Basics of Building Construction Technology

Chapters.....

- Building Materials
- Foundations
- Types of Bonds
- Concrete Structures
- Openings
- Roof
- Finishing Methods
- Building Rules

Foundations….

Foundation is the lowest part of the building or the civil structure that is in direct contact with the soil which transfers loads from the structure to the soil safely. Generally, the foundation can be classified into two, namely **shallow foundation** and **deep foundation.** A shallow foundation transfers the load to a stratum present in a shallow depth. The deep foundation transfers the load to a deeper depth below the ground surface. A tall building like a skyscraper or a building constructed on very weak soil requires deep foundation. If the constructed building has the plan to extend vertically in future, then a deep foundation must be suggested.

What is the Purpose of Foundation?

Foundations are provided for all load carrying structure for following purposes:

- Foundation are the main reason behind the stability of any structure. The stronger is the foundation, more stable is the structure.
- The proper design and construction of foundations provide a proper surface for the development of the substructure in a proper level and over a firm bed.
- Specially designed foundation helps in avoiding the lateral movements of the supporting material.
- A proper foundation distributes load on to the surface of the bed uniformly. This uniform transfer helps in avoiding unequal settlement of the building. Differential settlement is an undesirable building effect.
- The foundation serves the purpose of completely distributing the load from the structure over a large base area and then to the soil underneath. This load transferred to the soil should be within the allowable bearing capacity of the soil.

Functions of Foundation in Construction

Based on the purposes of foundation in construction, the main functions of the foundation can be enlisted as below:

1. Provide overall lateral stability for the structure
2. Foundation serve the function of providing a level surface for the construction of substructure
3. Load Distribution is carried out evenly
4. The load intensity is reduced to be within the safe bearing capacity of the soil
5. The soil movement effect is resisted and prevented
6. Scouring and the undermining issues are solved by the construction of foundation

Requirements of a Good Foundation

The design and the construction of a well-performing foundation must possess some basic requirements that must not be ignored. They are:

1. The design and the construction of the foundation is done such that it can sustain as well as transmit the dead and the imposed loads to the soil. This transfer has to be carried out without resulting in any form of settlement that can result in any form of stability issues for the structure.
2. Differential settlements can be avoided by having a rigid base for the foundation. These issues are more pronounced in areas where the superimposed loads are not uniform in nature.
3. Based on the soil and area it is recommended to have a deeper foundation so that it can guard any form of damage or distress. These are mainly caused due to the problem of shrinkage and swelling because of temperature changes.
4. The location of the foundation chosen must be an area that is not affected or influenced by future works or factors.

Types of Foundation and their Uses

Following are different types of foundations used in construction:

1. **Shallow foundation**
    - Individual footing or isolated footing
    - Combined footing
    - Strip foundation
    - Raft or mat foundation
2. **Deep Foundation**
    - Pile foundation
    - Drilled Shafts or caissons

What is Shallow Foundation?

The shallow foundation is also known as a stepped Foundation. If the depth of foundation is less than the width of foundation then it is known as Shallow or stepped Foundation.

It can be used where the bearing capacity of soil on which the structure is to be constructed is maximum then Shallow Foundation can be used. Minimum depth of this Foundation is 800mm and maximum depth not to be taken more than 4 meters.

