International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Laboratory Study on Piled Raft Foundation

Prof. J.M. Raut, Assistant Professor, YCCE, Dept. Of civil engineering, Nagpur(Mah.)India,
Dr. S.R. Khadeshwar, Professor YCCE, Dept. Of civil engineering, Nagpur (Mah)
Dr. S.P. Bajad Lecturer, Government Polytechnic Murtizapur, Dist. Akola (Mah.) India

ABSTRACT: *Modern geotechnical engineering is continuously being developed to achieve more economical foundation along with safety of the structure. Inventions of new monitoring structures play a important role in design of foundations. New foundation systems mainly Piled Raft needs more generalized and simple design methodology. As Piled raft foundation is combination of two separate foundations, pile and raft. More rigorous theoretical as well as laboratory analysis is required. Important design aspect in piled raft foundation is load sharing ratio between pile foundation and raft foundation. This paper presents model laboratory test on piled raft foundation to investigate load sharing ratio. Special equipment is fabricated to study the same. Structural mild steel bars of 10 mm dia and 1 m long are used as piles. Mild steel plate of 10 mm thick and 300 mm x 300 mm square plate is taken as raft foundation. Soil is deposited in the container with maximum dry density and having optimum moisture content. Load is applied on Plate only and load settlement curve is drawn. Ultimate load bearing capacity is calculated for raft foundation only. On raft foundation (steel Plate) with piles (steel bars) load is applied gradually and Ultimate bearing capacity is calculated. Total load taken by piles is calculated and load sharing ratio of raft and pile is calculated. Experimentation is done for four and sixteen number of piles and results are presented in the paper.*

Keywords: Piled Raft foundation, Pile, Raft, Experimental set up, foundation

INTRODUCTION

A raft foundation enhanced with pile is called as raft –pile. The piled raft is a foundation which acts as a composite structure consisting of three load bearing elements: piles, raft and subsoil. Piled raft foundations are treated as combined foundations on raft and pile groups. It is getting well known as one of the most economical foundations among engineers.

The reason for this may be partly because design code for piled raft foundations has not been established in India. The use of Pile Raft foundation is an effective way of minimizing both total differential settlements, of improving the bearing capacity of a shallow foundation and of reducing in an economic way the internal stress levels and bearing moments within a raft.

The concept of pile raft combines the load-bearing elements of piles, raft and soil in a composite structure.The behavior of pied rafts is determined by complex soil structure interaction effects.There are no definite design strategies or standards available for reliable design and analysis of piled raft foundation.

Piled raft foundations utilize piled support for control of settlements with piles providing most of the stiffness at serviceability loads, and the raft element providing additional capacity at ultimate loading. Consequently, it is generally possible to reduce the required number of piles when the raft provides this additional capacity. In addition, the raft can provide redundancy to the piles, for example, if there are one or more defective or weaker piles, or if some of the piles encounter drastic conditions in the subsoil.

Under such circumstances, the presence of the raft allows some measure of re-distribution of the load from the affected piles to those that are not affected, and thus reduces the potential influence of pile “weakness” on the foundation performance.Another feature of piled rafts, and one that is rarely if ever allowed for, is that the pressure applied from the raft on to the soil can increase the lateral stress between the underlying piles and the soil, and thus can increase the ultimate load capacity of a pile as compared to free-standing piles.

Methodology

In the laboratory model tests were conducted about only footing, piled footing,free-standing pile groups. All these testing are done under equal conditions in order to investigate the behaviours of

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

a piled footing. The main important aspect is to find the load sharing ratio of raft. Thesoil tank was 1.4 m in length, 1.4m in width and 0.7m in height, which was made by steel plate of 3mm thickness toprevent deformation during the tests. The test pile groups consistedof four piles (2x2 pile group) and sixteen piles (4x4 pile group). The model piles used in thetests were miledsteel piles with a diameter of 10mm and the pile lengthwas,100cm. And the thickness of the raft was10mmso that the raft could behave as a rigid foundation. Generally,the contact pressure of the raft, stress and settlement ofthe pile depends on the relative stiffness of thecomponents.The size of the raft is 300 mm x 300mm was used in model tests.

The size and thickness of the raft is kept constant. The length of pile is also kept constant. Two different piles groups are considered for the model testing. First four piles are considered and other sixteen piles are considered. All the soil properties are kept throughout testing. Optimum moisture content of the soil taken for testing is calculated. That moisture content and unit weight of soil kept constant. The soil used in the experimentation was expansive soil locally known as black cotton soil.

