# A Review Paper on Concrete Cast In-Situ Bored Piles Cushioned with Mixture of Sand and Aggregate

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**Abstract –** *Pile foundation consists of piles that are dug into soil till a layer of stable soil is reached. In terms of construction, piles may be either pre-cast or cast in situ. Cast in situ piles are formed by boring a hole and filling it with concrete. Pile foundations are useful in regions with unstable upper soil that may erode, or for large structures. The pile foundation is often built to exceed the weak soil and reach the firm deposit. The pile capacity and the surrounding soil conditions are closely related. Pile foundations are often required to resist lateral loading. Often pile load carrying capacity is derived from friction between pile and the surrounding soil. This magnitude of mobilized friction mainly depends on pile material, properties of the soil and method of construction. Black cotton soil is weak soil that has low bearing capacity and high settlement. Through a combination of pile volume displacement and driving vibrations, loose, cohesionless deposits compress on surrounding soil in cohesionless soil.*

***Key Words*: Cast in situ, black cotton soil, pile foundation, load carrying capacity, cohesionless soil**

## 1. INTRODUCTION

Through the use of a foundation, the load from the superstructure is transferred to the ground. The foundation serves as the link between a building and the earth and helps in the distribution of loads to the soil. Foundations are of two types as shallow foundation and deep foundation. If soil below the foundation is not capable to carry super structural loads, then deep foundation is provided. Pile foundation, well foundation, pier and caisson are the types of deep foundation. The most common type of deep foundation is pile foundation.

### 1.1 Pile Foundation

A pile foundation is the part of a structure used to support and transfer the load of the structure to the bearing ground, which is placed some distance below the surface of the ground. The pile cap and the piles are the foundation's primary building blocks. Long, slender elements i.e. piles transfer load from shallow soil to deeper soil or rock of high bearing capacity. Wood, steel and concrete are three primary materials used to construct piles. These materials are used to construct piles that are driven, drilled or jacked into the ground before being joined by pile caps.

Heavy structures should be erected on pile foundations because it is possible that shallow soil won't be able to support them in a way that is satisfactory. In typical ground conditions, piles can also be employed to withstand horizontal loads. For structures above water, like jetties or bridge piers, piles make an easy foundation.

## 2. CLASSIFICATION OF PILES BASED ON LOAD TRANSFER

### A. End bearing piles (point bearing piles)

End bearing piles shown in figure 1(a) rest on a solid layer of rock or dirt underground at their bottom. To prevent the structure from swaying, the end of the pile is pressed up against the thick layer. Additionally, the weak topsoil (which could not support its load) is replaced by the stronger stratum below by way of the pile, which depicts an end bearing pile, with the load of building above ground.

### B. Friction Piles

One type of pile foundation is friction pile. This kind of pile transfer the superstructure load using the frictional resistance force created between the pile surface and nearby ground surface. Frictional resistance force may emerge along a specific pile length or along the entire length, depending on the subsoil strata conditions. The friction force must be sufficient to sustain the super structure in order for the foundation to remain stable. In the soil, friction piles function more like a wedge. These piles, which are also known as floating heaps, get the majority of their bearing capacity from shear strains along the piles edges. They work best when the hard beneath layers of soil are too deep to effectively access. By adhesion or friction between the pile's surface and the soil, friction piles transfer load from the loose topsoil above to the soil below. In other words, the pile is held in place by the friction of the soil around it. Friction pile is shown in (Figure 1(b)).

**C. Both end bearing and friction piles**

As shown in (Figure 1(c)), these piles transfer loads through a combination of friction over the surface of the pile shaft and end bearing at the bottom of the pile. The sum of the load carried by the point ($Q_p$) and the load carried by the skin friction ($Q_s$) determines the total load carried by the pile.

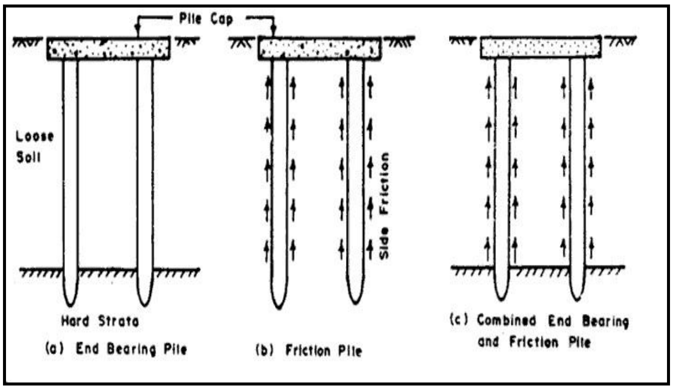


Fig 1: Classification of piles based on load transfer

## 3. LITERATURE REVIEW

Abdula Aziz and Mohammed M. Salman et al., (2017) investigated how improved soil conditions in the area affected driven pile friction capacity. Compaction of the soil around the pile was the solution indicted in their study. They designed the testing programme for that goal by choosing two different types of soils, one as the original soil and the other as an improving soil. The reinforcement steel bar was created for this purpose. The load-settlement test on the pile model was performed using a 50 kN automatic electromechanical compression machine. The testing process involved altering the soil's diameter, compacting the soil around the pile model, doing the load settlement test, and comparing the findings. The dirt under the pile tip and the soil around the pile become compacted as a result of the surrounding soil's compaction, becoming denser and increasing the angle of internal friction. The most efficient and cost effective diameter of improvement was identified by authors.