Strip Foundations

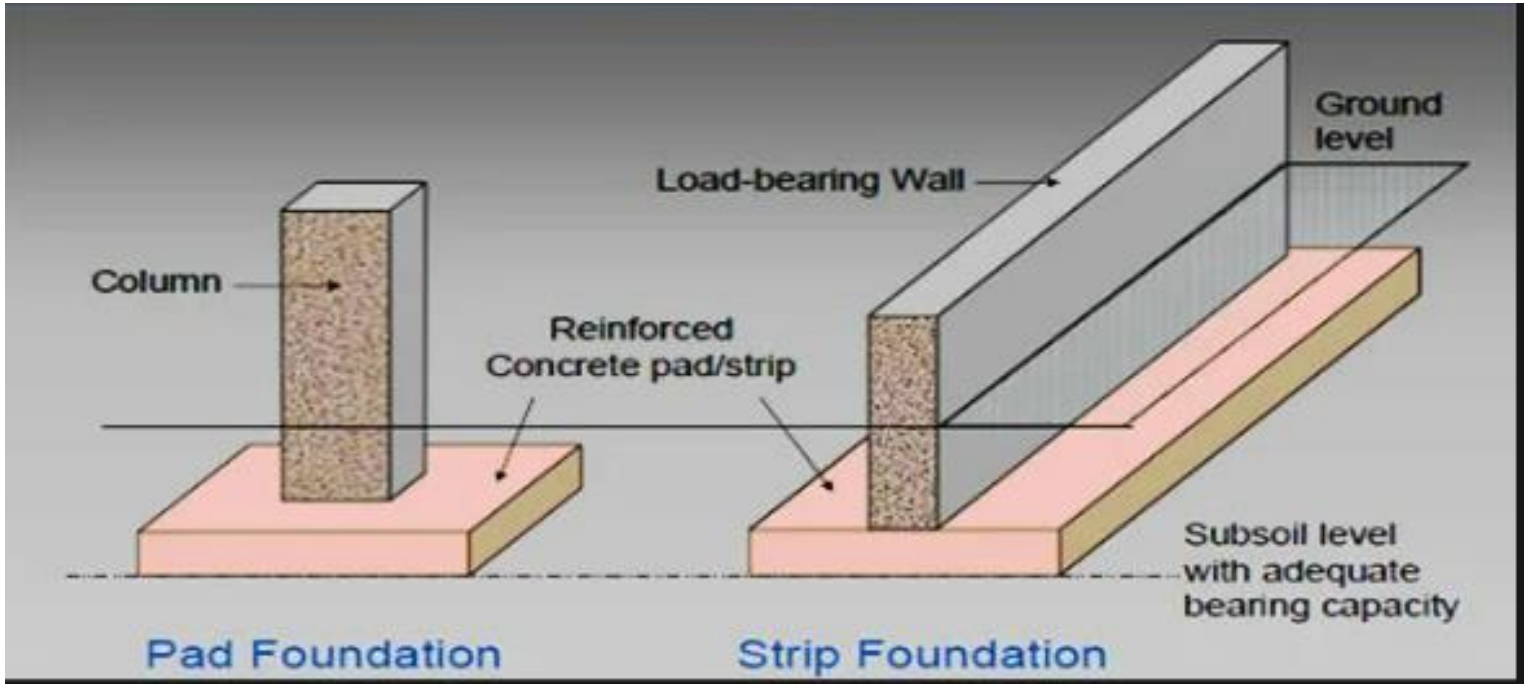
Strip foundations are one of the most commonly used foundations. They are generally used for ground where the subsoil is of a good bearing capacity. Strip foundations are designed for structures where the load is relatively modest, such as, low-to-medium rise domestic buildings. The traditional form of most house construction allows for the use of strip foundations.

Strip foundations consist of a continuous strip of concrete formed centrally under loadbearing walls. The continuous strip acts as support for which walls are built and is to a width to spread the load evenly of the building on the ground underneath it, supporting it. This is known as a 'uniformly distributed load' (UDL) and refers to the even transfer of a structure's loading at foundation level upon subsoil capable of supporting the load without undue compaction (See strip foundation table).

The minimum requirements for the depth of strip foundations are dictated by local ground conditions, but, as a rule, the depth of these foundations should be at least 450 mm below finished ground level to avoid damage from frost action in frost susceptible ground. (See BS 8004 for correct guidance on depth and width of foundations).

What is Pad Foundation?

The pad foundations are shallow foundation that take and spread point loads to the soil safely. The pad foundation are preferred if the soil at the site have sufficient strength and is not too deep to construct. The thickness of pad foundations are generally uniform. In some situations the upper surface can be stepped or sloped.The design of pad foundation is simple and straight which makes them an economic solution.



