IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Conference on Advances in Civil Engineering 2018 (CACE-2018)

Thakur College of Engineering and Technology, Thakur

Vol. 5, Special Issue 3, February 2018

Effect of Increase In Length of Pile On Bearing Capacity of Piled Raft Foundation

Prathmesh Khanvilkar[1], Roshni John[2]

PG Student, Department of Civil Engineering. Saraswati College of Engineering, Kharghar – 410210, India[1]

Head of Civil Engineering Department, Saraswati College of Engineering, Kharghar – 410210, India[2]

Abstract: Piled raft foundation is an economical foundation system where the bearing capacity of the raft is taken into consideration in supporting the loads from superstructure. The piles in a piled raft system are used to enhance the bearing capacity of the raft and also to control settlement, especially differential settlement and hence, these piles are commonly known as ''settlement reducing piles''. In this paper nonlinear finite difference analysis was carried out to model the piled raft problems using the commercial software "CSI SAFE." A comprehensive parametric study was performed on a piled raft. The variation was made in length of piles and diameter of piles over the raft area. The effect of these variables upon the average settlement and differential settlement was studied.

Keywords: Piled raft foundation, silty clay soil, 3D modelling, finite element analysis.

I. INTRODUCTION

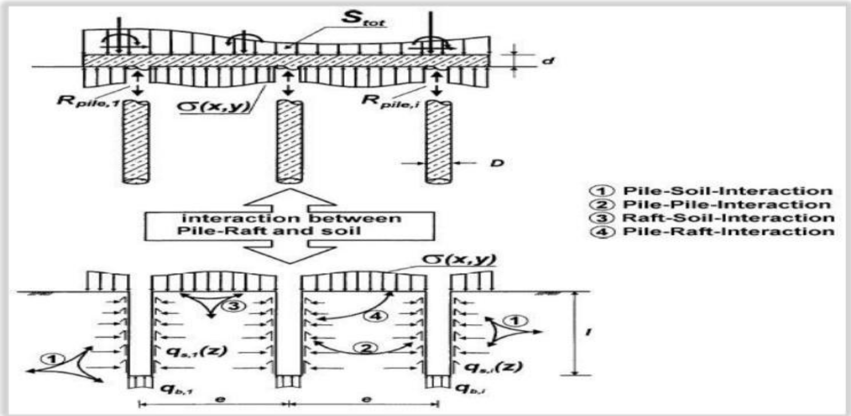
Piled raft foundation is a piled foundation that implements the piles as elements used for enhancing the behaviour of the raft to satisfy the design requirements, and they are not considered as carriers for the total structural load. The design requirements may be related to the settlement control or increasing the ultimate bearing capacity of the foundation. Since the main purpose of the piles in the majority of piled foundations is to limit settlement, then the piles in the piled raft will serve mainly as settlement reducers. The piled raft foundation has a complex behaviour involving different interactions between its various components. Therefore, a proper analytical model is needed to evaluate these interactions. Numerical methods, which are approximate, have been developed widely in the last two decades because numerical methods are less costly and may be used to consider many kinds of different soil and foundation geometries compared to field and model tests. The overall objective of this study focuses on investigating the behaviour of the piled raft foundation system by changing of parameters such as diameter of piles & length of piles. The concluded observations from the parametric study aims at helping the engineers in taking a logical path in an iterative design process for a piled raft foundation.

1. Pile Raft Interaction

Very often, the deep foundation elements are only placed beneath portions of a foundation & are intended to carry only a portion of the superstructure load. Thus this is fundamentally different from foundation application where the piles or shafts are placed beneath the entire foundation & are assumed to carry all loads. An additional unique aspect of the piled raft concept is that the deep foundation elements are sometimes designed to reach their ultimate geotechnical axial compressive capacity under service loads. A piled raft is a foundation which acts as a composite construction consisting of three load bearing elements viz. piles, raft and subsoil. According to its stiffness, the raft distributes the total load of the structure as contact pressure and over the piles in the ground. The piled raft concept needs evaluation of a number of factors in order to come up with analysis & design models that simulate the actual site conditions.

