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Review On Pile Types And Piles Used In Construction

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ABSTRACT

A pilefoundation is a civil engineering concept that is, at its most basic a structure that is supported by piles. It allows any type of structure to actually be supported by a layer or layers of soil. The pile concept helps create a good, solid foundation in different areas. The foundation cost for any structural systems can vary from 5% to 20% of the total construction cost of the structure while the number of piles required might exceed several thousands. Therefore it becomes necessary to design the best pile foundation according to the structure. Deep foundations are made when the safe bearing capacity of soils are not suitable for shallow foundation. Deep foundation types are; pile foundations, caissons and deep foot foundations. In this paper, the production forms and usage areas of the piles and piled foundations will be studied.

Keywords : Pile, Foundation, Concrete, Steel, Testing on piles, Analysis, Design

I. INTRODUCTION

The term foundation can be defined as the part of the structure which bears the weight of the structure as well as serve direct and indirect loads, and transmit them to the underlying soil or rock. A Pile foundation is a Deep foundation that transfer the loads deep below the surface up to a depth at which it can support the structure safely.[1]

1)

Piles are considered as a reliable and easily installable method that can be used to reinforced existing geotechnical structures like slopes, footing, etc. [6]

A Pile is a vertical structural element that is driven or drilled into the ground. It is provided over a shallow foundation for high-risers or skyscrapers. It is preferred when the soil is very weak and the budget is flexible enough to accommodate its construction.

II. WHEN TO PREFER PILE FOUNDATION

a) Load is heavy and uneven distribution

b) Soil has low SBC and expansive

c) Water is present in subsoil in large amounts and removing it is uneconomical in case of shallow foundation[1]

III. CLASSIFICATION OF PILES

2) Based on function:[1]

a) End bearing piles

b) Friction pile

c) Tension or Uplift pile

d) Anchor pile

e) Sheet pile

3) Based on material and composition:[1]
   a) Timber pile
   b) Concrete pile (Pre-cast and Cast-in-situ)
   c) Steel piles
   d) Composite piles

4) Based on effect of installation:
   a) Displacement pile
   b) Non-displacement pile[1]

A) End bearing pile:

These piles transfer the load from its bottom end which rest on a strong strata. Usually it rests at a transition layer of a weak and strong layer.

Even in situation where the soil or rock layer is weak, the pile does not buckle.[2]

Its capacity can be calculated by multiplying the area of the tip to the bearing capacity of the soil at the depth at which the pile rests.

B) Friction pile:

It transfers the load to the soil by the frictional force between the soil and the surface of the pile. Friction can be developed for the entire length of the pile or a specific length.

Its capacity is found by multiplying the surface area of the pile to the SBC.

The friction is to be evaluated at a reasonable factor of safety or change the diameter, depth, number of piles.

A friction pile is used in a situation where the soil is mainly soft clay and a stable strata is not available at ample depth.[2]

C) Tension pile:

It is use to resist uplift forces. These forces can be developed due to seismic activities, overturning moments, hydrostatic pressures etc. These forces may developed in the construction of large structures.

The country and their codes will specify the maximum or permissible displacement possible for the piles, the allowable loads can be calculated by adding a factor of safety to the computed load in the design of the pile for uplift pressure. It is analysed by following the Limiting Frictional Approach to evaluate the uplift resistance of the pile.

D) Anchor pile:

These are used to provide anchorage against horizontal pull. From sheet piling walls or other pulling forces. These resist uplift or inclined tensile forces in the surrounding soil. They also provide anchorage to react to cantilevered foundations. Allowance is to be made when anchoring into the rock for possible damage or shattering of rock or pile surface during driving.

E) Sheet pile:

It is mostly used to provide lateral support from loose soil, water flow etc used in cofferdams, trench sheeting etc. They are used to serve the following purposes : Retaining wall construction, protecting from river bank erosion, retain loose soil etc.

F) Timber pile:

They are placed under water level and last for about 30 years. They can be rectangular or circular of size or diameter of 12 to 16 inches, with the length about 20 times the top width. They can carry 15 to 20 tons, and can be strengthened by bolting fish plates to the site of the pile. They are easy to install, economical, removable but cannot be used as end bearing pile and special measures have to be taken to make them durable.

