# Fundamental of soil and its classification

## Definition:

The term soil in soil engineering is defined as an unconsolidated material, composed of solid particles, produced by the disintegration of rocks.
The void space between the particles may contain air, water or both. The soil may contain organic matter.
Main important functions of soil are:

a) as a medium of plant growth
b) as a means of water storage, supply and purification
c) as a habitat for organisms

## Formation of soil:

Soil are formed from rocks through the process of weathering and natural erosion, water, wind, temperature change, chemical interaction, living organisms and pressure difference all help break down parent material.
The type of parent materials and the conditions under which they break down will influence the properties of the soil formed.
For example, the soils formed from granite are often sandy and infertile whereas basalt under moist conditions breaks down to form fertile clay soils

## Some important definition:

**Water Content**: It is defined as the ratio of weight of water to the weight of solid.

$$w = (W_w / W_s) * 100$$

**Void Ratio (e):** It is defined as the ratio of volume of voids to the volume of solids.

$$e = (V_v / V_s)$$

**Porosity(n):** It is defined as the ratio of volume of voids to the total volume.

$$n = (V_v / V)$$

Volume of voids=volume of water + volume of air

Total volume=volume of voids+ volume of solids

**Permeability:** The property of soil by which it permits the flow of fluid through it, is called permeability of the soil . A soil with high porosity has high permeability.

# Classification of soil:

The classification of soil based on various system such as;

a) Preliminary Classification
b) Geological Classification
c) Classification by structure
d) Grain size Classification
e) Unfined Soil Classification
f) Indian standard soil classification

## Preliminary Classification:

In this approach, soils are described by designations such as boulder, gravel, sand, silt, clay, peat, china clay, bentonite, black cotton soil etc.

Boulder, gravel and sand belong to the category of coarse grained soils, distinguished primarily, by the particle size. They do not exhibit the property of cohesion and so said to be cohessionless soil.

Silt refers to a soil with particle sizes finer than sand and it is inorganic in nature. It exhibits some degree of plasticity.

Clay posess high plasticity over a firmly range moisture content. Three major clay minerals are kaolinite, illite and montemorillonite. China clay is a pure white clay.

## Geological Classification:

Soils may be classified on the basis of their geological origin. The origin of a soil may refer either to its constituents or to the agencies responsible for its parent state.

Based on constituents soil may be classified as,

a) inorganic soil

b) organic soil

Based on the agencies responsible for their present state, soil may be classified as,

a) Residual Soil

b) Alluvial Soil (transported by water)

c) Glacial Soil (transported by glaciers)

d) Lacustrine Soil (transported by lakes)

e) Aeoline Soil (transported by air)

## Classification By Structure:

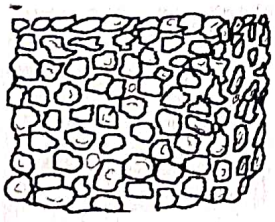
Depending upon the average grain size and the condition under which soils are formed and deposited in their natural state.

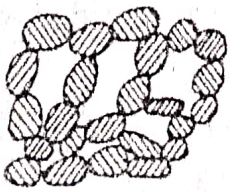
They may be classified by their structure,

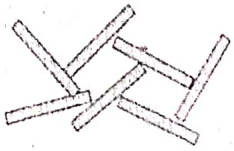
a) Soils of single grained structure

b) Soils of honey comb structure

c) Soils of flocculent structure







## Grain Size Classification:

Classification of soil based on the grain size distribution such as,

Soil with particle size less than 0.075 mm is called **Fine-Grained** soil (**Silt** or **Clay**) and soil with particle size in between 80 mm to 0.075 mm is called **Coarse-Grained soil(gravel)**.

However, soil with particle size less than 0.002 mm is called **Clay** and soil with particle size in between 0.075mm to 0.002 mm is called **Silt**.