A piled raft foundation is assumed to have four kinds of interactions. These interactions are Pile-Pile, Pile-Raft, Pile-Soil and Raft-Soil (Fig 1). A model for full analysis and design of piled raft foundations has to predict these interactions accurately. The model has to be able to simulate increasing settlement of a single pile under increasing loads, while taking into account the Pile-Soil interaction. Therefore, it is necessary to calculate the ultimate skin friction of the pile as a function of depth, in situ stresses and the strength of soil layers

With increasing raft settlement, the vertical and the horizontal stress states change (Interaction 3). Due to a higher stress state of the soil, the ultimate shear strength of the soil and thus the bearing capacity of the pile increase (Pile-Raft Interaction). When the pile spacing is small, the Pile-Pile interaction additionally has to be taken into account. The requirements of the interactions 1 – 4 can only be satisfied by a three dimensional model of the total structure



II. PROJECT RESOURCES

The work of soil investigation was comprised of five trial boreholes developed using rotary wash boring technique. It is noteworthy that the strength and geotechnical parameters of experiments on which results are based on are presented in the table below.

The values of dry density (DD), uniaxial compressive strength (UCS), specific gravity (SG), water absorption (WA), porosity (PST) of each sample are mentioned below.

Table 1: Rock Classes With Respect To Dry Density &Porosity

Class	DD	Descriptio	PST	Descripti
1.	> 1.80	Very Low	> 30	Very high
2.	1.80 - 2.20	Low	30 - 15	High
3.	2.20 - 2.55	Moderate	15 - 5	Medium
4.	2.55 - 2.75	High	5 - 1	Low
5.	Over 2.75	Very high	< 1	Very Low

Table2: Rock Test Data

Sr. No.	Core No.	UCS (Kg/cm^2)	SG	WA %	PST %	L/D Ratio
1.	30	597.00	2.73	0.04	0.12	1.94
2.	46	636.00	2.75	0.23	0.61	1.87
3.	34	1444.00	2.86	0.03	0.08	1.98
4.	17	1253.00	2.75	0.11	0.30	1.89
5.	21	1356.00	2.75	0.07	0.20	1.85
	(gm/cm^3)	n	(%)		on	

III. PARAMETRIC STUDY

A comprehensive parametric study was performed to study the behaviour of piled raft foundation founded on suitable subsoil conditions and using variable pile configurations and lengths under a raft. The pile configurations involved non uniform concentration below raft. The number of piles ranged from 132 to 360 piles. The pile socketing lengths used in the study were 2D & 4D. Each combination between a pile configuration and a specific pile length was tested. The raft used in the parametric study is square in plan with dimensions of 25 X 25 meters and thickness equals 1.2 meter which is kept constant throughout the study. Two pile configurations were used with number of piles ranging between 132 and 360 circular piles. The pile diameter used was 0.6 m & 0.9 m for all cases in the study. In order to

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Conference on Advances in Civil Engineering 2018 (CACE-2018)
Thakur College of Engineering and Technology, Thakur
Vol. 5, Special Issue 3, February 2018

examine the effect of variation in pile length upon the foundation behaviour, two different pile lengths were used which are 2D & 4D in socketing. Both the raft and the piles are made from reinforced concrete which is modelled as a linear elastic material. In order to get the maximum values of settlement and straining actions, all the analyses throughout the present study were effective drained analyses

3.2 Details of Model

The present study determined the ultimate bearing capacity, a hypothetical raft of thickness 1.2m &
cylindrical concrete piles with a diameter of 0.6m&0.9m and varying socketing length of 2D & 4D under different conditions as a primary base model are considered

Note that the details of piles is considered according to software guidance for concrete type to provide a Poison's ratio equal to 0.15. Young's module is equal to 2.1 X 105 MPa and pile density is equal to 25kN/m3. So according to the above, piled raft foundation modelled in soil has been studied to investigate the effect of length to diameter ratio on the bearing capacity of the piled raft foundation.

