AN EXPERIMENTAL INVESTIGATION ON BEHAVIOUR OF OPEN END PIPES IN SANDY SOIL

Prof .HARISH C[1], VINOD B.R[2], NITHIN YADAV S[3]

[1] *Assistant professor, Department of Civil Engineering, EWIT, Bengaluru, Karnataka, India*

[2] *Assistant professor, Department of Civil Engineering, BMSIT&M , Bengaluru, Karnataka, India*

[3] *M.Tech Student, Department of Civil Engineering, EWIT, Bengaluru, Karnataka, India*

---***---

Abstract - An experimental program in laboratory is conducted on model piled rafts in sand soil. The aim of the experimental program is to study the behavior of piled raft foundation system subjected to vertical load. The experimental program includes the model test on un piled raft, raft supported by single pile, two, three, four and five pile and pile groups. The model piles used in this test are hollow steel rods of diameter 26 mm and the varying length of 280 mm, 210 mm and 140 mm. The raft was made of mild steel plate with plan dimensions of 190mm x 190mm with different thicknesses of 10mm ,15mm and 20mm.

The load carrying capacity may depend with the area and thickness of raft. The steel piles which are placed below the raft to support will help in reducing the differential and overall settlement with increase in number of pile and length of the pile. The refinement in the bearing capacity is represented by load improvement ratio and the reduction in settlement is represented by settlement reduction ratio. The influence of number of piles and raft thickness on load improvement ratio and settlement reduction ratio are presented and discussed.

***Key Words*: diameter, raft pile L/d ratio 40%, 60%&80%.**

1.0 INTRODUCTION

Pile foundations are a kind of deep foundations which are usually long slender members of small diameter transferring the load of the superstructure to a suitable bearing stratum. The pile foundations are useful when the soil layers are weak to lay the shallow foundation and the suitable hard bearing stratum is found at greater depths.

1.1 **Uses of piles**

1) These help to achieve the required compressive strength in soft soils.

2) To build the foundation in river bed and within the scour depth.

3) The tension force in tall towers is resisted by piles and prevents their overturning due to winds.

4) Pile foundations are economical for the structures supporting vibrating machines such as turbines etc. to transmit their vibrations deep into the strata.

5) To compact the loose soil, the compaction piles are used to increase the bearing the capacity.

2.0 PROPERTIES OF SAND

The soil material taken for the experiment is sandy soil. The properties of sandy soil are as listed

Table -1 Properties of sand

Sl no.	Property	Value
1)	Specific Gravity	2.64
2)	D_{10} (mm)	0.28
3)	D_{30} (mm)	0.45
4)	D_{60} (mm)	0.8
5)	Coefficient of curvature "C_C"	0.9
6)	Coefficient of uniformity " C_u"	2.86
7)	Maximum void ratio "e_{max}"	0.512
8)	Minimum void ratio, "e_{min}"	0.355
9)	Maximum dry density, "γ_{max}"(kN/m^3)	19.1
10)	Minimum dry density, "γ_{min}"(kN/m^3)	17.2
11)	Angle of internal friction (Φ)	37^0
12)	Relative density attained by compaction	66%
13)	Density achieved by compaction (kN/m^3)	18.52

2.1 EXPERIMENTAL PROCEDURE

Step 1: About 40 kg of loose sand is collected which is passing through IS 4.75mm sieve is filled in the square test tank.

Step 2: A square test tank of size of 350mm×350mm×350mm is used for the model test, sides of the square test tank was made smooth by coating bitumen gel to reduce the boundary effects.

Step 3: The sand is filled in the three layers and compacted to obtain the density 18.52 kN/m^3, the piles whose length equal to 280 mm (80% of the tank height) is installed at the centre of the tank during the process of filling and compaction.

Step 4: The model raft is placed in the tank at the centre, on the surface of the inserted steel piles to avoid eccentric loading.

Step 5: The tank is placed on the universal testing machine to apply the load, which consist of movable platform that can move up and down in the different rates by a motorized mechanism and it facilitates to measure the load and settlement.

Step 6: The capacity of loading frame chosen should exceed the maximum load that has been applied throughout the experiment.

Step 7: A square model raft of size 190mm×190mm and 20mm thick made of mild steel is placed centrally on the surface of the steel pile.

Step 9: To measure the settlement dial gauge is fixed on the loading platform.

Step 10: The load applied on the raft by universal testing machine was taken analogue display and settlement of the raft and pile was measured by dial gauge. The load is applied to the raft at constant rate.

