Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 11, November -2017

A REVIEW ON PILED RAFT FOUNDATION FOR HIGH-RISE BUILDING

Anand .N. Naik[1], Payal Patel[2], Gunvant Solanki[3]

[1]*Civil Department, Chhotubhai Gopalbhai Patel Institute of Technology, UTU,*
[2]*Asst. Prof .Civil engineering Department, Chhotubhai Gopalbhai Patel Insttitue of Technology, UTU,*
[3]*Prof.Civil engineering Department, Chhotubhai Gopalbhai Patel Insttitue of Technology, UTU*

Abstract--- *The Piled raft foundation has gained popularity in the field of construction. Construction of raft at shallow depth on soil having low bearing capacity to get uniform settlement is very well known. In the situations where the raft foundation alone does not satisfy the design requirements, and then it may be possible to enhance the performance of the raft by addition of piles. The use of a strategically located limited number of piles, may improve both the ultimate load capacity and settlement performance of raft. The analysis of Piled raft is a complex problem, even more complex than that of a soil supported raft, as too many parameters influence the behavior of the system. There are various parameters which influence the sharing of load between piles and raft, between piles themselves and between piles and soil and as such the exact behavior is unpredictable for Piled raft system.*

Keywords- *Pile, raft, piled-raft, settlement, deflection*

I. INTRODUCTION

The foundations are classified mainly as shallow foundation and deep foundation. In shallow foundation load is transferred to the shallow strata through the foundation element i.e. footing or mat, while in case of deep foundation load is transferred to the deep strata by element like pile or pier. The stability of the foundation mainly depends on the type of strata/soil on which it is resting. According to this, the foundation type is decided. One has to go for a suitable option among these two types. It is common in foundation design to consider first the use of individual footing or raft foundation to support a structure when good soil strata is available at small depth near ground surface, and if this is not adequate one has to go for pile foundation. Under some circumstances like multi storey construction with basement in poor soil and high water table condition, the combination of both raft and pile is significant. In that situation, the piles are necessary to transmit the superstructure loads to a deeper strata and raft is required to transmit the superstructure load evenly on the piles and also to resists buoyancy forces of ground water. Piles are also significant to reduce settlement of raft. Such foundation is called as Piled raft foundation.

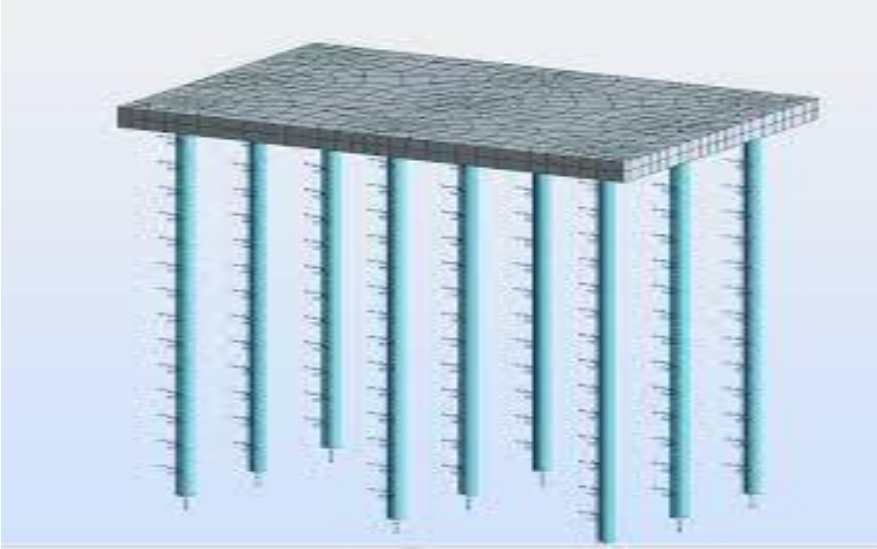

FIG 1- TYPICAL PILED RAFT MODEL

In situations where a raft foundation alone does not satisfy the design requirements, it may be possible to enhance the performance of the raft by the addition of pile. The piles must be located by an engineering judgment. Strategically located pile may improve both the ultimate load capacity and the settlement performance of raft. The Piled raft foundation is stiffer than that individual raft or pile foundation. Piled raft foundation transmits structural loads to the soil by way of both pile-soil contact stresses and raft – soil contact stresses. In such foundation design, contribution of raft in bearing the load is generally ignored. This results in conservative estimate of foundation performance and therefore it is an over design of foundation. With proper analysis technique one can calculate load sharing interaction among raft, pile

and soil. A Piled raft design considering interaction between pile, raft and soil be an economical design than pile group design with pile cap not taking any load.