## Unified Soil Classification:

In this system , soils are classified into broad categories,

a) Coarse grained soils with upto 50% passing through 75 micron sieve
b) Fine grained soils with more than 50% passing through 75 micron sieve

Each soil component is assigned a symbol as,

Gravel:- G  Silt:- M  Sand:- S  Clay:-C  Peat:- Pt

## Indian Standard Soil Classification System:

According IS soil is classified into 3 categories

1) **Coarse**: More than 50% of total weight is larger than 75 micron
2) **Fine:** More than 50% of total weight is smaller than 75 micron

**Highly organic soil:** These soil contains large % of organic matter and particles of decomposed vegetation.

# Fundamentals of foundation 23/04/20

Foundation are commonly known as substructure that are positioned below the ground level.

Foundations should be fulfill the structural requirements such as safe, be able to carry the load of the building and constructional requirements such as schedule, minimal resources, minimal cost.

In engineering, a foundation is the element of a structure which connects it to the ground and transfer load from the structure to the ground.

## Types of Foundation and their Uses:

Following are different types of foundations used in construction:

### 1. Shallow foundation

a) Individual footing or isolated footing
b) Combined footing
c) Strip foundation
d) Raft or mat foundation

< 0.075 F.G
80 - 0.075 C.G
< 0.002 clay
0.075 - 0.002 Silt

## 2. Deep Foundation

a) Pile foundation
b) Pier foundation
c) Caisson Foundation

## Types of Shallow Foundations & their uses

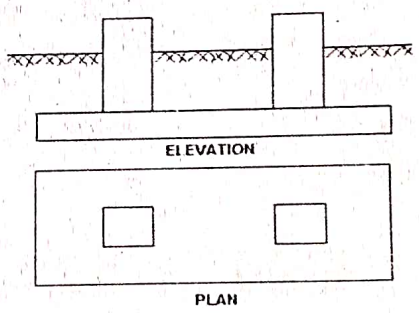
Shallow foundations are applicable where the soil surface is firm and strong enough to carry the structural load.

In shallow foundation mostly, the depth of the foundation is less than the width of the foundation.

### 1. Individual Footing or Isolated Footing

Individual footing or an isolated footing is the most common type of foundation used for building construction. This foundation is constructed for single column and also called as pad foundation.

The shape of individual footing is square or rectangle and is used when loads from structure is carried by the columns. Size is calculated based on the load on the column and safe bearing capacity of soil.

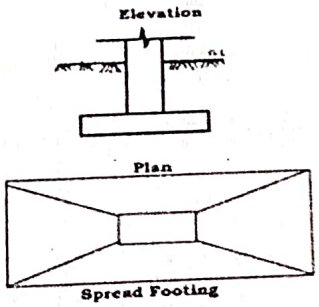



### 2. Combined Footing

A combined footing supports two columns. It is used when the two columns are so close to each other that their individual footings would overlap.

A combined footing is also provided when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line.

By combining it with that of an interior column, the load is evenly distributed. A combined footing may be rectangular or trapezoidal in plan.

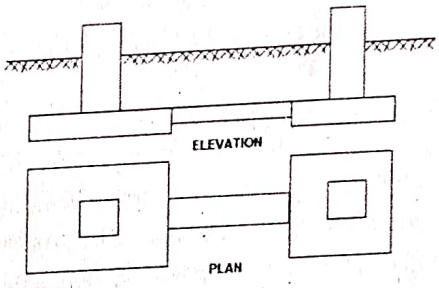


## 3. Strap or Cantilever Footing

A strap (or cantilever) footing consists of two isolated footings connected with a structural strap or a lever.

The strap connects the two footings such that they behave as one unit. The strap is designed as a rigid beam.

