TO STUDY VARIOUS TYPES OF SOIL FOR PILE FOUNDATION

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Abstract-Pile foundations consist of piles that are dug into soil till a layer of stable soil is reached. Pile foundations transfer building load to the bearing ground with the greater bearing capacity. Pile foundations are useful in regions with unstable upper soil that may erode, or for large structures. Pile foundations are often required to resist lateral loading. Lateral loads come from a varietyof sources including wind, earthquakes, waves, and ship impacts.The lateral capacity of a pile isusually much smaller than the axial capacity and as a result groups of piles are often installed toincrease the lateral capacity of the entire foundation system. When vertical or plumb pile groupsdonot provide sufficient lateral resistance the piles can be battered in order to mobilize some of thehigher axial capacity to resist the lateral load.

Index Terms - bearing capacity, Lateral loads, Pile foundations, structures, soil strata

INTRODUCTION-Pile foundation have been used for many years, for carrying and transferring the loads to soil considered to be weak in structure due to the soil conditions. In the early stages of development, villages and towns were located in the close vicinity of lakes and rivers due to the availability of water , and, also, to ensure proper protection of the area. Therefore, the weak bearing ground was reinforced by the use of timber piles that were manually forced into the ground, or fixed into the holes that were filled with stones and sand. The primitive methods of pile installation were modified after the industrial revolution, and the techniques of installation by steam or diesel driven machines were introduced. With the advancement in the technologies of soil mechanics and other related disciplines, superior piles and pile installation system have been developed.

NECESSITY OF PILE FOUNDATION

When the strata at or just below the ground surface is highly compressible and very weak to support the load transmitted by the structure. When the plan of the structure is irregular relative to its outline and load distribution. It would cause non-uniform settlement if a shallow foundation is constructed. A pile foundation is required to reduce differential settlement. Pile foundations are required for the transmission of structure loads through deep water to a firm stratum Pile foundations are used to resist horizontal forces in addition to support the vertical loads in earth-retaining structures and tall structures that are subjected to horizontal forces due to wind and earthquake. Piles are required when the soil conditions are such that a washout, erosion or scour of soil may occur from underneath a shallow foundation. In case of expansive soil, such as black cotton soil, which swell or shrink as the water content changes, piles are used to transfer the load below the active zone. Collapsible soils, such as loess, have a breakdown of structure accompanied by a sudden decrease in void ratio, when there is increase in water content. Piles are used to transfer the load beyond the zone of possible moisture changes in such soils.

Pile Foundation vs Well Foundation

Well foundations provide a solid and massive foundation for heavy loads as against a cluster of piles which are slender and weak individually and are liable to get damaged when hit by floating trees or boulder rolling in river bed. Wells provide a large section modulus with the minimum cross sectional area and hence efficient in taking large vertical and horizontal loads even when the unsupported length is large. Concreting of well steining is done under dry and controlled conditions and hence quality of work is assured, however same cannot hold good in case of cast-in-situ bored piles where concreting is to be done under water or below ground level. Even in case of precast piles, the concrete is subjected of heavy stresses during driving operation and consequent damages cannot be ruled out. When scour takes place, the piles act as long struts and have to be designed for buckling stresses, which are quite heavy due to the bending moments contributed by the longitudinal forces on the bridge deck due to tractive effort and braking forces. It is difficult to drive the piles through the strata having boulders and tree logs which are frequently encountered in alluvial soil, whereas in the case of a well foundation there is sufficiently access to remove the obstruction. Quite often the skin friction developed is of much magnitude as to prevent further driving of a pile although a firm stratum has not been reached. The adoption of pile foundations is advantageous over well foundations where the soil characteristics and conditions of water table are such that the phenomenon of blow occurs during dewatering of the well. Increased mechanization and advent of new machinery have brought down the cost of foundation with piles considerably low in comparison to well. New testing techniques for checking the integrity of piles and information about strata through piles have passed or resting have removed the uncertainty of load carrying capacity of piles to large extent. Pile foundations have a clear advantage over well foundations in terms of speedy construction. Wherever time is the criterion, the pile foundation is the natural choice.

TYPES OF PILE COSTRUCTION

Precast Driven Piles –These are usually of RCC or pre-stressed concrete and generally small in size for ease in handling. The main advantage of this type of pile is that its quality, in terms of dimension, use of reinforcement and concrete, can be ensured as the piles are cast in a yard under controlled conditions. However care is needed while handling, transporting and driving the pile to avoid damages. More to it, the limitation of length depending upon the capacity of the driving equipment is a disadvantage as these cannot be taken very deep except by joining. Generally, the depth over which these are used is restricted to 36 mt.

Driven Cast-in-Situ Piles-A steel casing pile with a shoe at the bottom is driven first to the required depth. The reinforcement cage for the pile is then lowered inside the casing and the pile is concreted. As the concreting of the pile proceeds upwards, the casing is withdrawn keeping a suitable overlapping length. When such piles are driven in soft soil and the tube is withdrawn while concreting, it affects resistance and changes the property of the soil and this also affects the capacity of individual piles. These are not suitable for use in soft soils, in greater depths or where keying with the rock is required.