G) Concrete pile:

a) Pre-cast pile:

They are cast in a horizontal bed if rectangular or vertically if circular, usually reinforced with steel to avoid breakage or deformation while moving it from the cast bed to the location of foundation. They have to be cured for 21 to 28 days or as per specification. They provide high resistance to chemical and biological cracks, have high strength, and are durable

but difficult to move, needs special equipments to drive and avoid any damage.

b) Cast-in-situ piles:

It is constructed by boring the soil upto the desired depth pour freshly mixed concrete in it and letting it cure itself. It is constructed by driving a metallic shell in the ground and filling it with concrete, leaving or pulling out the shell while concrete is poured. The shells are lightweight and easy to handle, may be assembled on site, can be used to construct more piles but require sufficient place for storage, needs special supervision and quality control, the pile can fail in tension due to uplifting force if it is uncased and un-reinforced.

H) Steel piles:

These are either I-section or Hollow pipe filled with concrete with size 10 to 24 inches in diameter and 3/4th inches in thickness. They are used as end bearing piles.

They are easy to install, carry heavy loads, reach a greater depth and penetrate through the hard layer of soil but are prone to corrosion, made may deform while driving, and are comparatively expensive.

The life of steel piles under water and sand is short due to its ability to corrode. [7]

I)Composite pile:

These are made of two different materials driven one over the other to act together as a single pile.

Some of the combinations of composite piles are as follows:

i. A timber pile below a concrete pile
ii. A timber pile below steel pile.

The timber is placed below ground water due to its vulnerability to insect attack and decay above ground water level.

J) Micropiles: These are widely used in areas where large drilling rigs are inaccessible. These are usually used in underpinning works, reinforcement or extending existing structures stabilizing slopes etc. The bearing capacity of the micropiles depends on the method of installation and grout injection parameters. [9]

IV. TESTS ON PILE

1) Pile Load test
2) Dynamic Load testing
3) Pile Integrity Test

1) Pile Load Test:

Pile load is carried out according to Indian Standard IS: 2911 (PART 4) 2013. According to IS:2911, the safe load is taken as the least of:

a) 1/2 of the load at which the total settlement is 10% of the pile diameter, or
b) 2/3rd of the final load at which the total settlement is 12mm, or
c) 2/3rd of the final load which causes a net settlement (residual settlement after removal of load) of 6mm.[5]

2) Dynamic Load Test:

Dynamic Load Test is a method to assess a pile's bearing capacity by applying a dynamic load to the pile head (a falling mass) while recording acceleration and strain on the pile head. For steel or timber, the test can be done during the installation or after it. It also gives information about resistance distribution (shaft resistance and end bearing) and evaluates the shape and integrity of the foundation element. The obtained data is analysed using the Pile Driving Analyser (PDA). This test is also called as High-Strain Dynamic Test. [3]

3) Pile Integrity Test:

A pile integrity test is also called as low-strain dynamic test, sonic echo test, and low strain integrity test. It is one of the methods to assess the condition of piles or shafts, It is cost effective and does not take a

lot of time to perform. It uses Transient Dynamic Response (TDR) as it is a rapid way of assessing the continuity and integrity of concrete piled foundations. It measures pile length or depth for anomalies, pile head stiffness, pile shaft mobility which depends on pile section and concrete properties. This requires minimal preparations. [4]

a) Load Carrying Capacity of Cast-in-Situ Piles in Cohesive Soil is calculated by : $Q_u = Q_b + Q_f$

Q_u is UBC, Q_b is end bearing resistance and Q_f is skin friction resistance.

b) For the Cast-in-Situ Piles in Cohesionless soil, $Q_u = Q_b + Q_f$

Where Q_u is ultimate load applied on top of pile, Q_b is end bearing resistance at the base or tip of the pile toe and Q_f is skin friction resistance. [8]

V. CONCLUSION

Piles are often used because adequate bearing capacity cannot be found at shallow enough depths to support the structural loads. Piles get support from both end bearing and skin friction, piles can be used to support various loads depending on the conditions of soil, forces acting upon the pile.

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