The tests were performed on black cotton soil from nearby form around Nagpur region. The Test was carried out to determine various properties of soil and results are tabulated in Table 1.

TABLE 1: SOIL PROPERTIES

Sr.No.	Soil Properties	Results
1	Specific Gravity (G)	2.63
2	Water content natural	9.88%
3	Liquid Limit (W_L)	55.90%
4	Plastic Limit (W_P)	28.5%
5	Optimum Moisture Content (O.M.C.)	20.02%
6	Maximum Dry Density (M.D.D.)	1.63 g/cc
7	Unconfined Compressive Strength (U.C.S.) at OMC	2.69 Kg/cm2

Initially the soil is filled up to 15 cm and compacted to get desired density. Then next 15 cm layer of soil is filled and compacted. In such a way soil is filled up to 0.6m of depth. Only raft is placed over the soil and load is applied over it. Load is applied and settlement was recorded in the dial gauge which was mounted over the plate. Loading and recording of settlement continues till the failure. Again the soil is excavated from the tank and refilled again like previous one keeping all the soil properties same. Four piles are connected to plate with the help of bolts and same loading procedure was repeated. Again instead of four piles sixteen piles were taken and procedure is repeated

Experimental Resultand Discussion

In this study main objective was to calculate load bearing ration of piled raft foundation. Experimentally we cannot determine in piled raft foundation the load taken by piles and load taken by raft separately in combine raft foundation. So we first determined the load taken by raft only up to failure. And then load carried by piled raft foundation up to a failure point. This total load taken by combine piled raft foundation minus load taken by raft gives us the load carried by piles. The experimental results of load taken by raft were presented in table no. 1. The load taken by piled raft foundation with 4-pile group and 16-pile group were presented in table no. 3 and 4 respectively. Also soil properties were presented in the table no. 1 of black cotton soil. The figures of experimental setup are presented in the figure no. 1, 2 and 3. The results are presented in the graph.

As per the observations shown in Table 2, only raft fails at load of 413.29 Kg. And as per the observation from table 3, it can be seen that piled raft of 4-group takes 486.28 load of 73 Kg taken by 4-piles. So the load sharing ratio between raft & pile comes out to be 0.15 or 15%. This means 15% load taken by piles and 85 % load is taken by raft. From table 3 we can observe that 16-pile group piled raft foundation fails at 669 Kg. Mean's additional 255.71 Kg load was taken by piles. Load sharing ratio between pile & Raft comes out to be 0.38 or 38 %. This means 38% load is taken by piles & rest of the load taken by raft.This means if we increase number of piles then load sharing ratio increases. If we increase more piles the numbers of piles then load taken by piles increases. Also comparatively load shared by raft decreases.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

TABLE 2RAFT WITH 16 PILES

Sr.No.	Normal Load Self weight added (kg)	Settlement Recorded (mm)
1	48.81	0
2	91.13	0
3	92.05	0
4	106.93	0
5	125.06	0
6	143.18	0
7	160.39	0
8	162.25	0
9	181.31	0
10	201.3	1
11	220.83	2
12	239.88	3
13	261.74	4
14	284.52	6
15	306.37	7
16	326.82	8
17	346.82	9
18	369.59	10
19	390.98	11
20	413.29	12
21	413.29	13
22	413.29	14
23	413.29	15
24	413.29	16

Fig. 1 Experimentation Model Side View

Fig.2 Proving Ring Attached to the Loading Frame

Fig.3 Sensitive Dial Gauge for Recording Settlement

Table 2RAFT WITH 4 PILES

Sr.No.	Normal Load	Settlement Recorded
1	48.81	0
2	to	0
11	225.9	0
12	241.75	1
13	263.6	2
14	282.66	3
15	301.72	4
16	319.38	5
17	340.77	7
18	367.74	8
19	386.7	9
20	406.32	11
21	426.31	12
22	446.79	13
23	446.79	14
24	486.28	16
25	486.28	17
26	486.28	18
27	486.28	19
28	486.28	20
29	486.28	21
30	486.28	22
31	486.28	23
32	486.28	24
33	486.28	25

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Table 3RAFTS WITH 16 PILES

Weight Added	Normal Load	Settlement Recorded
1	48.81	0
2	to	0
15	307.3	0
16	229.6	1
17	348.21	1
18	374.24	2
19	400.74	3
20	417.95	3
21	433.29	4
22	451.42	4
23	470.94	5
24	490.9	6
25	518.83	7
26	542.07	8
27	561.13	9
28	579.26	10
29	600.19	11
30	614.59	12
31	631.33	13
32	649.47	15
33	668.99	16
34	668.99	17
35	668.99	18
36	668.99	19
37	668.99	20
38	668.99	21
39	668.99	22
40	668.99	23
41	668.99	24
42	668.99	25

Following is graph Load Settlement curvefor the entire three tests.