Design Principle of Pad Foundation

As defined, the pad foundation is supposed to spread the concentrated load safely to the bearing stratum. Hence, pad foundation must be designed stiff so that uniform spreading of the load to the soil must happen without making the foundation pressure exceed the permissible bearing stress. This requirement is achieved by either reinforcing the pad or making the pad deep. Both the methods helps to spread the force in a predefined angle. The angle of spreading is determined based on te bearing capacity of the underlying soil and the concrete strength. The size of the pad must be such that tension need to be prevented within the concrete so that no cracking is caused, which will result in failure. The ability to resist the punching shear is the governing criteria that determines the depth of reinforced concrete pad foundations. Another important factor governing the depth of pad is the ability to resist the bending. The pad foundation arrangement is mainly dependent on the load bearing capacity of the soil, the structure to be supported, available space and the imposed loads. Based on these factors the "pads" can be arranged as:

Raft foundation

Raft foundation designs may be proposed and submitted by a suitably qualified engineer if they are fit for purpose and cost-effective. It is essential the raft foundation provides adequate bearing capacity, accounting for latent settlement characteristics, which often depends upon the strata make up. The imposed load is distributed over a wider area, usually the entire footprint, and can be thought to 'float' on the ground in a similar manner to a raft floating on water.

They are constructed using reinforced concrete slabs of a consistent thickness throughout, generally 150mm-300mm with a waterproof membrane above. To minimise the likelihood of cracking, steel reinforcement can be integrated into the concrete raft; this method is more cost-effective in comparison to adjusting the thickness of the slab. Especially where there are complex ground conditions (contamination, groundwater, trees etc.) or where additional support is needed for specific loads. The types of raft foundation are as follows:

Deep foundations – Piled foundations

Piles are often described as columns within the ground. They can be an unpopular choice of foundation due to the requirement for heavy equipment and the expense and additional time this involves.

For sites with less favourable ground conditions, piled foundations are often the only plausible solution if a project is to commence. Piled foundations are installed where ground quality close to the surface is poor or variable. The use of such a deep foundation in these conditions is often obligatory. Generally Piled foundations are categorised into 2 different types, and they differentiate in type due to their method of installation.

Displacement Piles (Driven)

Displacement piles are installed by forcing or driving a solid pile or hollow casing into deeper substrata, which displaces the surrounding ground. This method of driving a pile into the ground is one that requires a lot of force and energy. A driving rig is commonly employed for this process. This technique can create difficulties due to the noise levels and vibration generated as a result of the driving operation. These undesirable characteristics often make this method unsuitable for congested sites where adjacent buildings may be structurally affected, or areas where noise nuisance is prohibited. (Code of practice, BS 5228 deals specifically with piling noise and vibration).

Replacement piles (Bored)

In contrast, replacement piles are installed by removing a volume of soil and 'replacing' it with load supporting piles. The soil is removed by using a hollow weighted grab or a rotary boring auger. The excavation is prevented from collapsing by introducing a hollow shell, normally made from steel, or the viscous liquid, Bentonite. The bentonite is then displaced by concrete as it is poured into the excavation. There are four generic forms of replacement pile, see below:

- Bored cast in-situ piles (small diameter)
- Bored cast in-situ piles (large diameter)
- Friction piles and end-bearing piles
- Grout injection piles

Connection to piles

In many cases, piles are subjected to point loads. It is often the case that the load of the building will exceed the capacity of one single pile column. Therefore, piles are frequently grouped together to support the applied load. The connections to the end of piles are called Pile caps; they are used to link the heads of adjacent piles and to provide a platform for a buildings load. Ground beams are introduced to pile connections in order to uniformly distribute the load (UDL) of traditional built dwellings, therefore, acting as a suitable interface between walls and pile.

The ground beam is normally cast in-situ by using shuttering around pile caps. The concrete is poured into the shuttering, and is normally reinforced with a steel-rebar ring beam cage. Concrete spacers are installed to the steel reinforcement to ensure that, when the concrete sets, there is adequate coverage of the steel to avoid the steel corroding (See BS 7937 for guidance on concrete spacers).

To conclude, piled foundations should be installed by an appropriate specialist under a Structural Engineer's supervision. All piles should be suitable for their design load. Once installed, piles should be integrity tested to ensure the piles can support their designated load.