2.1Depth of foundation:

Many factors affect the depth of foundation. such as type of soil, ground water table, loads from structure, bearing capacity and density of soil and other factors. The minimum depth of foundation is calculated by Rankine's formula when the bearing capacity of soil is known by soil investigation report.

General factors to be considered for determining depth of foundation are:

1.Load applied from structure to the foundation

2.Bearing capacity of soil

3.Depth of water level below the ground surface

4.Types of soil and depth of layers in case of layered soil

5.Depth of adjacent foundation

The minimum depth of foundation should be considered to ensure that the soil is having the required safe bearing capacity as assumed in the design. However, it is advised to carry out soil investigation before deciding on depth of foundation.

Soil investigation report will suggest the foundation depth based on the type of structure, soil properties, depth of water table, and all other variable that should be considered. Soil investigation report provides bearing capacity of soil at different levels and at different locations.

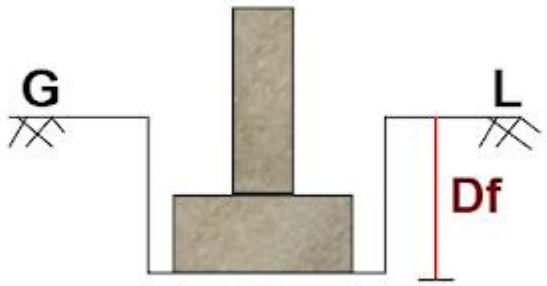

Fig 1.Depth of Foundation

[Fig 1 https://www.paramvisions.com/2021/04/calculating-depth-of-foundation-by.html]

When the soil investigation report is not available, the depth of foundation should be selected such that it is not affected by swelling and shrinking of soil due to seasonal changes. Depth of foundation should also consider the depth of water table to prevent and scour below the ground.

For foundation near existing foundation, it must be ensured that pressure bulbs of foundations do not coincide if the depth of new foundation has to be taken below the depth of existing foundation.

The foundation should not be contracted at shallow depth considering the frost action in cold countries.

Rankine's formula provides the guidance on minimum depth of foundation based on bearing capacity of soil.

Rankine's Formula

$$h = \frac{p}{\gamma}\left(\frac{1 - sin\varphi}{1 + sin\varphi}\right)^2$$

Where, h = minimum depth of foundation

p= gross bearing capacity

γ= density of soil

φ= angle of repose or internal friction of soil.

The above formula does not consider the factors discussed above and just provides the guidance on minimum foundation depth, assuming that the foundations are not affected by factors such as water table, frost action, types and properties of soil etc. as discussed above. This formula does not consider the loads from the structure on the foundation.

In the Rankine's formula, it can be seen that foundation depth depends on the bearing capacity of soil, so, if the bearing capacity of soil increases, the depth of foundation also increases.

FACTORS AFFECTING DEPTH OF FOUNDATION

- Before calculating depth of shallow foundation, the following factors have to be considered well in advance.
- Foundation should be placed at such a depth so that it is safe against damages due to swelling, shrinkage or freezing of sub soil.
- Bearing capacity of soil beneath the foundation must be adequate to support the load coming from foundation.
- If foundation has to be placed on cohesive soil, then the settlement due to consolidation should not be excessive.
- Never place foundation on loose or disturbed soils which have a tendency to erode by wind or flood.
- If possible then foundation should be placed above ground water table as this can avoid cost of pumping, and can prevent instability of soil due to seepage of water into the bottom of an excavation.
- Make an investigation on foundation soil to know its physical and chemical properties, because presence of sulphate can damage foundation.

To perform its function properly a footing must be laid at a suitable below the ground surface. The vertical distance between ground surface and the base of the footing is known as the depth of the footing(D_f). The depth of the footing contains the ultimate bearing capacity and the settlement. While fixing the depth of footing, the following points should be considered.

1.Depth of top soil:

The footing should be located bellow the top soil consisting the organic materials which eventually decompose. The top soil should be removed over an area slightly larger than the footing.

2.Frost depth:

The footing should be carried bellow the depth of frost penetration. If the footing is located at insufficient depth, it would be subjected to the frost damage due to formation of ice lenses and consequent frost heave. During summer, thawing occurs from the top downwards and the melted water is entrapped

3.Zone of soil volume change:

Some clay, especially clays having high plasticity, such as black cotton soil, undergoes excessive volume changes. Such soil shrinks upon drying and swells upon wetting. The volume changes are generally greater near the ground surface and decreases with increase in depth. Large volume change beneath a footing may cause lifting and dropping. The footing should be placed bellow as strata that are subjected to large volume change.

4.Adjacent footing and property lines:

- The footing should be so located that no damage is done to the existing structure. The adjacent structure may be damaged by construction of a new footing due to vibrations, undermining or lowering of the water table. The new footing may also impose additional load on the existing footing which may cause settlement.
- In general, deeper the new footing and closer to the existing structure the greater is the potential damage to the existing structure. This is this is particularly more severe if the new footing is lower than the existing footing.
- As far as possible, the new footing should be placed at a small depth as the old ones and the sites of excavation adjacent to the existing structure should be suitably supported. If the footings are placed at the different levels, the slope of the line joining the two footings should not be steeper than two horizontal to one vertical as per IS: 1904-1978.

5.Sloping ground:

If a footing is located adjacent to a sloping ground, the sloping ground surface should not encroach upon a frustum of bearing material under the footing having sides

making an angle of 30‟ with the horizontal. Moreover, the minimum distance from lower edge of the footing to be sloping ground surface should be 90cm.

6.Water table:

The footing should be placed above ground water table as far as possible. The presence of ground water within the soil immediately around a footing in undesirable as it reduces the bearing capacity of the soil and there are difficulties during construction. The water proofing problem also arises due to dampness.

7.Scour depth:

The footings located in streams, on water fronts or other locations where there is a possibility of scouring should be placed below the potential scour depth.

8.Underground defects:

The depth of footing is also affected by the presence of underground defects such as faults, causes and mines. If there are manmade discontinuities, such as sewer lines, water mains, underground cables, these should be shifted or footing should be relocated.

9.Root holes:

If there are root holes or cavities caused by burrowing animals or worms, the footing should be placed bellow such a zone of weakened soil.

10.Minimum depth:

IS 1904 – 1978 specifies that all foundations should extend to a depth of a least 50cm below the natural ground surface. However, in case of rocks, only its top soil should be removed and the surface should be cleaned and if necessary stepped.