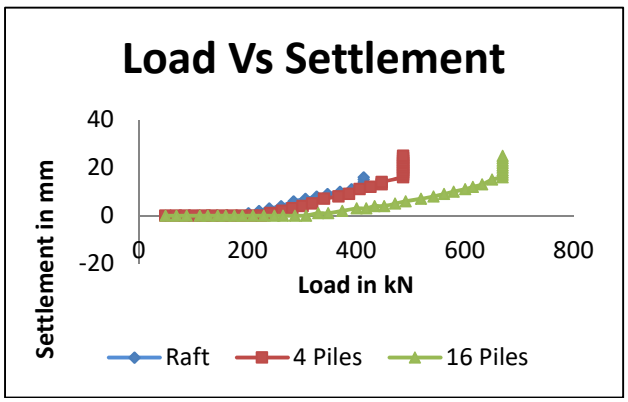

Fig.4 Load settlement curve

It is observed that ultimate bearing capacity of raft is less as compared to the 4-pile group piled Raft foundation. The 16-piled group piled raft foundation has more bearing capacity than others.

CONCLUSIONS

It is observed that load sharing ratio of piled raft foundation depends on stiffness of pile and raft. While designing piled raft foundation depending upon situations we can adjust load sharing of piled & raft, by changing thestiffness (dimension) of the piles as well as raft. If we increase the thickness &dimension of raft we can reduce the number of piles in piled raft foundation.

REFERENCES

1. H.G.Poulos*"Design applications of Raft foundations"*book Published by Thomas Telford Publishing.
2. Dilip Kumar Maharaj (2004*) "The Effect of raft size and pile length on load settlement behaviour of axisymmetric piled raft foundation"*Electronic Journal of Geotechnical Engineering.
3. Dilip Kumar Maharaj (2004)*"Three dimensional nonlinear finite element analysis to study the effect of raft and pile stiffness on the load–settlement behaviour of piled raft foundation"*Electronic Journal of Geotechnical Engineering.
4. A report prepared on Behalf of Technical Committee TC18 on Piled foundations. *"Methods of Analysis of piled Raft foundations"*
5. Harry G. Poulos()*"Piled Rafts In Swelling or Consolidating soils"*Journal of Geotechnical Engineering ,Vol.119,No.2, February © ASCE
6. Y.C.Tan, C.M.Chow& S.S. Gue , Gue& Partners SdnBhd, Kuala Lumpur, Malaysia.*"A Design Approach for Piled Raft with Short Friction Piles for Low Rise Buildings on Very Soft Clay"*
7. Oliver Reul and Mark F. Randolph.*"Design Strategies for Piled Rafts Subjected to Nonuniform Vertical Loading"*Journal of Geotechnical and Geoenvironmental Engineering Vol, 130 No. 1 January 1,2004 ©ASCE
8. Tan,Y.C, Cheah S.W. and Taha M.R.*"Methodology for Design of Piled Raft for Five – Storey's Buildings on Very Soft Clays*
9. `Luca de Sanctis and Gianpiero Russo *"Analysis and Performance of Piled Rafts Designed Using*

Innovative Criteria" Journal of Geotechnical Engineering and Geoenvironmental Engineering, Vol.134, No8, August 1, 2008, © ASCE

10. R.P.Cunha, H.G.Poulos, and J.C. Small(2001)*"Investigation of Design Alternatives for A Piled Raft Case History"*. Journal of Geotechnical Engineering and Geoenvironmental Engineering, Vol.127,No© ASCE
11. Widjojo A. Prakoso student member ASCE and Fred H. Kulhaway Fellow ASCE (2001)*"Contribution to Piled Raft Foundation Design"*Journal of Geotechnical Engineering , and Geoenvironmental Engineering Vol.127,No 1,© ASCE
12. Luca de Sanctis and Alessandro Mandolini (2006)*" Bearing Capacity of Piled Rafts on Soft Clay Soils Vol,132 No. 12 ©ASCE.*
13. Brown, E.T. and Babu, G.L.S. (2009), Strength of a model of jointed soil,*Soils and Foundations*, 96(SM2), 685-704.
14. Indian Standard*"Code of Practice for Design and Construction of Pile Foundation"* Part I- Concrete piles, Section – 2 Bored Cast In Situ Piles - IS: 2911(Part I/sec-2)-1979.