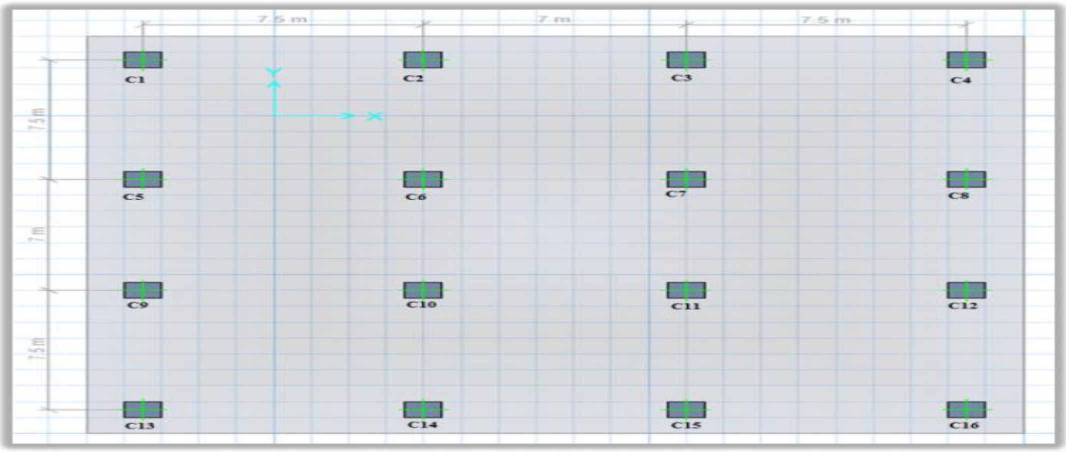


Figure 1: Plan of Raft Foundation & Column Location

IV. RESULTS & SOFTWARE OUTPUTS

The results of this study shows the increment in the amount of ultimate bearing capacity of piles buried in the soil by increasing the length of piles.

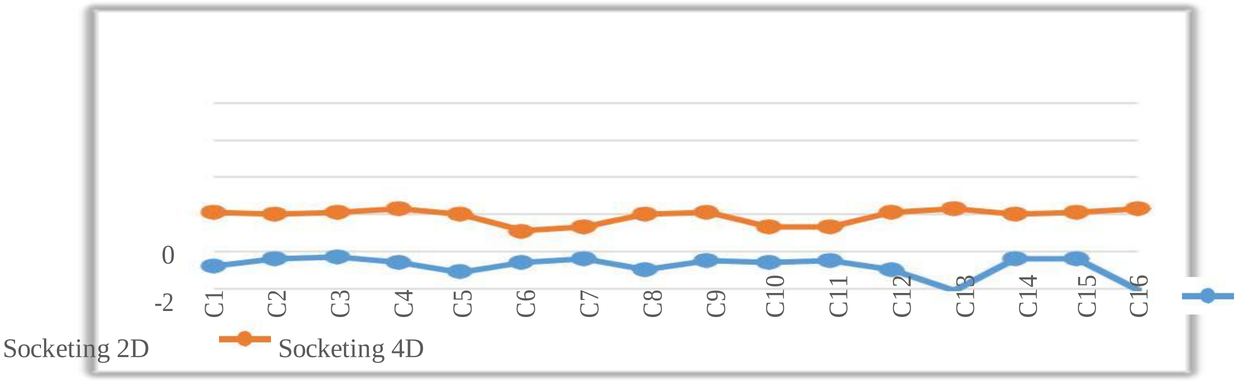


Figure 2:Settlement Curve for raft thickness of 1.2m & diameter of pile 0.6m

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

Conference on Advances in Civil Engineering 2018 (CACE-2018)

