Foundation

Foundation: It is the structure which is provided at the base of the building below the super structure and which is constructed to transmit the load of the superstructure directly into the soil is called as foundation.

Purpose:

- To transmit the load of superstructure safely into the soil.
- Providing plain platform for the super structure
- Reduce the unequal settlement.
- To hold the building in its position

Site Exploration: it is the process of acquiring the complete information about –

- Safe bearing capacity of soil.
- Type of foundation
- Type of soil
- Characteristics of soil.
- Depth at which foundation must be taken into the soil.
- To know the ground water table
- Difficulty which will comes in construction.

Some important definitions;

Gross pressure intensity (q): the gross pressure intensity ‘q’ is the total pressure at the base of footing due to the weight of the superstructure, self weight of the footing and weight of the earth fill if any.

Net pressure intensity (qn) : it is defined as the excess pressure or the difference in the intensities of the gross pressure after the construction of the structure and the original overburden pressure.

Ultimate bearing capacity: the ultimate bearing capacity is defined as the minimum gross pressure intensity at the base of the foundation at which the soil failure in shear.

Net ultimate bearing capacity: It is the minimum net pressure intensity causing shear failure of the soil. The ultimate bearing capacity and net ultimate black cotton are evidently connected by the relation

$$(QF)=(qnf) +r.D$$

Net safe bearing capacity (qns): the net safe bearing capacity net ultimate black cotton divided by factor of safety

$$(qns)=qnf/f$$

Safe bearing capacity: the maximum pressure at which the soil can carry safely without risk of shear is called the SBC of soil

Allowable bearing capacity: it is not the net loading intensity neither soil fails in shear nor there is excessive settlement.

Method of testing bearing capacity:

- Analytical method
- Plate load test
- Standard Penetration test
- Method of loading
- Method of dropping weight
- Presumptive values of bearing capacity.

Types of foundation:

A) Shallow foundation

B) Deep foundation

a)Types of shallow foundation

- Spread Footing
    - Wall footing
    - Reinforced concrete footings
    - Inverted arch footings
    - Column footings
- Grillage Foundation
- Eccentric loaded footing
- Combined Footing

- Mat or raft foundation

Short Description of foundations:

1] Spread footing: in this type of foundation the base member transmitting load to thesis is made wider so as to distribute the load over wider area. The type of the spread foundation is stated above.

2] Grillage Foundation: when heavy structural load from the column, piers or stanchion are required to be transferred to the soil of low bearing capacity, grillage foundation is used in such a condition.

(a) Steel grillage: Steel grillage foundations consists of still beams (RSJ) also known as grillage beams which are provided in single or double tiers. In the case of the double tier grillage , the top tier is laid at right angles to the bottoms the grillage beams of each tier are held in position by 20mm spacer bars with 25 mm die pipe sepreatorThe beam are suitably spaced so as to provide facilities for the placing and robbing of concrete between them.
(b) Timber Grilllage : Wherethe soil encountered is soft and is permantly water-logged building walls can be economically supported by suitably designed timber grillage foundations. This type of foundation can be safely used for light building by limiting the loading on the soil to 5.5 tonne/m2. In this type of foundation the concrete blocks usually provided below the wall footing is replaced by timber platform.

Eccentrically loading footing :As far as possible , the foundation ,(itmay be for a wall or column) should so shaped and proportional that the centre of gravity of imposed loads coincide with the c.g. of the supported area of the base.

(a) Offsetting the footings : The footing of a boundry lad bearing wall is so shaped so as to have considerable wider base with requlars offsets on the inside while the outside wall face is kept flush with the boundry line. As is obivious , the imposed load acting on one side of the centre of of the footing loads the supported area unequally.
(b) By providing strap footing : offsetting of the footing is desirable in firm soil, while in soft soil and under heavy loading conditions ,there is danger of the maximum pressure at the outer edge of the footing exceeding the bearing capacity of soil. In such a condition the outer weight of the column is adjusted by the weight of inner column.

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Combined footing : A combined footing is so proportional thatbthe centre of gravity of the supporting area is in line with the c.g. of the two column loads. A combined footing may be rectangular or trapezium in shape . Rectangular shape is only possible where loading conditions is such that either the two column are equally loaded or the interior column carries greater load. On the other hand ,in case of trapezodial footing no such condition is applicable.

