Analysis of Piled Raft Foundation using ANSYS

Rashmi R. Gadpande
Assistant Professor
Department of Civil Engineering
Karmavir Dadasaheb Kannamwar College of Engineering, Nandanvan, Nagpur, India

Abstract

In recent years, there have been an increasing number of structures using piled rafts as the foundation to reduce the overall settlement. For cases, where piled raft is subjected to a uniform loading, the use of identical piles can improve the performance of foundation. Extensive research has been performed in the past to examine the behaviour of piled raft. In this paper, the behaviour of piled raft supported by identical piles is examined by using computer program ANSYS based on Finite Element Method. Full interaction between raft, piles and soil which is of major importance in the behaviour of piled raft is considered in the analysis. The interaction between identical piles subjected to vertical uniform loading is examined. Program ANSYS can be used for the analysis of piled raft subjected to vertical loadings in which the base of raft is treated being rough and slip along pile-soil interface is allowed in analysis. By having a rough raft base, there is significant effect on vertical movement of raft base, there is significant effect on vertical movement of raft due to lateral resistance of also soils and piles.
Keywords: Piles, Raft, Analysis

I. INTRODUCTION

Foundation is the most important structure of the building. Clay deposits of large thickness commonly occurring along coastal belts in many places like Cochin, Vizag, Kandala, etc. Due to high rise in land cost in urban areas, normal tendency is to utilise all land area available for building. Therefore, considerable stress can be transferred to foundations of adjacent structures which may be old or weak. In such situations, a piled raft can be provided where part of total load is taken by raft through contact with soil and remaining load by pile through skin friction. Piles in this case have to penetrate the full depth of clay layer but it can be terminated at higher elevations.

Thus, piled raft is economical compared to first alternative though it may result in settlement more than pile foundation but less than raft foundation. Such piled raft foundations have been used successfully.

Piled raft foundation is a foundation in which the total load coming from the super structure is transferred to the soil by a load sharing mechanism between raft and pile. Piled raft foundation is provided in the circumstances where the raft alone does not satisfy the design requirements.

II. MODELLING & ANALYSIS OF PILED RAFT FOUNDATION

Simplified 3D finite element analysis ANSYS 11 software is used to model the piled raft system in this study. The raft, pile and soil in the piled raft have been defined by solid 45 (brick 8 node) elements. The element types, used for this model are available in table number 1.As it can been seen, element brick 8 node 45 has been used for pile, raft and soil, element contact-3D surface to surface Conta 174 has been used for contact and element Target 170 has been used for target in the model. By using these elements, all characteristics of model can define. Considered soil depth in analysis is 16m. The soil has been modeled as Drucker-Prager elasto-plastic material.

Table – 1
Models

Model	*Element Type*
Pile	*Brick-8 node-Solid 45*
Raft	*Brick-8 node-Solid 45*
Soil	*Brick-8 node-Solid 45*
Contact	*Contact-3D-surface to surface-Conta 174*
Target	*Target 170*

Elements used in modelling:

- SOLID45 (8-noded brick element)
- TARGE170
- CONTA174

The below problem is taken from paper named as, Singh N.T. and Singh B. (2008).

All rights reserved by *www.ijirst.org*

A. "Interaction Analysis for Piled Rafts in Cohesive Soils"

1) Description of problem

The analysis is illustrated through an example of a raft of 16m x 16m in plan with 16 square piles of 0.4m x 0.4m cross sectional area and 12m length. Only the raft part of the foundation is analysed first and then piles are added to form a piled raft. Since the structure is symmetrical, one fourth of the plan area of the foundation is taken for modelling. The plan area of soil model is taken as double of the dimensions of the raft area. The depth of soil is taken as twice the raft width. For piled raft, the depth of soil considered is two-thirds of pile length plus one half times the raft width.