Step 11: After testing for the single pile, whose length equal to 280 mm (80% of the tank height). Test is carried out for two, three, four and five number of piles, installed at the spacing of 100mm.

Step 12: The above procedure is repeated for varying raft thickness of 15mm, 10mm and for the pile length of 210 mm (60% length of the tank) and 140 mm (40% length of the tank).

Fig 1.0 Experimental setup with a square tank and dial gauge

2.2 RESULTS AND DISCUSSION

2.2.1 COMPARISON OF LOAD-SETTLEMENT GRAPH FOR 20 MM THICK UN-PILED RAFT AND PILED RAFT

The sand is filled in the test tank in three layers and it is properly compacted to achieve the required density of 18.52.kN/m^3, to maintain the relative density of 66%. The 190×190×20mm raft was placed over the surface of the sand and load was applied till the total settlement reaches 25 mm.

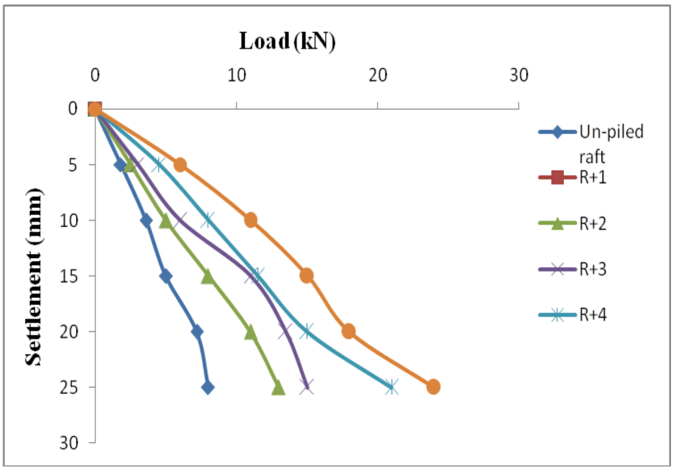

Fig 1.1 Comparison of load -settlement plot for 20 mm thick un-piled raft and piled raft system.

2.2.2 COMPARISON OF LOAD-SETTLEMENT GRAPH FOR 15 mm THICK UN-PILED RAFT AND PILED RAFT

The number of pile increases the load carried by the pile-raft system also increases and increase in load carrying capacity of pile is mainly due to the increase of proportion of load shared by the piles due to the increase of the number of piles.

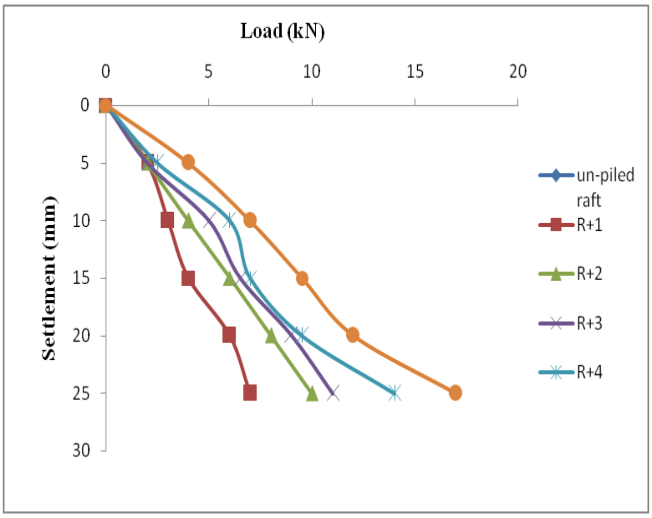

Fig 1.2 Comparison of load -settlement plot for 20 mm thick un-piled raft and piled raft system

2.2. COMPARISON OF LOAD-SETTLEMENT GRAPH FOR 10 mm THICK UN-PILED RAFT AND PILED RAFT

The number of pile increases the load carried by the pile-raft system also increases and increase in load carrying capacity of pile is mainly due to the increase of proportion of load shared by the piles due to the increase of the number of piles.