II. LITERATURE REVIEW

A. PILED RAFT FOUNDATIONS: DESIGN AND APPLICATIONS,

H.G. Poulos in this paper describes the philosophy of pile enhanced rafts, and outlines that are favorable for such foundation. Methods of analysis are described and compared and some of the key characteristics of piled raft behavior are described. This paper concludes that the Conventional approach of assuming that all should be carried out by the pile can often lead to an un-economical design.

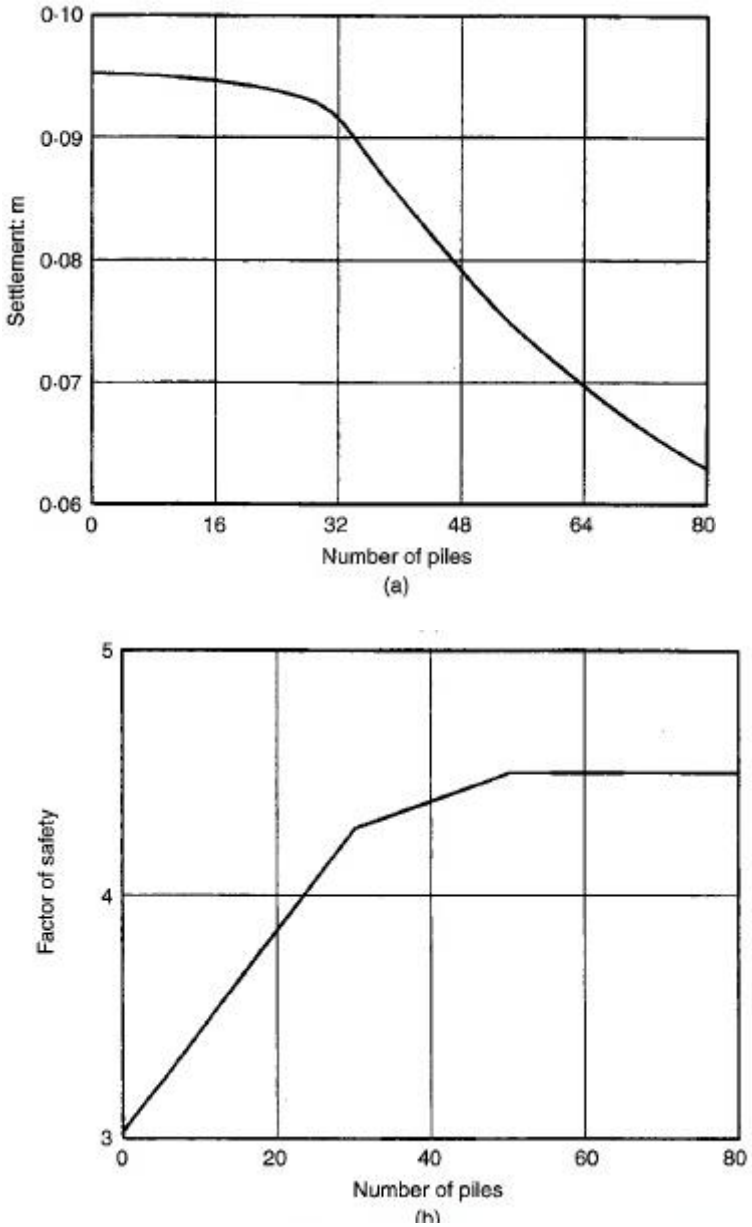

Fig-2 Typical results from Mathcad Analysis: (a) Settlement (b) factor of safety plotted against number of piles

B. A DYNAMIC BEHAVIOURAL STUDY OF 25 STOREY BUILDING WITH PILED RAFT FOUNDATION WITH VARIABLE SUB-SOILS

Shukla S J, Desai A K in this paper sets out the effect of subsoil types on the behavior of tall building, with attention being focused on piled raft foundation systems. Some of the advantages of piled rafts are outlined, and then effect of subsoil on the behavior of tall building was checked by time history analysis. If 25-storey building with piled raft have

shown that effect of sub-soil on behavior of structure is very significant. It concludes that piled raft with dense sand type of subsoil was a very good combination for good behavior of structure.