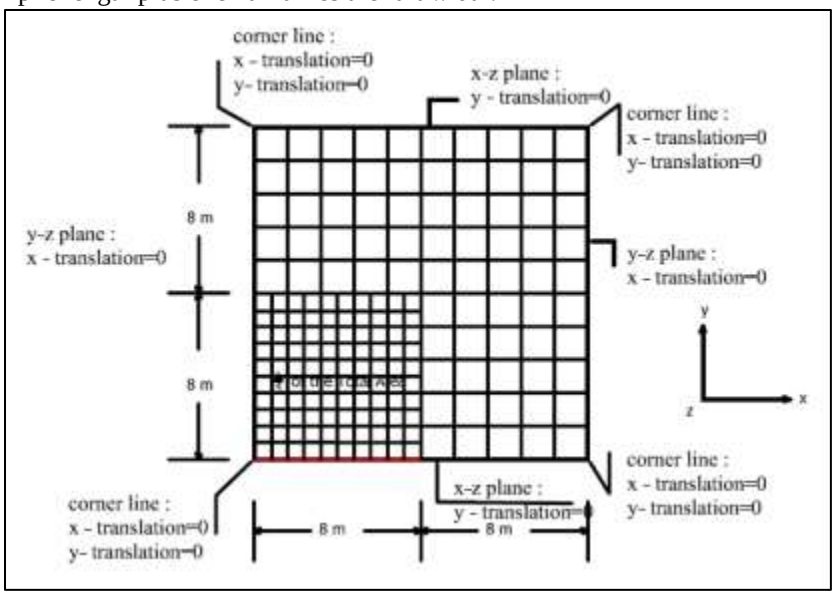

Fig. 1: Discretization for raft

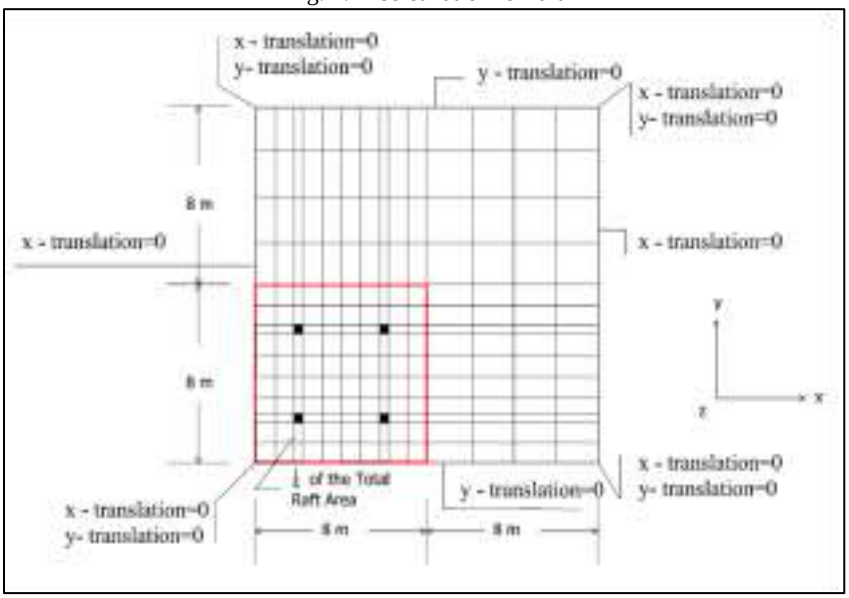

Fig. 2: Discretization for piled raft

Table – 2
Material properties and parameters

Soil modulus, E_s (kN/m²)	*50000*
Poisson's ratio of soil, μ_s	*0.45*
Soil Cohesion, c (kN/m²)	*50*
Soil angle of friction, ϕ (degree)	*0*
Soil dilatancy angle ,φ (degree)	*0*
Raft Modulus, E_r (kN/m²)	*$20x10^6$*
Poisson's ratio of raft, μ_r	*0.3*
Raft thickness, t_r (m)	*1*