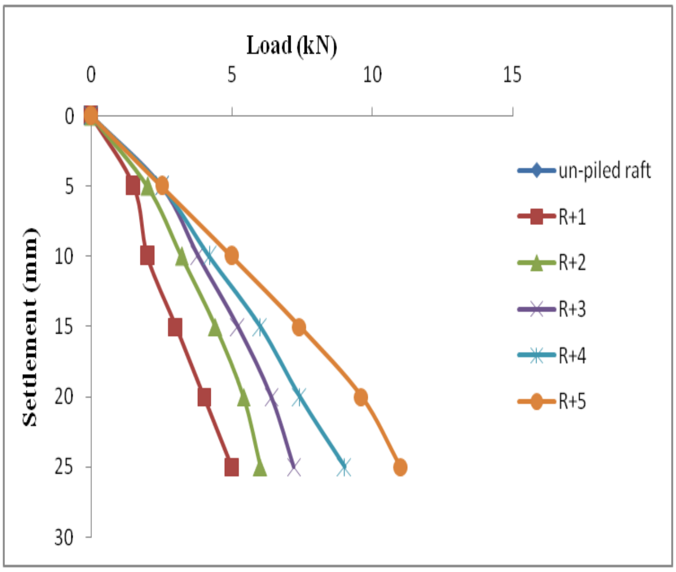

Fig 1. 3 Comparison of load -settlement plot for 10 mm thick un-piled raft and piled raft system.

2.3 COMPARISON OF LOAD CARRIED BY THE DIFFERENT THICKNESS OF UN-PILED RAFT

.

The load-settlement curves for the unpiled raft system of different raft thicknesses. It is observed that the load carrying capacity of the unpiled raft increase with the increase in raft thickness. Therefore thickness of the raft has the influence on the load carried by the piles.

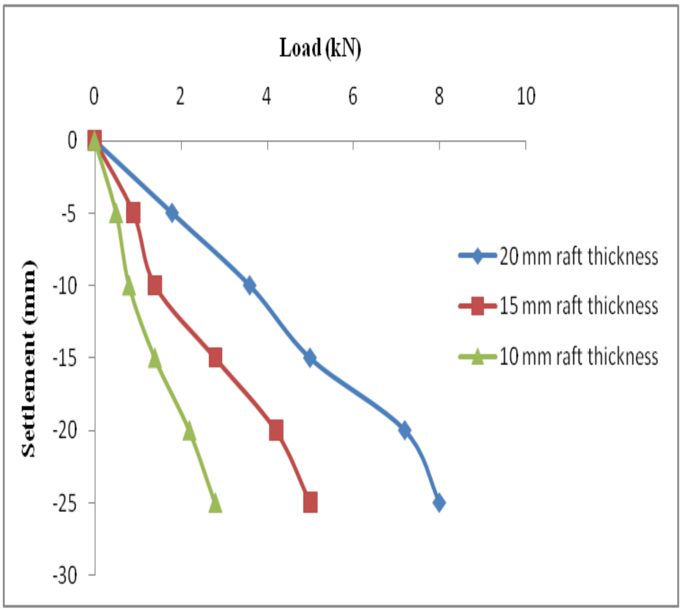

Fig 1.4 Load-settlement curves for different thickness of un-piled rafts

2.4 INFLUENCE OF NUMBER OF PILES BENEATH THE RAFT ON LOAD IMPROVEMENT RATIO

The load improvement ratio v/s number of piles at 25 mm and 15 mm settlement respectively. Load improvement ratio is defined as the ratio of the load carried by the piled raft to load carried by unpiled raft at a given settlement. For the present thesis work load improvement ratio is calculated for 25 mm and 15 mm settlement. From the fig, it can be observe that for the given raft thickness the value of load improvement ratio increases as the number of piles beneath the raft increases.