Bored cast-in-situ piles –In the bored cast-in-situ process, a larger diameter casing is used. A casing of 3 to 4 m in length is provided on top of the bore hole which is driven with the help of a bailor. Boring further below this casing is carried out by chiseling and the side walls are kept stable by circulating bentonite slurry inside the bore hole. The boring is continued up to the layer decided for founding the structure. After reaching the desired founding level, the chisel is removed, bore-hole flushed, reinforcement cage lowered into the hole, and held in position by tack welding it to the support bars at the top of the casing. After this, concreting is carried out by using tremie, keeping its end always below the top level of rising concrete.

According to soil strata Use of pile-The concreting is continued till a good quality concrete is seen at the top of the bore hole. After this, the tremie is removed and when the concrete has reached the top, the casing pipe on the top is also removed. The bentonite mix should be periodically checked for its specific gravity and changed as, due to constant use, it can get mixed with the soil and deteriorate in quality. This type of pile can be used even where the pile is keyed into the rock as chiselling in the rock can be carried out more easily. These piles serve as bearing-cum-friction piles. The diameters of such piles are generally more than 1.0m and can go up to 3.6m or more. They can be used singly or in group and are good replacements for well foundations required for bridge piers in rivers with clayey and mixed soils.

Bored pre-cast piles – In this, as the name itself suggests, a hole is bored using a casing and a pre-cast pile is inserted into it. After securing it in position, the casing is withdrawn. A particular process used for bored pre-cast piles is the Benoto process which involves a steel tube being pushed into the soil, turned and reversed using compressed air. The tube is in the form of a casing and is driven for the entire depth after the soil is progressively grabbed from the tube. The process is continued till the tube reaches the pre-determined level. Then the pre-cast pile is lowered inside and held in position. The tube is lifted gradually after filling the annular gap between the pre-cast pile and the soil by grouting.

Driven steel piles –Steel piles can be circular or in other structural shapes. The circular ones are made in the form of either welded or seamless piles. Usually steel or cast iron piles used earlier for bridge structures are of longer diameter and screw type. These were used in past when loading was less. These piles are suitable for being driven through cohesive soil to reach up to the hard strata and to serve as bearing piles. They are not suitable where heavy scour is expected and for foundation for bridges when foundations are situated wide apart.

Driven timer piles –Timber piles have been extensively used in America. These have been used in India on the railways and highways, for temporary bridges. Timber piles are of hard wood, and used in natural form with thin end cut or suitably sized. They are used mostly as end-bearing piles in clusters. They are normally used in lengths of 12m and extended by splicing for use in deeper channels. The piles protruding above bed/low water level are suitably braced in cluster.

FACTORS INFLUENCING CHOICE OF PILE:

- Location and type of structure
- Ground conditions
- Durability
- Cost

There are many factors that can affect the choice of a piled foundation. All factors need to be considered and their relative importance taken into account before reaching aafinal decision.

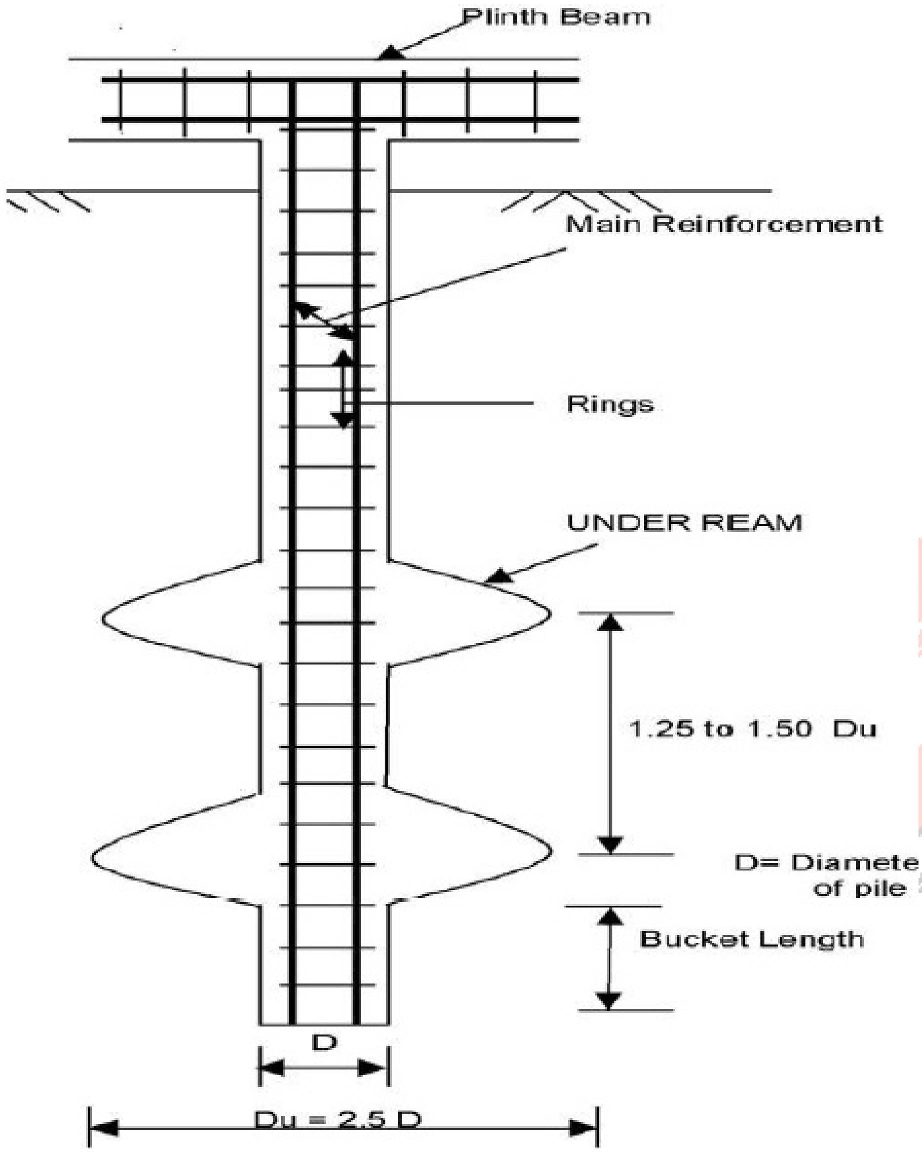
LOCATION AND TYPE OF STRUCTURE-For structures over water, such as wharves and jetties, driven piles or driven cast-in-place piles (in which the shell remains in place) are the most suitable. On land the choice is not so straight forward. Driven cast-in-place types are usually the cheapest for moderate loadings. However, itis often necessary for piles to be installed without causing any significant ground heave or vibrations because of their proximity to existing structures. In such cases, the bored cast-in-place pile is the most suitable. For heavy structures exerting large foundation loads, large-diameter bored piles are usually the most economical. Jacked piles are suitable for underpinning existing structures.