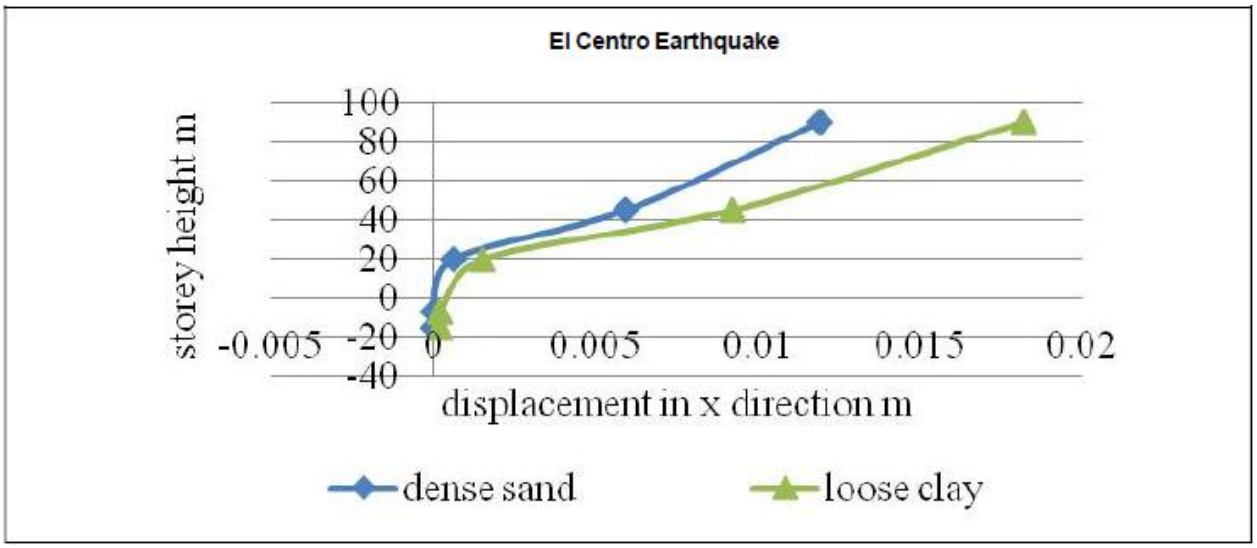

Fig-3 Displacement in X-direction for Bhuj Earthquake, l=15

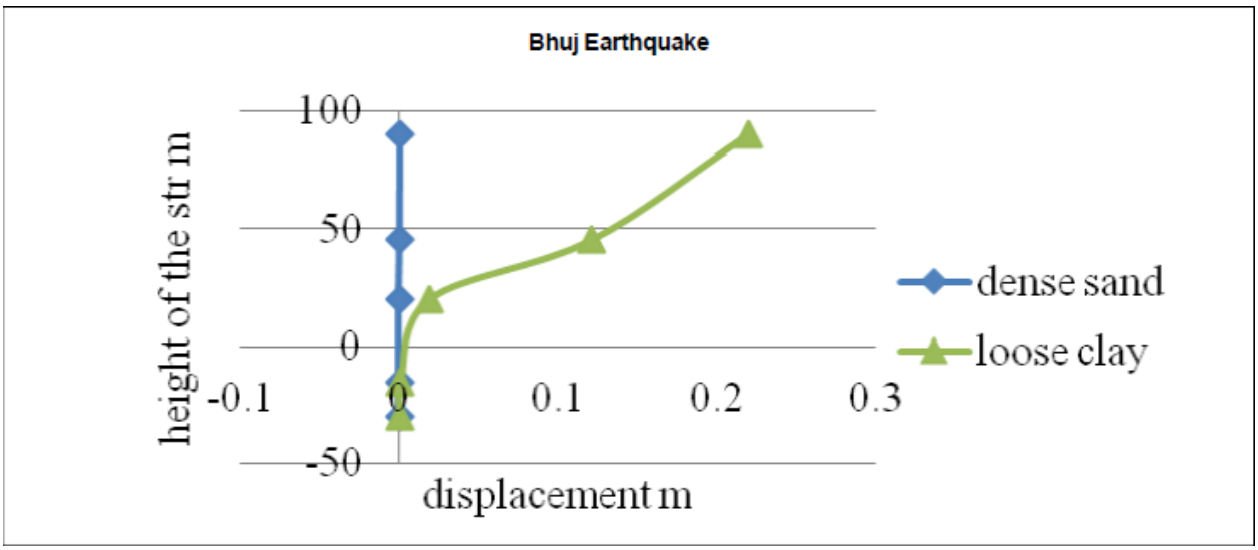

Fig-4 Displacement in X-direction for Bhuj Earthquake, l=30

The full scale finite element modelling of a 25 storey building supported with piled raft foundation have shown that effect of sub soil on the behavior of the structure is very significant.
It has been observed that building supported with dense sand gives minimum displacement in x direction for both pile length l = 15 m and l = 30 m.

C. PILED RAFT FOUNDATION FOR TALL BUILDINGS

Small J C, Chow H in this paper sets out a limit state design approach for tall building foundation systems, with attention being focused on piled raft foundation systems. Some of the advantages of piled rafts are outlined, and then the principles of the design approach are set out. A published case history involving a 9-pile group is then analyzed to compare the performances of a pile group and a piled raft. The finite element analyses of a full scale building (the Incheon Tower) have shown that by considering the effect of the basement, the estimated lateral deflections are smaller than the deflections of a raft on the surface only. Because the deflections are smaller, the moments in the piles are also smaller, but the effects are relatively modest in this case. This arises because the lateral stiffness of the piles is large in comparison with that of the raft.

Example of piled raft:
The following observations can be made:

a) When the passive pressure acting on the side of the pile cap and the friction on the base of the cap is neglected, the computed deflections are much larger than the measured values.
b) By considering forces acting on the cap, a fairly good estimate can be made of the measured load-deflection behaviour of the piled raft subjected to lateral loading as shown in Figure 5.