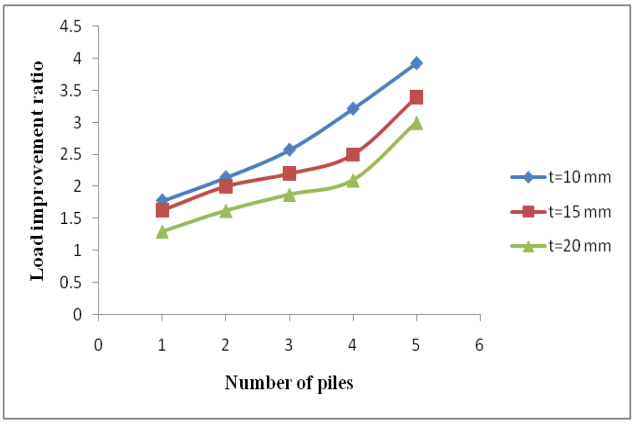

Fig 1.5 Load improvement ratio with number of piles at 25 mm settlement

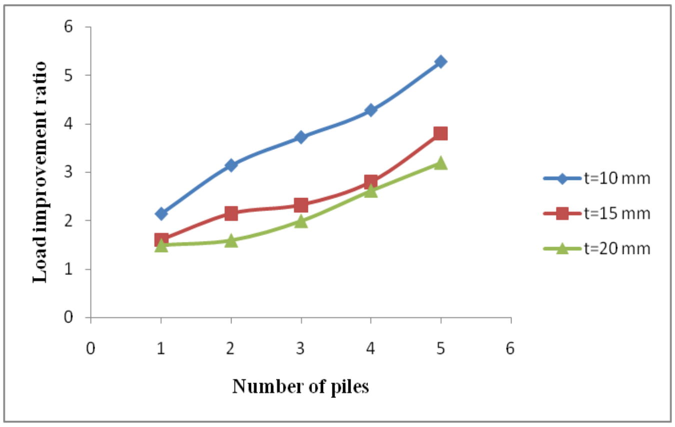

Fig 1.6 Load improvement ratio with number of piles at 15 mm settlement

3.0 Comparison of load improvement ratio at 25 mm settlement and 15 mm settlement with respect to the raft thickness

The load improvement ratio for the raft thickness of 10 mm, 15 mm and 20 mm at 15 mm and 25 mm settlement respectively. From the graphs it is clear that load improvement ratio at 15 mm settlement is greater than the load improvement ratio at 25 mm settlement. The similar observation had been recorded by Phung (2010) and Jaymin D Patilet. al.,(2014)from their test results

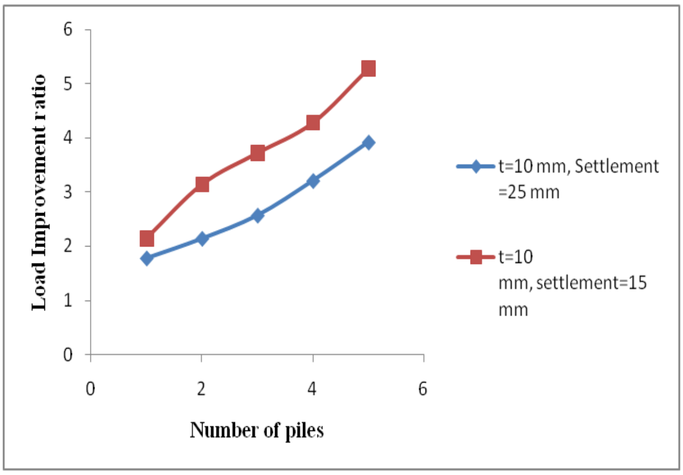

Fig 1.7 Variation of Load improvement ratio for 10mm raft thickness at 15 mm settlement and 25 mm settlement.

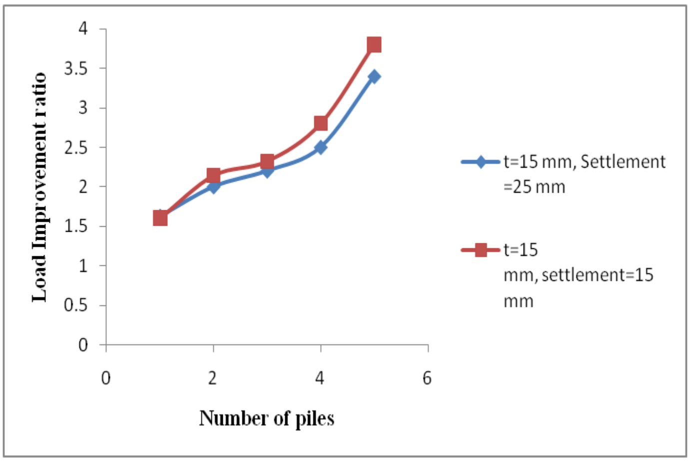

Fig 1.8 Variation of Load improvement ratio for 15 mm raft thickness at 15 mm settlement and 25 mm settlement

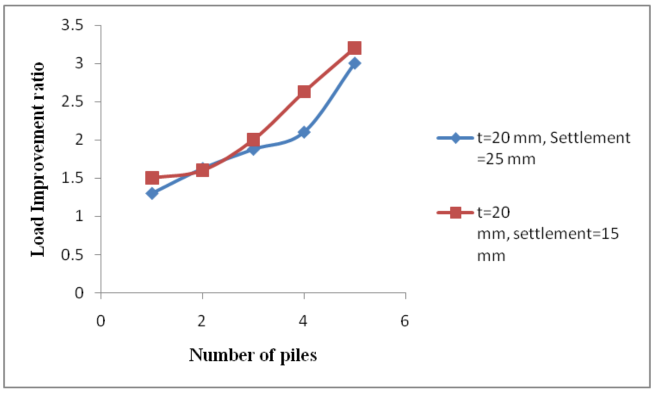

Fig 1.9 Variation of Load improvement ratio for 20 mm raft thickness at 15 mm settlement and 25 mm settlement

