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Combined Piled-Raft Foundation a Sustainable Option for Week Soil (Alluvial Soil)

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Abstract

There are no standards and no design rules for Combined Piled-Raft Foundation available up to now. A preliminary stage and a final stage are involved in the construction of a piled raft base. The preliminary design stage includes determining the critical parameters, such as the number of piles, their diameter, and length, as well as the Es value of the subsoil strata, in order to establish an optimal design that can achieve the necessary settlement reduction. Precision and accuracy of the current design strategies is calculated by in-situ parameters such as Es, despite that, the computational effort and time do not justify their use for preliminary studies that may require.

Keywords

Piled-Raft Foundation, subsoil strata, Week Soil, Alluvial Soil

1. Introduction

Combined piled raft foundation system (CPRF) is a batter geotechnical principle in which the applied load is distributed through a load sharing mechanism provided by the interaction between the pile soil and the raft. The presence of the raft and its contribution in sharing the load with the pile's is recognized in the piled raft foundation method, which varies from the typically built pile assisted raft. The pile category is used to manage settling in the piled raft base, with the piles supplying most of the stiffness at service loads and the raft elements providing additional capacity at ultimate load levels. The piled raft system idea originated from the assumption that every structure has a certain amount of allowable settlement, and the foundation system must aim to reduce the settlement as close to the allowable value as possible rather than completely removing it. In the last two decades researchers like Cooke (1986), Borland (1995), and Poulos (2001) have provided considerable insight into the behavior of piled raft.

2. Design Process

The initial stages of the piled raft design process include deciding the optimum number of piles, pile length and diameter, and pile positioning in a strategic manner to achieve the necessary settlement re-duction as well as the load is partly shared by the pile. Depending on the design and specifications, this procedure can necessitate a number of trials. The evaluation of in-situ parameters, especially the elastic modulus, is often recognized as the most difficult part of geotechnical engineering. Majority of the time, such parameters are derived from laboratory experiments or standard correlations between tests, such as SPT and Es values, which can affect the accuracy of the results. However, there has been a major change from laboratory research to in-situ testing in recent years, resulting in the widespread use of findings from in situ tests such as CPT and pressure meter tests to determine stress strain characteristics and critical parameters such as the in-situ elastic modulus of the soil over the length of the pile.

