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STUDY OF DESIGN AND ANALYSIS OF PILE FOUNDATION FOR RESIDENTIAL APARTMENT BUILDING

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ABSTRACT

The pile foundation is the substructure which is located below the ground level. The super imposed load is transferred to the pile foundation through the columns. It is provided for the saturated soil condition and heavy settling propertied soil. The pile foundation plays a vital role in heavy industrial buildings. The pile foundation is located, where the water table is high. To design the pile foundation considering the live load, spacing of pile by referring the code book IS456-2000 (plain and reinforced concrete) and IS 6403-1981 (determination of safe bearing capacity of soil for deep foundation) and using this software as STADD Pro and STADD Foundation. For this design M 25 Grade concrete and Fe 415 HYSD Bars (High yield strength deformed bars) are used.

KEYWORDS: Sand, Clay, Pile Cap, Static Analysis, Point load, Pile Group, Single Pile, Soil Displacement, Design Details.

INTRODUCTION

FOUNDATION: Foundation is a substructure which is always in contact with soil to transfer super imposed load safely to the soil, so that the soil should not fail in shear as well as soil should not fail in excessive settlement.

FOOTING: A footing is the bottom most portion of the foundation which is always contact with soil to transfer super imposed load safely to the soil.

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History and Development of Piles

In Britain, a Roman bridge spanned the Tyne at Core bridge, about 20 miles west of Newcastle on Tyne, using piles to support the construction. The piles used in this were block oak and were 3mts in length. Amsterdam was founded about 1000 years ago, was build almost entirely on pile foundations of 15-20 meters of length. The Romans capped their piles with a mixture of stone rubble and concrete. Creasy (An Encyclopedia of Civil Engineering 1861) says that in Holland piling and capping by planking was still in use, with rough stones rammed between the planks.

Neccessity of Pile Foundation

The pile foundation is necessary to resist the uplift forces created due to water table rise or any other cause. Uplift forces are more common in the construction of transmission towers and off-shore platforms. These structures will need pile foundations:

- When the strata just below the ground surface is highly compressible and very weak to support the load.
- When the plan of structure is irregular to its outline and load distribution. It would cause non-uniform settlement.
- When horizontal forces in addition to vertical loads are to be resisted.
- When soil layer immediately below the structure are When structure is subjected to uplift, overturning moments subjected to scour.
- Where expansive soils, such as black cotton soil exist, which swells or shrink due to change in water content.
- In areas where settlement issues are common due to soil liquefaction or water table issues, pile foundation is a better choice.
- Pile foundation is necessary for areas where the structure surrounding has chances for soil

erosion. This might not be resisted by the shallow foundations.

- Pile foundation is needed near deep drainage and canal lines.

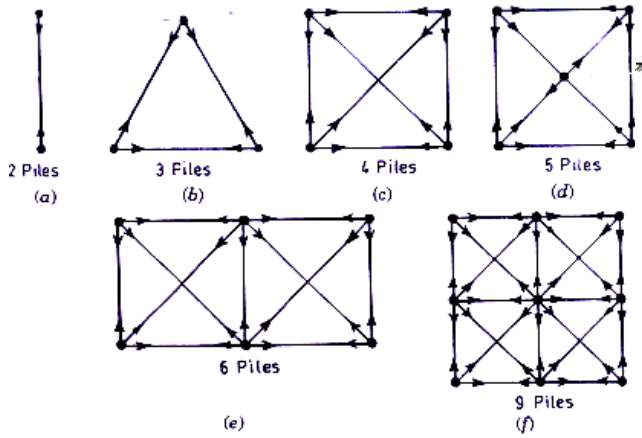
Deep Foundations

A deep foundation is a type of foundation that transfers loads from superstructures to the earth a greater depths from the surface than a shallow foundation does to a subsurface layer or a range of depths. When the soil at/or near ground surface is not capable of supporting a structure, deep foundations are required to transfer the loads to deeper strata. As per Terzaghi, it is defined as foundation whose depth is greater that its width. There are many reasons that a geotechnical engineer would recommend a deep foundation over a shallow foundation, such as for a skyscraper. Some of the common reasons are very large design loads, a poor soil at shallow depth, or site constraints like property lines.

Pile Groupings

Pile is not used singularly beneath a column or a wall, because it is extremely difficult to drive the pile absolutely vertical and to place the foundation exactly over its centre line. If eccentric loading results, the connection between pile and column may break and the pile may fail structurally because of bending stresses.

Efficiency = It is the ratio average load per pile to load at failure of comparable single pile. Settlement Ratio = It is the ratio settlement of group to settlement of single pile. In real practice, structural loads are supported by several piles acting as a group. The settlement of the group will therefore be greater than that of single pile. It is common to term it as "Efficiency" or "Settlement ratio" of groups.



