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A comprehensive study of types of foundation

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Abstract
To build any structure which can remain withstand during any calamity we need a perfect substructure which can easily and safely transfer the load to the ground and can support the superstructure. Foundation plays a very crucial role in stability of any structure. The selection and design of the foundation depends upon many factors including the soil type, nature (eccentric or concentric) and magnitude of the load over the structure. Different scientists and engineers gave many theories for computation of the bearing capacity of the soil. The bearing capacity of the soil is computed by considering the shear as well as settlement criteria whichever is less is taken into computation. Foundations are mainly classified into two types on the basis of the depth of the foundation which are as follows - Shallow foundation and Deep foundation. A lot of research works and publications dealing with these technologies have been insightful.

Keywords: Raft foundation, pile foundation, friction pile

Introduction
Foundations are essential components of any building structure, providing stability and support. There are several types of foundations commonly used in construction, each with its own unique characteristics and advantages. Understanding the different types of foundations can help ensure that the right foundation is chosen for a specific project.

Some common types of foundations include
Shallow foundations, which are typically used for smaller buildings and structures. These foundations are placed close to the surface of the ground and spread the load of the building over a larger area.
Deep foundations, which are used for larger buildings and structures that require additional support. These foundations extend deep into the ground to transfer the building's load to more stable soil or rock layers.
Pile foundations, which are a type of deep foundation that consists of long, slender columns driven into the ground. Pile foundations are often used in areas with weak or unstable soil conditions.
Raft foundations, which are large, flat foundations that spread the load of the building over a wide area. Raft foundations are commonly used in areas with poor soil conditions or where the building's load is distributed unevenly.
By understanding the different types of foundations available, builders and engineers can make informed decisions about which foundation is best suited for a particular project. Choosing the right foundation is crucial to ensuring the long-term stability and safety of a building structure. The foundation of a building is crucial to its stability and longevity. The foundation acts as the support system for the entire structure, transferring the weight of the building to the ground below. It is important for the foundation to be designed properly in order to withstand the various loads such as dead loads, live loads, and wind loads that the building will experience over its lifetime. The type of foundation chosen will depend on factors such as the soil conditions, building size, and local climate.
One key factor that must be considered when designing a foundation is the bearing capacity of the soil. Bearing capacity refers to the ability of the soil to support the weight of the building without excessive settlement or failure. The bearing capacity of the soil is determined through a series of tests and analyses, such as soil boring tests and plate load tests. It is important to ensure that the bearing capacity of the soil is adequate for the specific type of foundation being used in order to prevent structural failure or collapse.
The type of soil present at a construction site can greatly impact the design and construction

of a building's foundation. Different types of soil have varying properties, such as cohesion, angle of internal friction, and compressibility, which can influence the stability and bearing capacity of the foundation. It is important for engineers and architects to conduct thorough soil investigations and analysis in order to determine the most suitable foundation type for the specific soil conditions. By considering the soil properties, the foundation can be designed to effectively distribute the building loads and ensure its structural integrity for years to come.

Objective

The broad objective is to study the types of foundations, need to design a foundation as per various bearing capacity of soil and to study the criteria for determining the bearing capacity.

Methodology and Classification

There are various theories for classification of foundations given by various geotechnical engineers.

Terzaghi's Classification

This theory assumes the base of the foundation to be rough. He assumes that the shear resistance of soil above the foundation level is ignored, i.e., only base resistance is considered while side resistance is ignored, therefore this theory is not applicable for deep foundation.

He classified the foundation as

- **Shallow Foundation:** When depth of foundation is less than the depth of the foundation.
- **Deep Foundation:** When depth of foundation is more than the depth of the foundation.

He also assumed the foundation to be shallow with failure as general shear failure. The stress zone of the soil extends only up to the foundation level but not up to the ground level. He considered vertical and eccentric loading placed on horizontal surface and foundation level is also horizontal. Also, the Water Table is beyond the zone of influence of stress, i.e., Water Table is not considered.
Terzaghi's Equation of Ultimate Bearing Capacity
For strip foundation;

$$qu = CNc + qNq + 0.5B\gamma N\gamma$$

For square foundation;

$$qu = 1.3CNc + qNq + 0.4B\gamma N\gamma$$

For circular foundation;

$$qu = 1.3CNc + qNq + 0.3B\gamma N\gamma$$

For rectangular and raft foundation;

$$qu = (1+0.3B/L)CNc + qNq + (1+0.2B/L)B\gamma N\gamma$$

Skempton's Classification

This method is suitable for pure cohesive soil (Clay) but it can be applied for both shallow as well as deep foundation. This theory considers side resistance and base resistance.
He classified foundation as:

- Shallow Foundation - When depth of foundation is less than 2.5 times the width of the foundation.
- Deep Foundation - When depth of foundation is more than 2.5 times the width of the foundation.