GROUND CONDITIONS-Driven piles cannot be used economically in ground containing boulders, or in clay when ground heave would be detrimental. Similarly, bored piles would not be suitable in loose water-bearing sand, and under-reamed bases cannot be used in cohesionless soils since they aresusceptible to collapse before the concrete can be placed.

DURABILITY-This tends to affect the choice of material. For example, concrete piles are usually used in marine conditions since steel piles are susceptible to corrosion in such conditions and timber piles can be attacked by boring molluscs. However, on land, concrete piles are not always the best choice, especially where the soil contains sulphates or other harmful substances.

COST-In coming to the final decision over the choice of pile, cost has considerable importance. The overall cost of installing piles includes the actual cost of the material, the times required for piling in the construction plan, test loading, the cost of the engineer to oversee installation and loading and the cost of organisation and overheads incurred between the time of initial site clearance and the time when construction of the superstructure can proceed.

UNDERREAMED PILES-Underreamed piles are bored cast-in-situ concrete piles having one or more bulbs formed by enlarging the pilestem with a suitable cutting tool. Enlarged base in the form ofunderream bulb made in the strata of good bearingprovides larger bearing area and piles of greater bearing capacity can be constructed. These piles have beenextensively used in India to support a wide variety of structures in almost all types of soil strata on the basis ofsafety and economy. Depending on these considerations these piles are being increasingly used for a wide variety of structures, e.g., buildings both residential and industrial, transmission line, TV, antenna and satellitetracking towers, tanks, over bridges, machine foundations and dry docks etc. The provision of bulbs is useful in two ways.



Under reamed pile with two under reams

It provides larger bearing area at greater depthswhich are more firmand stable. It also serves as an anchor and keeps the foundation stable in the event of any upward drag of thepile stem. The provision of more than one bulb along the stem further improves the performance of the pile andthe latter is then called multi-underreamed pile. For selecting an appropriate underreamed pile the variables arepile length, stem diameter and number of bulbs. A general configuration of underreamed piles and typical detailsare shown in fig.The safe load on underreamed piles, like any other bored piles, can be determined from the static formulae usingsoil properties. These formulae give ultimate capacity of pile and afterapplying a suitable factor of safety safeloads are determined. But this approach is reliableonlyifcorrelations are locally established for a particular area.

Qu = cNcAb +&c'As'

where,Ab = area of enlarged base Nc = 9

Adhesion factor & is 0.4. Another direct approach is to perform field load tests on piles and determine safe load fromthe load-deflectioncurves. This approach for safe loads is preferable but load tests requireelaborateset up and are costly. In theanalysis developed herein, Finite Element Approach has been adopted to analyze underreamed piles in varioustypes of soils. In this method all the complexities of the problems, like varying shape, boundary conditions and loads are maintained as they are but the solutions obtained are approximate.

CONCLUSION

Piles are often used because adequate bearing capacity cannot be found at shallow enough depths to support the structural loads. It is important to understand that piles get support from both end bearing and skin friction. The proportion of carrying capacity generated by either end bearing or skin friction depends on the soil conditions. Piles can be used to support various different types of structural loads.

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