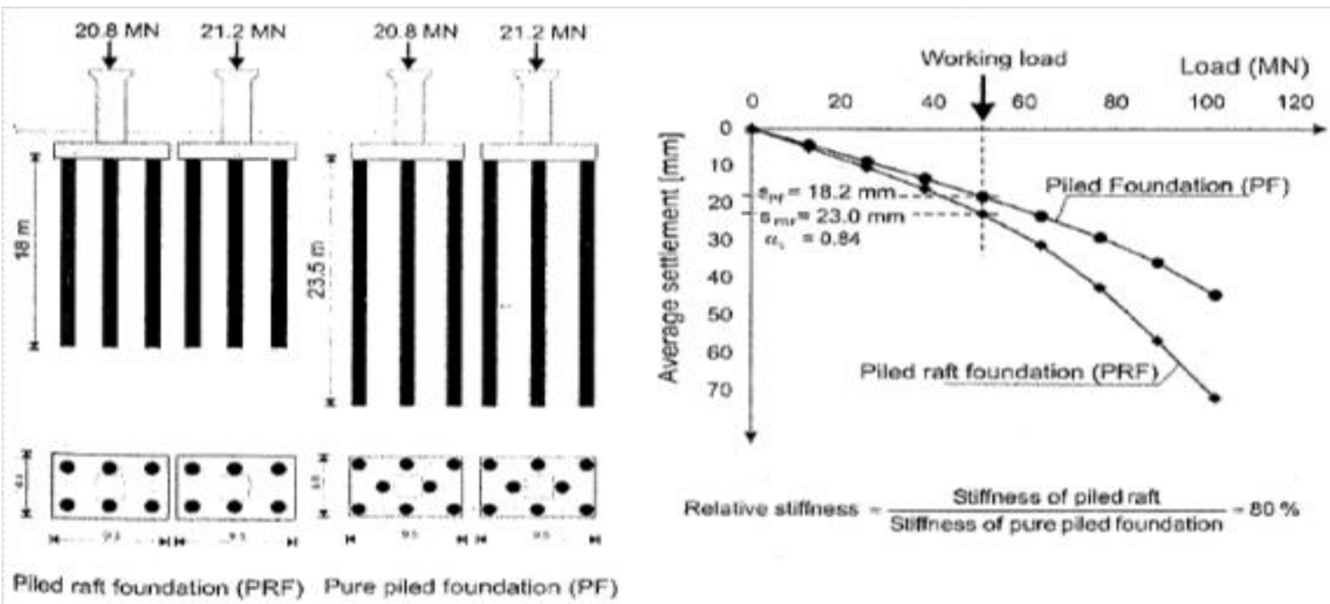

Figure 1. Design Process

3. Problem Statement

Solved example on plied raft for displacement limiting criteria:

Illustrative example: The case of a square rigid raft, 15m resting on a deep deposit of Alluvial soil. The total working load on the raft is 35000 kN. The relevant average parameters of soil are,

Cu = 76 kN/m2

Φu = 0

Eu = 7777 kN/m2

E' = 7000 kN/ m2

v' = .35

$$\rho = 0.947 \frac{P}{B}\left[\frac{(1-v_s^2)}{E_s}\right]$$

Now settlement of raft alone is

Settlement of the raft is ρ = 280 mm

this settlement is excessive as compared to 150mm settlement, so we need to provide piles to reduce the settlement. So, we provide 3 m diameter 30 m long piles,16 in number.

Thus, immediate settlement is given as

$$\rho = 1.062e^{-5} R_{G0.5} P_A + 0.947 \frac{(35000 - P_A}{B}\left[\frac{(1-v_S^2)}{E_S}\right]$$

This is 148 mm for 16 piles hence safe for the permissible settlement of 150mm.

4. Settlement Under Point Loads

The settlement of a piled raft under a point load has different approach for theoretical analysis. The approximate analysis of piled raft settlement under point loads is given in the paper by Poulos, where he has derived equations for settlement bending moment and shear forces under the same point load. For settlement of piled raft under point load use can be made of the solutions summarized by Salvadorian for load settlement analysis. The settlement under the colu mn is given by

$$S = \omega \frac{(1-v_s^2)P}{E_s.a}$$

Same example was taken for solution of settlement of piled raft under point load. Except this time the loading was changed from udl to point load of 10,000 kN at center of raft. The case of a square rigid raft, 15 m x 15 m and 0.5 m thick resting on a deep deposit of Alluvial soil. The total working load on the raft is 35000 kN. The relevant average parameters of soil are,

Cu = 76 kN/m2

ϕu = 0

E' = 7000 kN/ m2

v' = 0.35

The characteristic length a was found to be 4m. The settlement found was 118 mm by theoretical calculation used in above formula. Parameters Considered to study behavior of piled raft:

1. Thickness of Raft provided in combined pile raft foundation system (CPRF)
2. Diameter of Piles used in combined pile raft foundation syste m (CPRF)
3. Length of the Piles used in combined pile raft foundation system (CPRF)