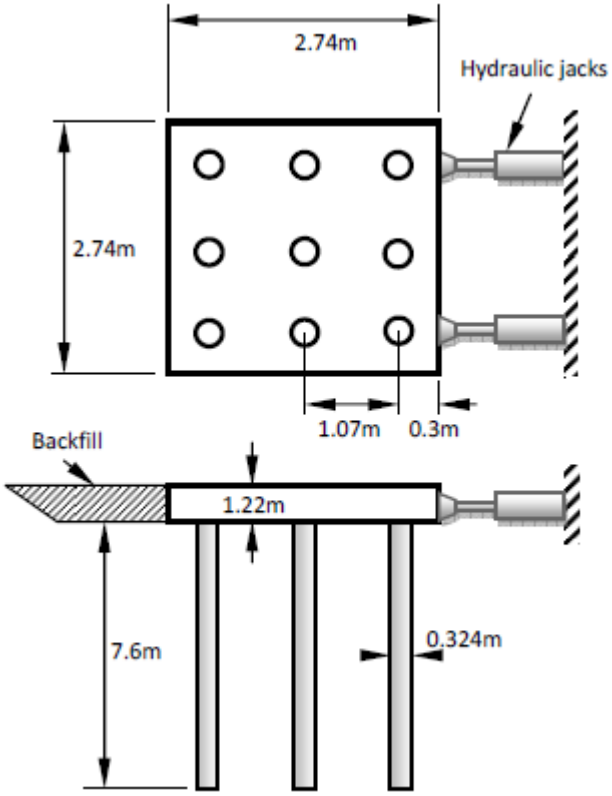

Fig-5 Lateral pile loading test layout

Material		Thickness (m)	Strength	OCR	Modulus (MPa)	Lateral yield pressure p_y (kPa)
Compacted sandy GRAVEL fill		1.22	$\phi' = 42^o$	–	Against cap	Against cap
Bedding ▽		0.15	$\phi' = 42^o$	–	45	239
Sandy SILT - ML		0.6	$s_u = 37kPa$	5	7.4	233
Gray CLAY - CL		1.5	$s_u = 42kPa$	3	9	264
Light grey Sandy SILT - ML		0.85	$s_u = 30kPa$	2.1	6	189
Poorly graded light brown SAND - SP		1.7	$\phi' = 39^o$	–	45	844
Grey Clay - CH		0.3	$s_u = 25kPa$	1.25	5	225
Grey clay - CL		0.3	$s_u = 25kPa$	1.25	5	540
Light grey SILT - ML		0.6	$s_u = 60kPa$	1.4	12	540
Light brown Sandy SILT - ML		0.9	$s_u = 60kPa$	1.25	12	540
Light grey Silty SAND - SM		1.4	$\phi' = 36^o$	–	30	1121
Grey SILT - ML		1.5	$s_u = 75kPa$	1.13	15	675

Fig-6 Soil properties used in analysis

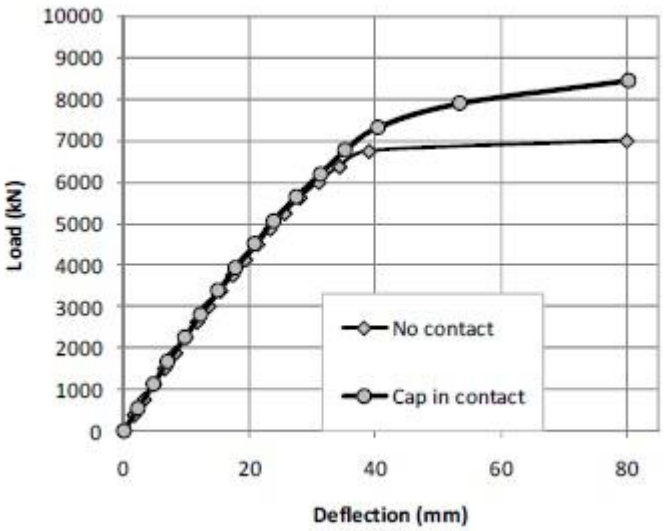

Fig-7 Computed load-settlement curves for pile group and piled raft

D. NUMERICAL ANALYSIS FOR HIGH-RISE BUILDING FOUNDATION AND FURTHER INVESTIGATIONS ON PILED RAFT DESIGN

Won Jinoh Lee, Jin Hyung, Cho Chunwhan in this paper introduces detailed three-dimensional numerical analyses on a bored pile foundation for a high-rise building. A static load test was performed on a test pile and a numerical model of a single pile, which was calibrated by comparing it with the test. The detailed numerical analysis was then conducted the entire high-rise building foundation. Further study on focused soil pressures under the base slab of piled raft foundation. Total seven cases with different numbers and raft- soil contact conditions