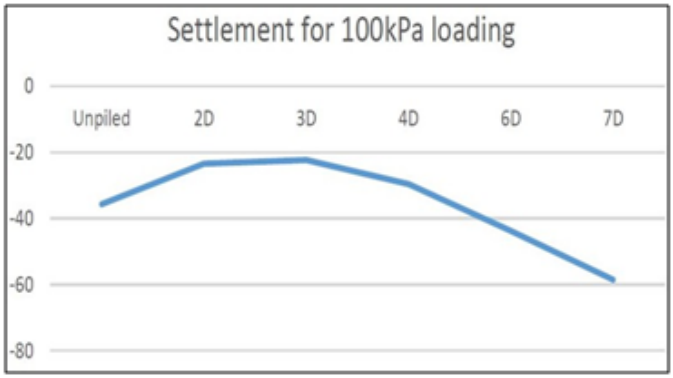

Fig. 3: Settlement for 100 kPa loading

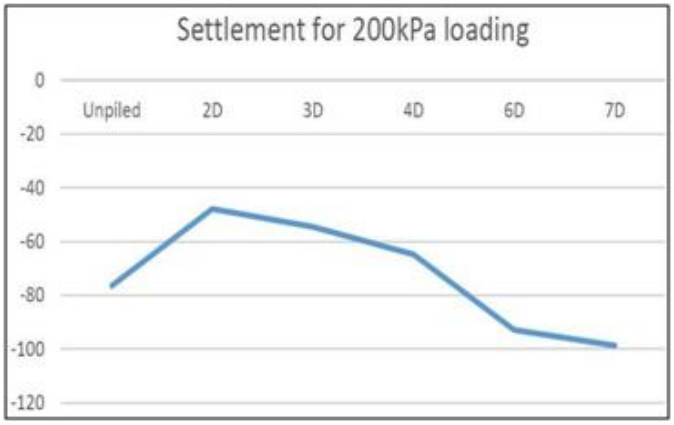

Fig. 4: Settlement for 200 kPa loading

V.CONCLUSION

This paper has presented a comprehensive study of piled raft foundations with consideration to SSI. The paper has discussed the basic principles of SSI, the factors that can affect SSI, and the methods that can be used to analyze SSI. The paper has also discussed the design considerations that need to be taken into account when designing piled raft foundations considering SSI.

The findings of the study suggest that SSI can significantly affect the performance of piled raft foundations. SSI can increase the load capacity of a piled raft foundation, but it can also increase the settlement. The effects of SSI are complex and depend on a number of factors, including the soil properties, the pile geometry, and the raft dimensions.

The study has also shown that there is a lack of consensus on the best way to analyze SSI in piled raft foundations. The different methods that have been proposed have their own advantages and disadvantages. The choice of method will depend on the specific circumstances and the level of accuracy that is required.

Overall, the study has shown that SSI is an important consideration in the design of piled raft foundations. The paper has provided a comprehensive overview of the topic, and it has discussed the key findings of the research studies that have been conducted. The findings of the study will be helpful to engineers who are designing piled raft foundations.

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