Skempton's net ultimate bearing capacity
Nc is Skempton's Bearing Capacity Factor which depends upon Df/B.
When Df/B = 0 (Foundation at ground level)
For strip footing; Nc = 5
For square/ rectangle/ circular/ raft; Nc =6
When Df/B > 2.5 (deep foundation)
For strip footing; Nc = 7.5
For square/ rectangle/ circular/ raft; Nc = 9.0
When 0< Df/B < 2.5 (shallow foundation)
For strip footing; Nc = 5(1 + 0.2Df/B)
For square/ circular; Nc = 6(1 + 0.2Df/B)
For rectangle/ raft; Nc = 5(1 + 0.2Df/B)(1 + 0.2B/L)

Mayerhoff's Theory

This theory can be applied to rough shallow and deep foundations. It is most generalised theory in which shape factors, depth factors and inclination factors are used to account for shape of footing (Square, circular, rectangular, raft), variation of depth (Shallow and deep) and inclination of ground and load (Horizontal or inclined).
The stress zone is considered to be extended up to Ground level therefore Meyerhof theory is applicable for shallow as well as for deep foundation.

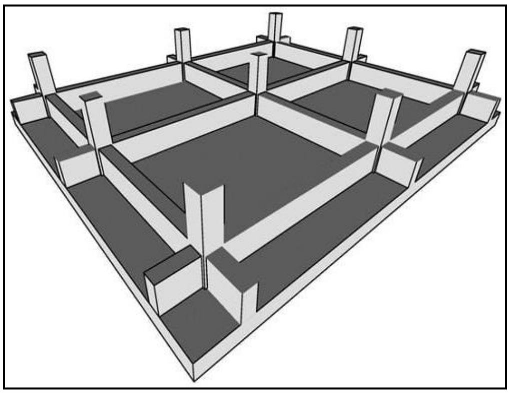

Fig 1: Raft Foundation with column and beam

Classification According to Materials Used piles may be classified as

a) Timber piles.
b) Concrete piles.
c) Steel piles.
d) Composite piles.

Timber piles: Circular seasoned wood can be used as piles. Their diameter may vary from 200 mm to 400 mm. The bottom of the pile is sharpened and is provided with iron shoe, so that it can be driven in the ground easily by hammering. These piles are cheap and can be easily driven rapidly. The main disadvantage is their load carrying capacity is low and are likely to be damaged during driving in the soil.

Concrete piles: These piles may be further classified as precast piles and cast in situ piles. Precast piles are reinforced with steel and are manufactured in factories.

Square, circular and octagonal sections are commonly used. The length of piles may be up to 20 m. They are provided with steel shoe at the lowest end.

Fig 2: Concrete Pile

These piles can carry fairly large loads. Cast in situ concrete piles are formed first by boring the holes in the soil and then concreting them. Concreting is usually made using casing tubes. If the hole is filled with only plain concrete it is a pressure pile. The load carrying capacity of the piles may be increased by providing an enlarged base.
The reinforcement caging may be inserted in the bored holes and to increase load carrying capacity one or two under reams may be formed. After that concreting may be carried out. Such piles are known as under reamed piles. These piles are provided at regular interval of 2 to 4 m and capping beam is provided over them.

Steel Piles: A steel pile may be a rolled steel I sections, tubes or fabricated in the form of box. These piles are mostly used as bearing piles since surface available for friction is less and also the coefficient of friction is less. These piles are very useful for driving close to existing structures since they disturb the soil least.

Fig 3: Steel Pile

Composite Piles: Composite piles may be of concrete and timber or of concrete and steel.

Fig 4: Composite Pile

Conclusion

The appropriate foundation may be essential to the project's progress and influences the construction project stages. In conclusion, foundations are an essential component of any structure as they provide the necessary support and stability to ensure the structural integrity of buildings. There are various types of foundations that can be used depending on the specific requirements of the project, including shallow foundations such as spread footings and mat foundations, as well as deep foundations like piles and caissons. Each type of foundation has its own benefits and can be chosen based on factors such as soil conditions, load requirements, and budget constraints. It is important to carefully consider the type of foundation to be used in a construction project to ensure adequate support and minimize the risk of settlement or structural failure.
One of the main benefits of using a properly designed foundation is its ability to distribute the loads of the structure evenly to the underlying soil, thereby preventing excessive settlement and ensuring long-term stability. The bearing capacity of a foundation is another crucial factor that must be considered during the design and construction process. The bearing capacity refers to the maximum load that a soil or foundation can support without experiencing failure or excessive settlement. By conducting thorough site investigations and analyzing soil properties, engineers can determine the appropriate type of foundation and size of footings to ensure the required bearing capacity is achieved.
In summary, foundations play a critical role in the construction of buildings and other structures, providing the necessary support and stability to ensure safe and durable construction projects.

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