Thakur College of Engineering and Technology, Thakur

Vol. 5, Special Issue 3, February 2018

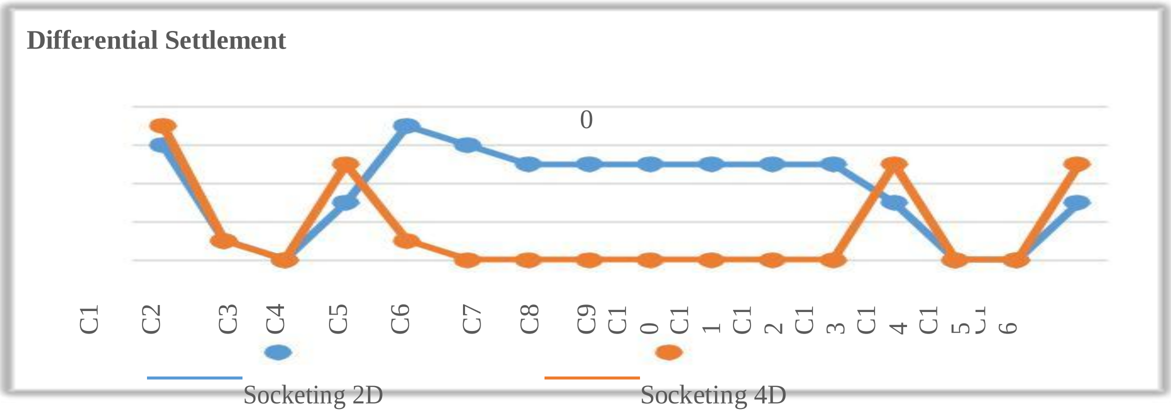
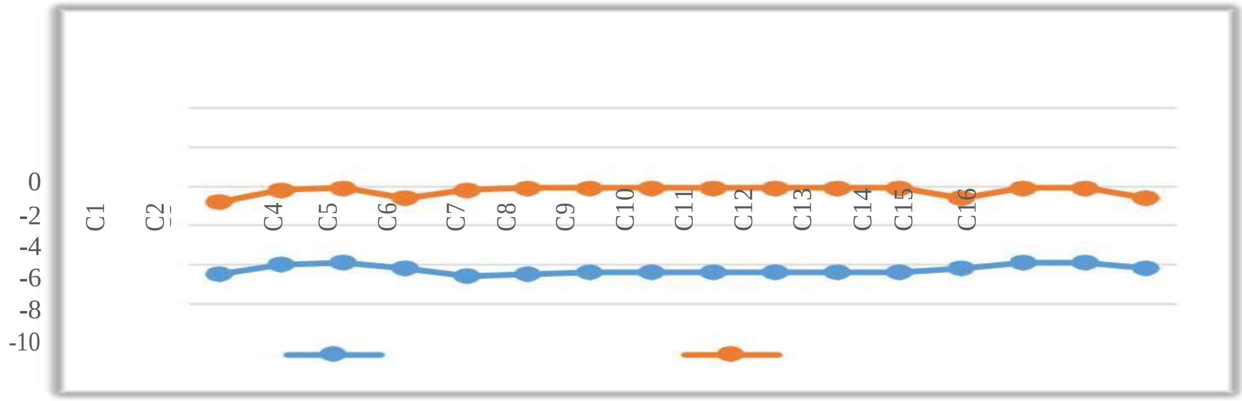


Figure 3: Differential Settlement Curve for raft thickness of 1.2m & diameter of pile 0.6m Settlement



Socketing 2D Socketing 4D

Figure 4: Settlement Curve for raft thickness of 1.2m & diameter of pile 0.9m Differential Settlement