5. Results for Different Parameters

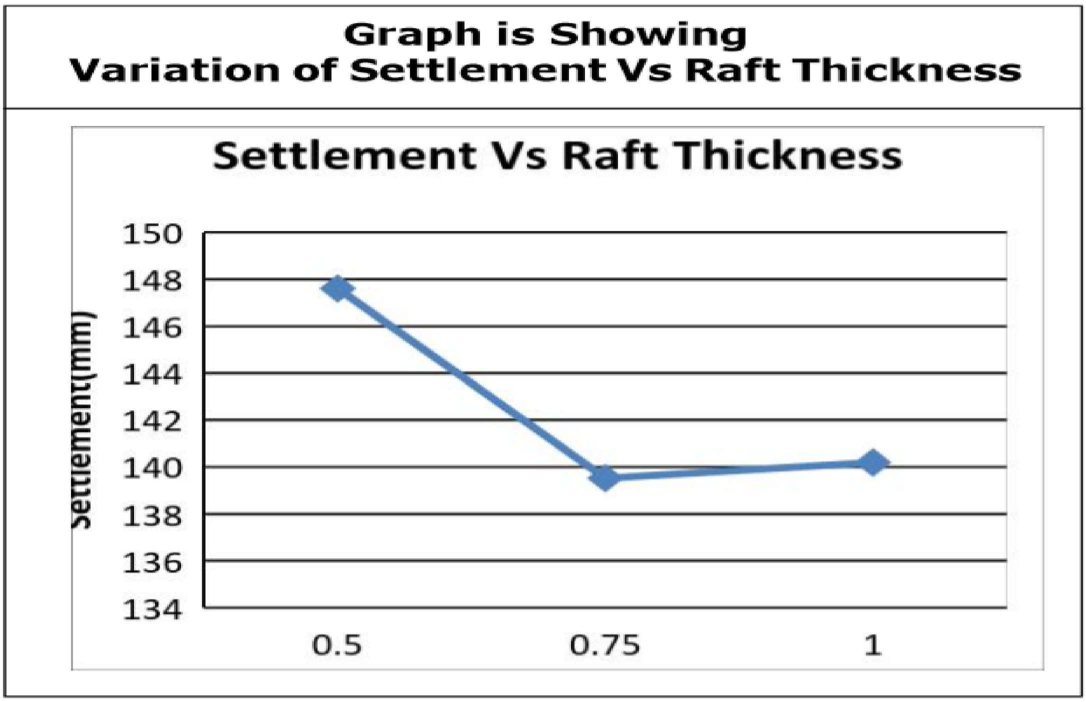

Figure 2. Variation of settlement vs Raft thickness

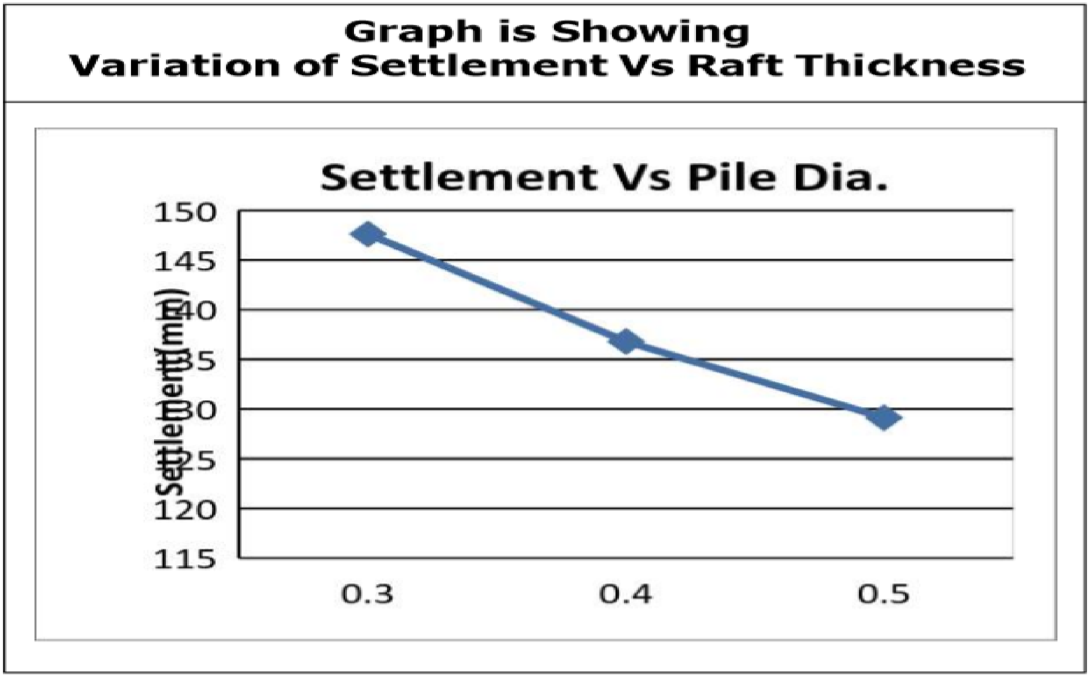

Figure 3. Variation of settlement vs pile diameter

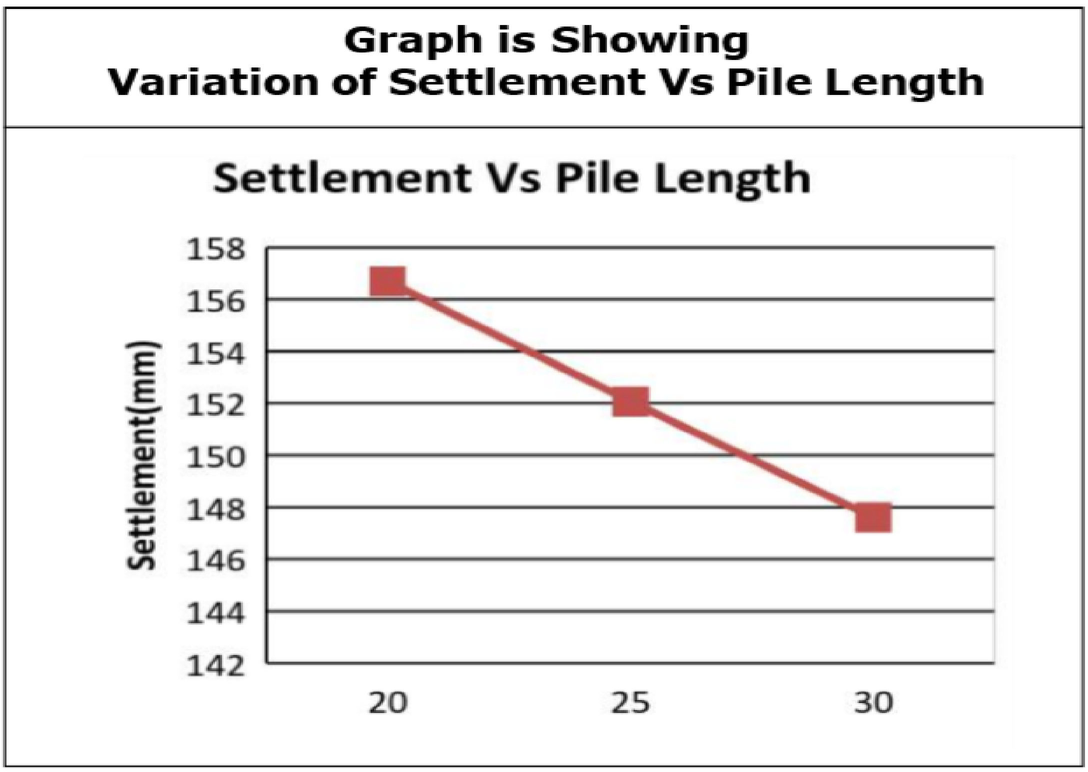

Figure 4. Variation of settlement vs pile length

6. Conclusion

As we increase the diameter of the pile, the settlement gets reduced significantly, so diameter of the pile used in combined pile raft system plays a very important role in total settlement of the foundation. As we increase the Length of the pile, the settlement gets reduced significantly, so Length of the pile used in combined pile raft system plays a very important role in total settlement of the foundation. As the thickness of raft increases the settlement reduces due to flexible behavior of raft, but later with increase in thickness of raft, the settlement increases because of rigid behavior of raft. So, to avoid uneven settlement, more focus should be given on thickness of the raft. Polous and Davis's method for piled raft settlement analysis is most useful in case of manual calculation because it gives fairly accurate result as that of software result. CPRF (combined pile raft foundation) is very effective foundation system in Alluvial soil (Week soil). Software's play a vital role these days for the analysis and design of any structural member. It can only give desired results if and only if we give them proper input. Hence for the cross checking and verification of software we need to compare the results with the theoretical and manual calculation wherever possible.

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