All rights reserved by *www.ijirst.org*

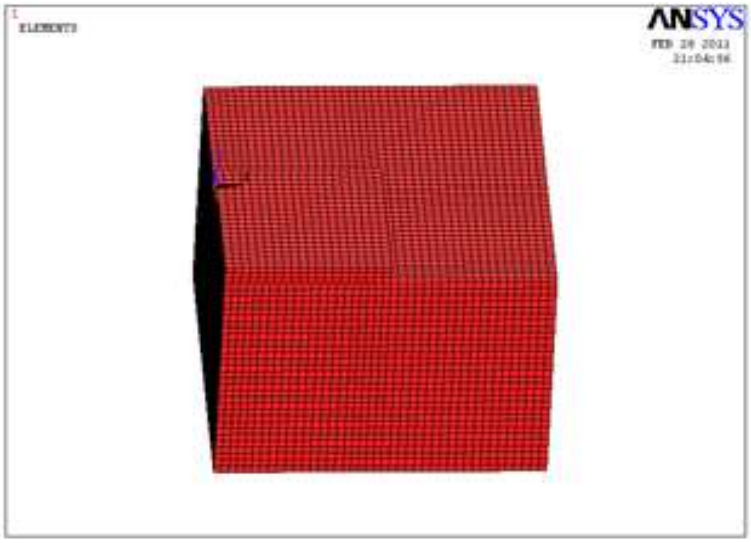

Fig. 3: Meshed model of raft in ANSYS

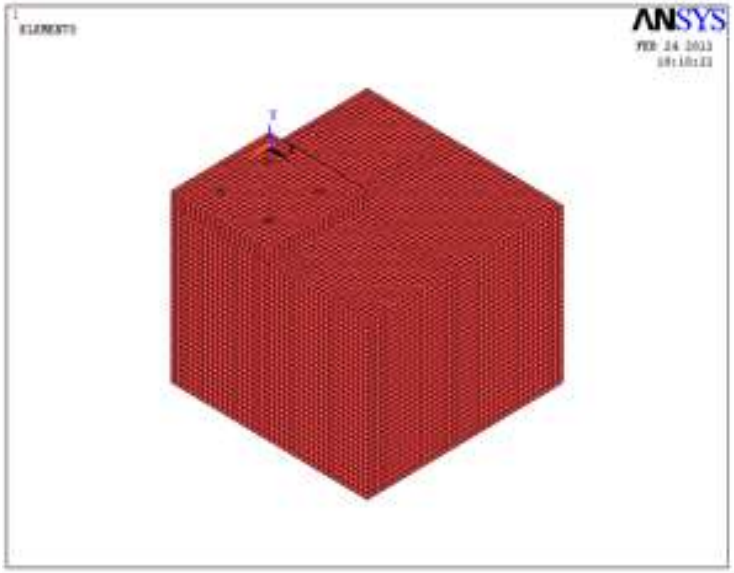

Fig. 4: Meshed model of piled raft in ANSYS

III. RESULTS

Table - 3
Settlement values for raft and piled raft

Load (kN/m^2)	*Raft Settlement (mm)*	*Piled Raft Settlement (mm)*
100	*54.324*	*38.715*
200	*126.635*	*81.753*
300	*187.72*	*122.249*
400	*265.432*	*163.772*
500	*291.223*	*205.337*
600	*325.52*	*245.537*
700	*887.938*	*284.99*
800		*334.343*