3.1 Influence of number of piles beneath the raft on settlement reduction ratio

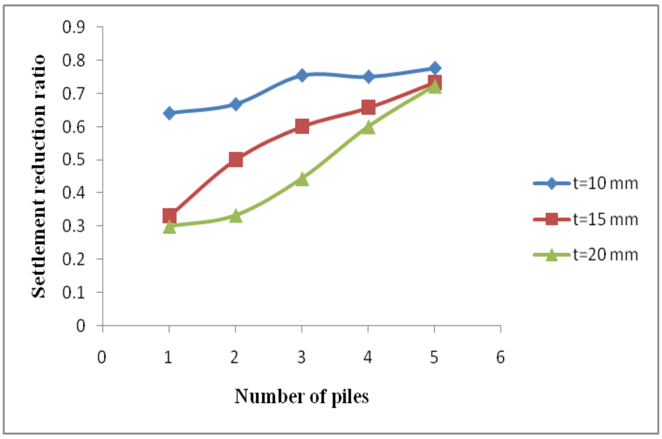

Fig 2.0 Settlement reduction ratio with number of piles

4.0 CONCLUSIONS

1. The load carrying capacity of piled raft system increased with increase in number of piles.
2. The load carrying capacity of un-piled raft increased with increase in raft thickness.
3. The value of load improvement ratio increased as the number of piles beneath the raft increased.
4. The value of load improvement ratio for 15mm settlement of piles proved to be greater than the load improvement ratio for 25mm settlement.
5. Load improvement ratio decreased with increase in raft thickness.
6. As the number of piles underneath the raft increased it exhibited an increase in settlement reduction ratio.
7. The load settlement behaviour for 20 mm piles raft thickness directly resting on sand surface is 7.6 KN for the 25mm settlement
8. The load carried for the 20mm piles raft thickness is more than the load carried by the 80% length single pile to five pile load will be improvement upto the 25mm settlement
9. The load settlement behaviour for 15 mm piles raft thickness directly resting on sand surface is 5.0 KN for the 25mm settlement
10. The load carried for the 15mm piles raft thickness is more than the load carried by the 60% length single pile to five pile load will be improvement upto the 25mm settlement
11. The load settlement behaviour for 10 mm piles raft thickness directly resting on sand surface is 2.6 KN for the 25mm settlement
12. The load carried for the 10mm piles raft thickness is more than the load carried by the 40% length single pile to five pile load will be improvement upto the 25mm settlement
13. Influence of number of piles beneath the raft on load improvement ratio of different piles raft thickness 20mm,15mm&10mm. It is observed that the load carrying capacity of the unpiled raft increase with the increase in raft thickness
14. The Settlement reduction ratio with number of piles underneath the different raft thickness 20mm,15mm&10mm. increases, there is an increase in settlement reduction ratio.

REFERENCES

[1] **Balakumar V and IllamparuthiK(2010)**, Piled raft behavior basede on 1-g model studies, Indian Geotechnical Conference 2010, IGS Mumbai chapter & IIT Bombay.

[2] **Fioravante, V.Giretti, Jamiolkowski M (2010),** Contact versus non-contact piled raft foundation, Canadian Geotechnical Journal, Vol 47.

[3]**Jaymin D. Patil, Sandeep A Vasanwala et al (2014),** An experimental investigation on behavior of piled raft foundation, International Journal of Geomatics and Geosciences, Volume 5,No 2.

[4] **JayminD.Patil, Prof. S. A. Vasanvala et al (2013),** A study on piled raft foundation: State of Art, International Journal of Engineering Research and Technology, Vol 2, Issue 8.

[5] **Lee S-H, and Chung C-K (2005)**, An experimental study of the interaction of the vertically loaded pile groups in sand, Canadian Geotechnical Journal, Vol 42.

[6] **Matsumoto T, Nemato H, et al (2010**), Load test of piled raft models with different pile head connection conditions and their analysis, Soils and foundations, Japanese Society of soil mechanics and foundation engineering, Vol 50.

[7] **V.A Barshov and G.G Boldyrev (2009),** Experimental and theoretical research on analytical models of piled raft foundations, Soil Mechanics and Foundation engineering, Vol 46, No 6.

[8] **Textbook of Analysis and Design of Substructures** – Swami Saran

[9] **Textbook of soil mechanics and foundation engineering** – V.N.S. Murthy