By compacting the soil, the cohesion of the soil particles increased, which increased the friction between the compacted block and pile model. Increased soil density around the pile model increased friction, but this effect was only observed in a limited range around the pile model, so when it went beyond those bounds, it started to become lighter. However, there was also a reverse effect, which appeared as a result of driving the pile model, which collapsed almost all of the soil compacted block and divided into pieces. The collapsed portion only functions as a frictional component, but it could provide greater strength if it were kept together as a single block, which led to conclusion that it provided greater load capacity in the case of bored piles with improvement that kept the compacted block together as a single block.

Zhijun Zhou and Yuan Xie et.al., (2019) conducted an experiment to increase the pile foundation's bearing capacity using the post grouting approach. They watched how post grouted piles and conventional piles behaved in terms of end resistance, lateral friction and bearing capacity. The static load failure test of the pile foundation, in conjunction with the theory of grout-soil interaction and the Bingham fluid model, was used to analyse the mechanism of increasing the bearing capacity of post grouting at the end of the pile. The findings demonstrate that the interaction between the soil and grout strengthens the soil at the pile's end and encourages the application of end resistance. With the alteration of the interface property of pile-soil reduces while the lateral friction increases. Additionally, post grouting unmistakably enhanced the bearing characteristics of the pile, slowing settlement of the pile foundation and enhancing bearing capacity.

The post grouting decreased the pile settlement under the load and increased the soil's strength at the pile end. The pile foundation load carrying capacity was 28.57% greater than the traditional piles. The post grouting pile settled less than conventional pile under the identical load conditions, and the pile foundation settled 26.19% less than the conventional pile when the load on the pile top was 17500 kN. As the relative displacement of the pile and soil in the climbing portion of the grout, more lateral friction was exerted. Each portion of the pile's lateral friction was increased at the same time, and the effect of the increase diminishes upward towards the pile's end. In comparison to the traditional pile, the value of lateral friction under the ultimate load was increased by 16.13%.

Jiajin Zhou et al. (2020) examined the influence of the frictional capacity of the precast concrete pile cemented soil interface. To find out the frictional capacity of the precast concrete pile-cemented soil interface, a series of shear tests were carried out. The experiments were carried out in a shear test apparatus that had been specially designed. For various cemented-soil mixes, the unconfined compressive strength of the cemented soil was also measured. Consideration was given to the influence of the strength of the cemented soil while evaluating the friction capacity of the precast pipe pile-cemented soil interface. The test findings demonstrate that the strength of the cemented soil had a significant impact on the frictional capacity of the precast pipe pile-cemented soil interface. The strength of the cemented soil rose almost linearly with the peak friction resistance of the precast pile-cemented soil contact.

As the strength of the cemented soil increased from 65 to 1500kPa, the peak friction resistance at the precast pile-cemented soil interface increased virtually linearly increasing from 7.58 to 204 kPa. A correlation between the peak skin friction at the precast pile-cemented soil interface and the strength of the cemented soil is proposed. The strength of the cemented soil varied from 65 to 1500kPa, and the adhesion factor ranged from 0.116 to 0.141 with an average value of 0.129. The adhesion factor can be used to calculate the peak skin friction at the precast pile-cemented soil interface for pre-bored grouted planting pile design. Once the precast pile diameter, peak skin friction, and skin friction of the soil around the cemented soil are known, the diameter of the borehole (the diameter of the cemented soil zone) can be determined. As soon as the precast pipe pile-cemented soil interface achieved its maximum frictional resistance, brittle failure occurred. It has been discovered that the cemented soil strength has no effect on the residual skin friction at the contact. The precast pipe pile-cemented soil interface shear test showed the scale effect to be present as well. The precast pile-cemented soil interface had a lesser scale effect than the pile-sand interface, and the cemented soil did not appear to dilate during the shear test process. When the pile diameter was reduced from 85 to 37 mm, the scale effect factor was 1.9.

Qian Zhang et al. (2021) developed building tools and a procedure for a pressure-cast-in-situ pile with spray-expanded frustum to fully utilize the skin friction of the soils surrounding the pile. A unique pile known as the pressure-cast-in-situ pile with spray-expanded frustum was made up of ribbed plates, an expanded body with double frustum, and a pile body. The extended body was created using a multipurpose auger drill by vibrating and squeezing the pile body, pouring super fluid concrete, and rotatingly spraying cement slurry at a predetermined depth. With the help of a hollow drill pipe, cement slurry was fixed sprayed to complete the ribbed plates. The larger pile body's improved skin friction resulted in the new pile's increased bearing capacity. Additionally, the soils around the pile were compressed as a result of the super fluid concrete's squeezing impact during pile construction, which also clearly increased the unique pile bearing capacity. Static loading experiments on the three novel piles and one conventional cast-in-situ pile were used to confirm the use of the novel pile technique as proposed. Comparison between the four test piles show that, when the same amount of concrete is consumed per unit volume, the ultimate bearing capacity of the new pile increases by more than 45%. The pressure-cast-in-place pile with spray expanded frustum provides a substantial cost advantages and a bearing capacity for practical purpose.

## 4. CONCLUSIONS

From the brief review on use of friction pile to increase the bearing capacity of black cotton soil, it can be concluded that,

1. By compacting the soil, the cohesion of the soil particles increased, which increased the friction between the compacted soil block and pile model.
2. The post grouting decreases the pile settlement under the load and increases the soil's strength at the pile end.
3. As the strength of the cemented soil increased, the peak friction resistance at the interface of precast pile-cemented soil also increased.
4. Bearing capacity of the pressure-cast-in-situ pile with spray-expanded frustum increased with time due to increasing strength of the interface between compacted soil and pile body.

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