were investigated. The design criteria of a foundation, especially settlement requirement were satisfied beneath. Thereby even for the cases with fewer piles under considerable soil press base structural design of the base slab was reduced by incorporating soil pressures beneath the pile. Through the comparative studies, it was found that a more efficient design can be achieved by considering the soil pressure beneath the slab.

III CONCLUSION

From the above literature we conclude that

1. The piled raft with dense sand type of subsoil was a very good combination for good behavior of structure.
2. Conventional approach of assuming that all should be carried out by the pile can often lead to an un-economical design.
3. As the number of piles increases, the stiffness of Piled raft foundation increases. As the stiffness of Piles increases the load shared by raft gets reduced and load transferred to the piles increases.
4. Piled rafts can offer a cost-effective foundation solution for high rise building.

REFERENCES

1. H.G. Poulos, Piled raft foundation: Design and applications, Geotechnique, 2001, Vol 51.
2. Shukla S J, Desai A K, Dynamic behavioral study of 25-storey building with piled raft foundation with variable sub-soils, 2013, Vol 2.
3. Small J C, Chow H, Piled raft foundations for tall buildings, Geotechnical Engineering Journal of the SEAGS & AGSSEA, 2011, Vol 42.
4. Won Jinoh Lee, Jin Hyung and Cho Chunwhan, Numerical Analysis for High-rise building foundation and further investigations on piled-raft Design, International Journal of High-rise Building, 2015, Vol 4.