All rights reserved by *www.ijirst.org*

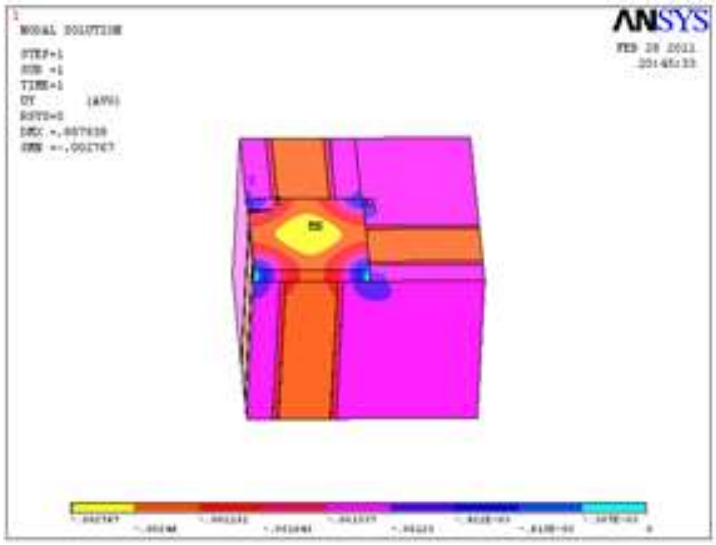

Fig. 5: Settlement of raft foundation

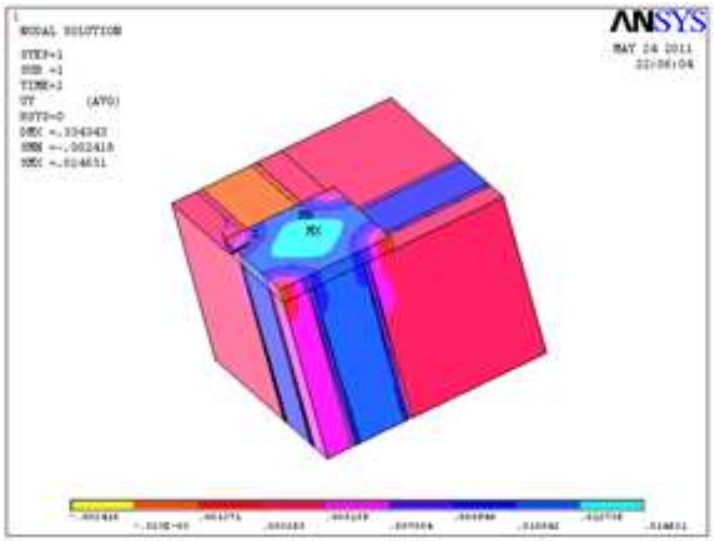

Fig. 6: Settlement of piled raft foundation

IV. CONCLUSIONS FROM ANALYSIS

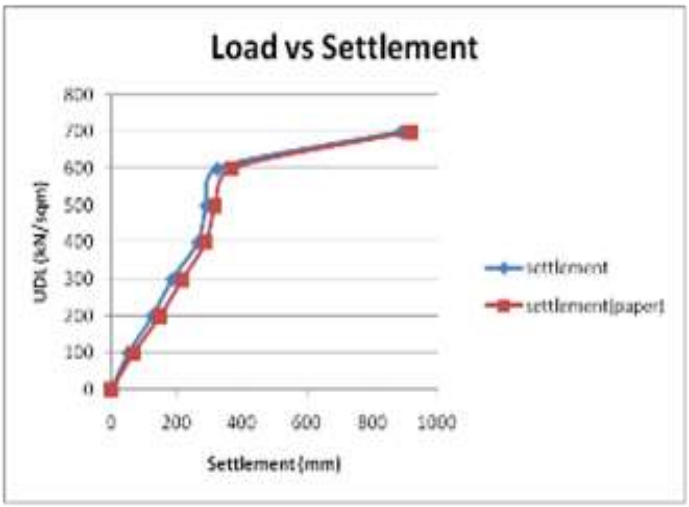

Fig. 7: Load – Settlement Behaviour for raft foundation

All rights reserved by *www.ijirst.org*

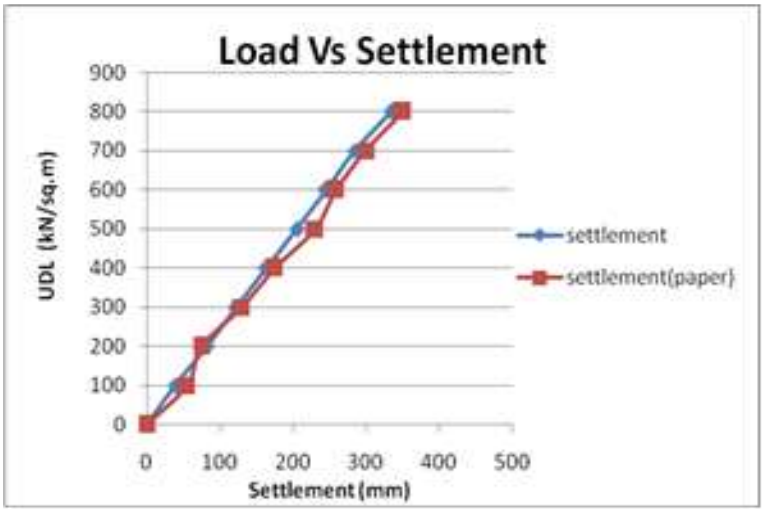

Fig. 8: Load – Settlement Behaviour for piled raft foundation

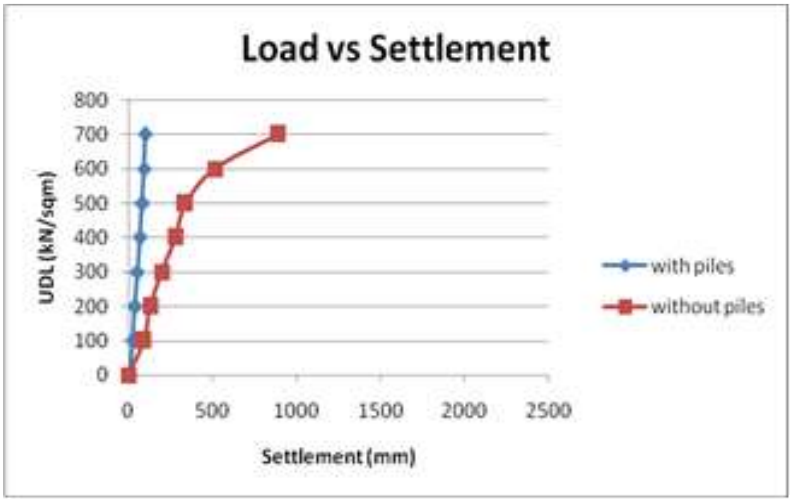

Fig. 9: Load- Settlement Behaviour with and without piles

V. CONCLUSIONS

- It is observed that by introducing piles in raft, settlement of foundation can be reduced.
- It is observed that raft foundation supported by soil only, settles more as compared to raft foundation with piles supported by soil.
- From analysis of piled raft foundation for cohesive soil, settlement can be reduced by 60% by introducing piles in the raft.
- Piled raft foundation gives less settlement in clayey soil as compared to raft foundation.

REFERENCES

[1] Davis EH, Poulos HG (1972), "The analysis of piled raft systems". Australia Geotechnique Journal 2 21–7.