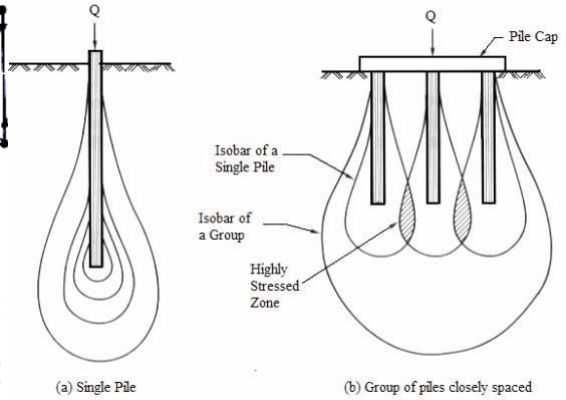
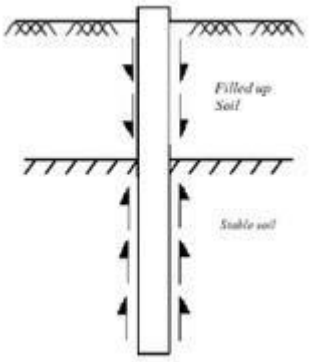


Fig. 1: Arrangement of pile in Pile Group. Fig. 2: Stress of individual pile and group of pile.

Negative Skin Friction

When a fill is placed in a compressible soil deposit, consolidation of the compressible material will occur. When a pile is driven through the compressible material before consolidation is complete, the soil will move downward relative to the pile. This relative movement will develop skin friction between the piles and moving soil is termed as "negative skin friction". The principal effect of negative skin resistance is to increase the axial load in the lower fixed portion of the pile. It may also result in increased pile settlements due to the axial shortening and/or additional point penetration of the pile under the increased axial load. It causes large tension stresses when the effect is from expansive soils, especially if no or insufficient gap is left between soil and pile cap, the soil expands against both the pile and the cap.



LITERATURE REVIEW

Stamante. M and Gianeselli. L (1982): The design analysis according to the unified method indicate that the maximum load (sustained load plus drag load) is well within acceptable limits for the pile structural strength and that the expected settlement of the piled foundations will be smaller than the assigned limit of 25mm. Therefore, the performed tests prove that the project piles can be constructed to bearing in the glacial till and do not need to be taken onto or into the bedrock.

H.FELLELIUS AND OCHOA.M (2009): Design for a large refinery expansion was undertaken at a site reclaimed from a lake 40 years ago. The natural soil consist of sand deposited on normally consolidated, compressible post glacial lacustrine clay followed by silty clay till on limestone bedrock found at about 25m to 30m depth below existing grade. The site will be raised an additional 1.5m , which will cause long term settlement .Some of the new units are 30m to70m in height and will be supported on piles several thousand in all. In anticipating negative skin friction to develop, the initial design called for subtracting the

drag load from the allowable load determined from the pile capacity. Initial design also expected the piles to be constructed to bed rock. However a review of the design made clear that a drag load is a problem for the axial structural strength of a pile and should not be subtracted from an allowable load based on bearing capacity. Moreover analysis of the results of full scale static and dynamic loading tests demonstrated that it was not necessary to reach bedrock, but the pile would develop adequate capacity in the clay with till and they would not experience excessive down drag duo to settling clay. The final revised design resulted in a saving of close to 25 million dollars and considerable construction time. the piles selected for the foundation were 457mm(18")diameter bored piles installed to about 1.5m into the glacial till. The paper presents site conditions, test results, and the design principles employed.

SUMMARY

From the literatures referred the following things are taken,

- A complete analysis of single pile for its load bearing capacity, is considered with different types of soils with different consistency, different density having different angle of internal friction and layers of sand and clay is carried out which also includes different pile parameters such as diameter, length and type of installation of it. The analysis is done with the IS 2911: 1979 code provisions.
- The analysis method solved in the literature gives dimensions of the individual pile as per the soil data and given load.
- Nine cases where solved in it for the evaluation of the bearing capacity of the individual pile considering different pile cap shapes i.e. triangular, square & rectangular for different types of the soil condition i.e. sand, present. The results are tabulated in table in the literature.
- Pile cap with pile group analysis of different shapes mainly triangular, square & rectangular consisting of the different number of shapes is done.
- The analysis for the pile group gives the ultimate bearing capacity of pile group by group action and by individual action, number of piles as per the soil condition and given load.
- To get the idea of load carrying capacity of the pile group, in the literature different number of piles in a group were considered with pile having shape circular and square varying in the size from 0.15 m to 0.40 m in cohesion and cohesion less with different types of soil conditions. The variations of about 9 cases for single pile and pile group capacity were solved in it.
- As given in the literature design of the different pile cap geometry having circular shape of

piles under it is prepared showing the reinforcement details, considering the different type of loads i.e. vertical load acting on the pile cap.

- To know the most economical pile group for some given constant load conditions, 9 different cases were taken in the reference, considering the variation in number of piles in a group, shape of pile and soil conditions.

CONCLUSION

From the study of many literatures referred it can be conclude that, On comparing the manual and staad foundation results, it is observed that the load carrying capacity of pile by staad foundation is 1.42% higher than that of manual calculation. Errors and inaccuracies manual calculations is surmounted by the use of computer applications, such as staad foundation. This could save the time as well as cost involved in analysis.

1. The deflection of a laterally loaded pile is found to increase when stress–displacement response of soil strata is higher.
2. The amount of deflection of piles depends on the stiffness of the piles as well as of the soil deposit.
3. The advantage of the studied approach of Negative friction is that it is not the same all the time; it develops during construction and gradually decreases afterwards.
4. Pile-soil interaction is found to affect the behavior of a laterally loaded pile group more.

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