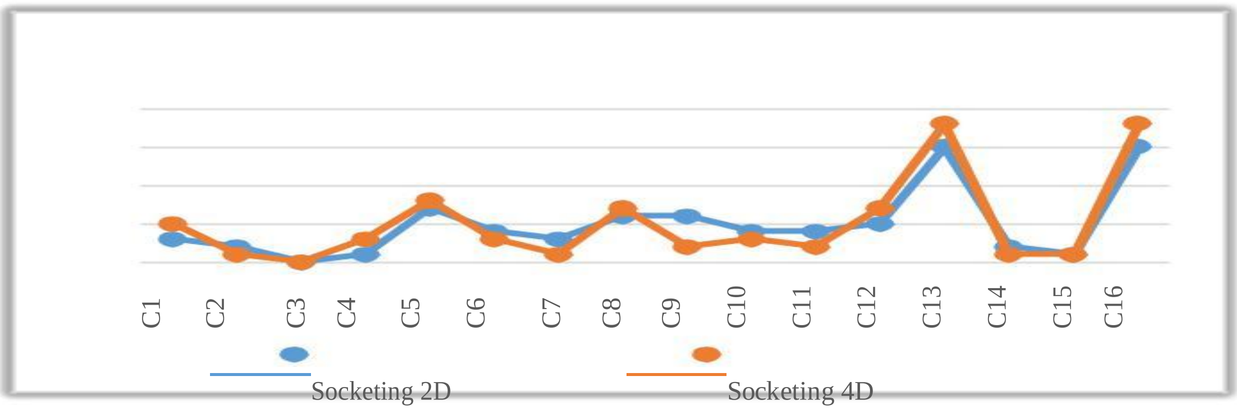


Figure 4: Differential Settlement Curve for raft thickness of 1.2m & diameter of pile 0.9m

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Conference on Advances in Civil Engineering 2018 (CACE-2018)

Thakur College of Engineering and Technology, Thakur

Vol. 5, Special Issue 3, February 2018

V. CONCLUSIONS

- The three dimensional finite difference modelling of piled raft foundation proved to be an efficient tool for analysing real piled raft systems.
- Increasing length of piles has a significant effect on the piled raft average settlement and differential settlement between raftndile.
- The average and differential settlements of the piled raft are dependent on the combination of pile geometries; thus the design of pile raft geometries should be carefully considered to satisfy the both settlement criterion.
- In this study, the results indicated a considerable increase in amount of ultimate bearing capacity of combines piled raft foundation with the increase in length of pile.
- To reduce the maximum settlement of piled raft foundation, optimum performance is likely to be achieved by increasing the length of the piles involved

VI. REFERENCES

1. IS 2950. (Part I) (1981). Code of practice for design and construction of raft foundations (second revision), BIS, New Delhi, India.
2. Cho, J., Lee, J. H., Jeong, S., and Lee, J.
(2012). "The settlement behaviour of piled raft in clay soils." Ocean Eng., 53, 153-16.
3. Chow, H. (2007). Analysis of piled-raft foundations with piles of different lengths and diameters. Ph. D. Thesis, School of Civil Engineering, University of Sydney, Sydney, Australia.
4. Ealami, A., Veiskarami, M., Eslami, M. M.,
(2012). "Study on optimized piled raft foundations performance with connected and non-connected piles-three case histories." International J. of Civil Eng., 10(2), 100-111.
5. Gowri, S. (2011) "Analysis of Mat foundation using finite element method", J. Earth Science and Eng., 04, 113-115.
6. Gupta, S. C. (2008) Raft Foundations – Design and analysis by practical approach. New Age International, New Delhi, India.
7. Kurian, N. P. (2005). Design of foundation systems - Principles and practice. Narosa Publishing house, New Delhi, India.
Noh, E. Y., Huang, M., Surarak, C., Adamec, R. and Balasurbamaniam, A. S. (2008). "Finite element modelling for piled raft foundation in sand." Proc., 11th East Asia-Pacific Conference on Structural Engineering and Construction (11EASEC-2008), Taipei, Taiwan, 1921.
9. Prakoso, W. A. and Kulhawy, F. H. (2001).
"Contribution to the raft foundation design." J. Geotech and Geoenviron. Eng., ASCE, 127(1), 17-24.
10. Rabiei, M. (2009). Parametric study for piled raft foundations. World Wide Web of
Geotechnical Engineers. < http://www.ejge.com/2009/Ppr0906/Abs09 06.htm > (June 30, 2012).