[2] Gandhi, S.K. and Maharaj, D.K. (1996), "Analysis of Piled Raft Foundation." Proceedings of Sixth International Conference and Exhibition on Piling and Deep Foundations, Mumbai, India, January 15-17.
[3] Gandhi S. R. Maharaj D.K. (1995) , "Behaviour of piled raft under uniform loading." Proceedings of Indian Geotechnical Conference, Bangalore, Dec-1995, Vol.1.
[4] IS: 2911(Part 1/Sec 1)-1979 "Code of Practice for Design and Construction of Pile Foundations, Part 1, Concrete piles." Beaureu of Indian Standard, New Delhi.
[5] IS: 2950(Part 1)-1981 "Code of Practice for Design and Construction of Raft Foundations, Part 1 , Design." Beaureu of Indian Standard, New Delhi.
[6] Kurian N. P., "Design of Foundation systems." Tata Mc. Graw Hill Publications, second edition, New Delhi, 1991.
[7] Singh, B., Singh, N.T., (2008). "Interaction Analysis for Piled Raft in Cohesive Soils." 12th International Conference of International Association for Computer Methods and Advances in Geomechanics(IACMAG). 1-6 October, 2008. Goa, India.
[8] Small, J. C. & Booker, J. R. 1986. Finite layer analysis of layered elastic materials using a flexibility approach. Part 2-circular and rectangular loadings. International Journal for Numerical Methods in Engineering 23: 959-978.

All rights reserved by *www.ijirst.org*