Raft footing:

Raft foundation is a large combined thick slab designed to seat and support the whole or a large part of a structure.

A raft is usually used when subsoil is weak, or columns are closely located and with deviated loadings. It also serves as a transfer slab to combine and tie up all the vertical loading elements to the plate-formfoundation. By doing so, differential settlement can be avoided.

Foundation Material:

The foundation would normally consist of one or more the following materials :

· concrete
· concrete block
· brick
· stone.

If the concrete block is fully grouted and reinforced, it will tend to act as concrete. If it is not grouted or reinforced, it will act as brick or stone
Continuous concrete footings and foundation walls are the best material type.
This is one reason their presence is required in some prescriptive standards.
Expansion anchors require concrete and are not approved for connections to masonry.
Some adhesive anchor products can be used for reinforced masonry.
Reinforced masonry is not as strong as concrete but when fully grouted is strong enough to resist the seismic loads of light wood frame buildings.
Hollow masonry is usually unreinforced.
When the foundation walls or footings are constructed with any unreinforced material such as stone or pre-1933 brick, retrofitting requires the expertise of an engineer or architect. Many engineers believe that unreinforced masonry materials cannot adequately resist seismic loads. Common retrofit methods for unreinforced masonry foundations include replacement, new parallel systems or strengthening by pneumatically placed concrete (shotcrete or gunite).

Foundation Conditions :

- **Deterioration**

Deterioration of the foundation wall is normally visible to the naked eye. Before beginning work, a visual inspection of the foundation walls can find excessive concrete or masonry cracking and weathering . Mortar in reinforced masonry should be well pointed and tooled. Existing concrete should be smooth and without separation or exposure of stone aggregates. Poorly finished and consolidated concrete frequently suffers later from excessive weathering. If parging or repointing cannot repair the wall, a full foundation retrofit is required. You will learn more about this later in this section.

- **Foundation Cracking**

When concrete foundation walls are constructed without expansion joints, hairline crackling will normally occur. Cracks that are wider at the top than at the bottom are often caused by expansive soil. When the crack is wider at the bottom than at the top, there is likely a problem with soil settlement. These problems can prevent the seismic loads from safely dissipating through the soil (Fig. 5-11).

The effects of expansive soils are best reduced with deepened footings and control of adjacent watering. Keeping roof and surface water away from footings is always a good idea since settlement can also occur with excessive water in the soil. Underpinning, roof gutters with downspouts to yard drains and new concrete paving can help alleviate expansive soil problems. The presence of expansive soils or foundation settlement indicates the need for professional advice. Geotechnical engineers specialize in solving these problems.

Depending on the size of the crack, concrete cracking can be repaired with various epoxy or cementitious mortars. These products require special inspection and careful quality control by the approved applicator. These products should be used only under the qualified advice of an engineer or architect

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Foundation in black cotton soil:

Constructionon black cotton soil,commonly known as a shrinkable soil has always been a difficult problem for the engineer. First the the type of expansive soil like black cotton should be modified by chemical admixtures, which is a common method for stabilizing the swell shrink tendency of expansive soils. The advantages of chemical stabilization are that they reduce the swell shrink tendency of the expansive soils and also render the soils to be less plastic. Among the chemical stabilization methods for expansive soils, other methods like lime stabilization is most widely adopted method for improving the swell shrink characteristics of expansive soils. Lime stabilization of clays in field is achieved by shallow mixing of lime and soil or by deep stabilization technique. Shallow stabilization involves scarifying the soil to the required depth and lime in powder or slurry form is spread and mixed with the soil using a rotovator. The use of lime as deep stabilizer has been mainly restricted to improve the engineering behaviour of soft clays deep stabilization using lime can be divided in three main groups: lime columns, lime piles and lime slurry injection.

So foundations for these type of soil may be like Deep foundations, where in situations the soil at shallow depth is poor, the depth of foundation is increased till suitable soil stratum is met. Piles and piers are examples of deep foundations. Lightly loaded structures on expansive clay such as black cotton soil, which is seen mostly in south India and more so in places nearby to Chennai, these are most susceptible for damages as a result of volume changes in the soil. Under reamed piles are most suitable as foundation for houses in such areas. The pile with a bulb at the bottom are taken to a suitable depth and founded in a zone where seasonal moisture variation is less.

Precautions:

The following precautions are generally adopted while building structures on black cotton soil:

1. To limit the load on the soil to 5.5 tonnes/ sqr. m. if water is liable to to find an access to the foundations, the limit of loading should be restricted to 4,900 kg/ sqr. m.

2. To take the foundation to such depths where the cracks cease to extend. The minimum depth of foundation should be at least 1.5 m.

3. To provide reinforced concrete ties or bands all around the main walls of the building. The R.C.C ties or bands which may be 10 cm to 15 cm deep should be placed at plinth level, lintel level and eaves level. In case of flat roof, R.C.C slab it self acts as a tie and as such no extra band needed to be provide near the roof in such cases.

4. If the depth of the black cotton soil at a given site is only 1 to 1.5 m, the entire black cotton soil above the hard bed may be completely removed and the foundation may be laid on the hard bed below.

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5. The swelling of soil in direct contact with the foundation material causes maximum damage. Hence it is necessary to prevent the direct contact of black cotton soil with masonry work below ground level. These can be achieved by making wider trenches for foundation and filling spaces on the either side of the foundation masonry with sand or moorum.

6. The bed of foundation trench should be made firm or hard by ramming it well. On the rammed bed a 30 cm layer of good hard moorum should be spread in layers of 15 cm, each layer being well watered and rammed before laying the next layer. On this layer either stone or sand bed should be provided to the desire height to place the foundation concrete bed block upon it.

7. In case of ordinary buildings, the foundation should be taken at least 30 cm deeper than the depth where the crack stop.

8. In important structures raft foundation should be provided so as to float the building on the bed below the depth, quite independent of the surrounding soil.

9. For less important structures like compound walls etc., the foundation should preferably be taken at least 15 cm below the depth at which cracks in soil cease to occur.

10. Construction in black cotton soil should be undertaken during dry season.

11. The masonry for the walls should start at least 15 cm below the general ground level.

12. The width of trench for main walls or load bearing walls of a building should be dug 40 cm wider than the width of foundation. This is necessary to ensure provision of at least 20 cm wide layer of coarse sand on either side of foundation masonry thereby separating the sub-structure from having direct contact with black cotton soil.
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In case of compound wall, width of sand layer on either side of foundation masonry could be 15 cm.

Merits and demerits:

Merits: The enrich agro-friendly contents make black cotton soil fertile. These soils are highly moisture retentive, thus responding well to irrigation. These are enriched with calcium carbonate, magnesium, potash and lime which are all nutrients. Poor phosphoric contents render rich production of corps like cotton. The iron-rich granular structure makes them resistant to wind and water. Fertility, erosion resistance, and properties of retaining moisture in

their grain are the most useful condition for better crops growth. So these soils are the best option for farmers who like to produce plenty of crops.
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Demerits: These soils contain fine clay particles. This property induces a great affinity to water of such type of soil. Alternate swelling and shrinkage in extensive limit during wet and dry process respectively results cracks in soil without any warning. These cracks may sometimes extent to severe limit like ½" wide and 12" deep. So building to be founded on this soil may suffer severe damage with the change of atmospheric conditions.

Pile foundation :

A pile is a column of concrete that extends downward deep into the soil.

Piled foundations consist of a number of piles connected by a ring of concrete called a ground beam. This is similar to a strip foundation but not as wide.

One method of construction is to drive precast piles into the soil using specialised percussion drivers.
The other method requires the drilling of a pile hole in the soil, which is then poured with concrete and reinforced with steel.

Once the piles are complete, the ground beam can be created. This is the surface of which the walls of the dwelling can be built.

A compacted hardcore base of minimum 150mm is installed to form a platform for the subfloor and the subsequent loads of the dwelling.

The 150mm concrete subfloor is poured on the hardcore in order to provide a strong, smooth platform for the insulation.

A radon barrier is installed to form a continuous seal on the entire footprint of the house.

A Damp Proof Course is installed in order to repel any rising moisture. It is vital that the DPC is carried up into the blockwork to form a water tight seal over the entire floor area.

The DPC must run through the blockwork at a minimum of 150mm above finished ground level.

100mm of rigid insulation is installed below the finished floor to ensure that there is no heat

lost through the foundation.

75mm concrete screed then provides the finished floor.

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