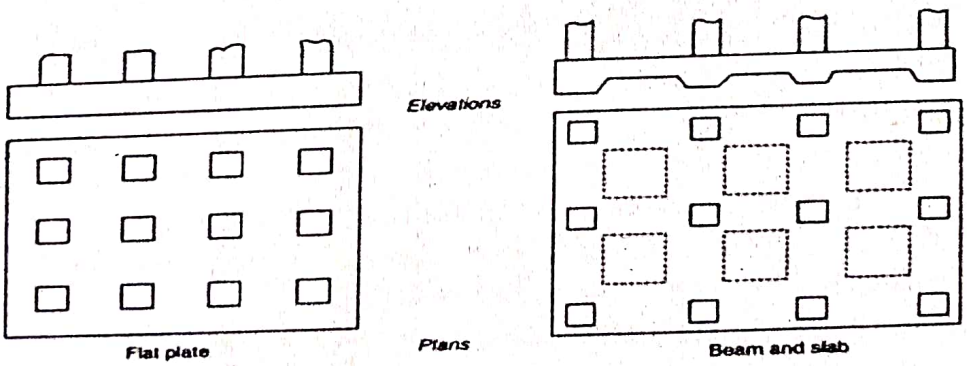
The individual footings are so designed that their combined line of action passes through the resultant of the total load. a strap footing is more economical than a combined footing when the allowable soil pressure is relatively high and the distance between the columns is large.




## 4. Mat or Raft Foundations

A mat or raft foundation is a large slab supporting a number of columns and walls under the entire structure or a large part of the structure. A mat is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each other.

Mat foundations are useful in reducing the differential settlements on non-homogeneous soils or where there is a large variation in the loads on individualcolumns.



## DEEP FOUNDATION:

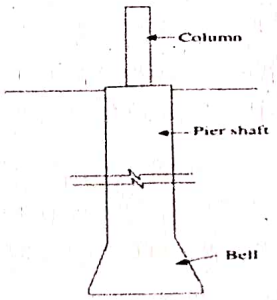
Deep foundations are used where the soil bearing capacity near the earth surface is too low. Here, the structural load could transfer through long, slender material to the deep where the strong soil layer is available.
When compare to shallow foundation, deep foundation need enough time period, skilled labours, heavy machinery.

### 1. PILE FOUNDATION:

Pile foundations are principally used to transfer the loads from superstructures, through weak, compressible strata or water onto stronger, more compact, less compressible and stiffer soil or rock at depth, increasing the effective size of a foundation and resisting horizontal loads.

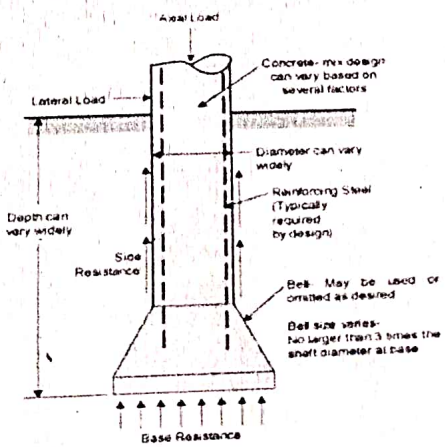
### 2. PIER FOUNDATION

A **pier foundation** is a collection of large diameter cylindrical columns to support the superstructure and transfer large super-imposed loads to the firm strata below. It stood several feet above the ground. It is also known as "post **foundation**".




### 3. CAISSON FOUNDATION

Caissons are hollow substructures designed to be constructed on or near the surface and then sunk as a single unit to their required level.



25/04/20

# FUNDAMENTALS OF IRRIGATION ENGINEERING

The science of planning and designing a water supply system to the plants, crops, for their normal growth during the period of no rainfall with the help of dam, weir, barrage, reservoir and canal system with head works, cross drainage works, and miscellaneous works of canal like canal fall is called Irrigation.

## Advantages of irrigation:

**Increase in food production:** Irrigation helps in increasing cropyields,and hence to attain self-sufficiency in food.

**Optimum Benefits:** Optimum utilisation of water is made possible by irrigation. By optimum utilisation, we generally mean, obtaining maximum crop yield with required amount of water.

**Elimination of mixed cropping:** In the areas, where irrigation is not assured, generally mixed cropping is adopted. By mixed cropping, we mean sowing together of two or more crops in the same field.

**Generation of Hydro-electric power:** Cheaper power generations can be obtained from water development projects, primarily designed for irrigation alone.

## Disadvantages:

# Irrigation may contribute in various ways to the problem of water pollution. One of these is the seepage into the ground water of the nitrates, that have been applied to the soil as the fertilizers.

# Over irrigation may lead to water logging and may reduce crop yields.

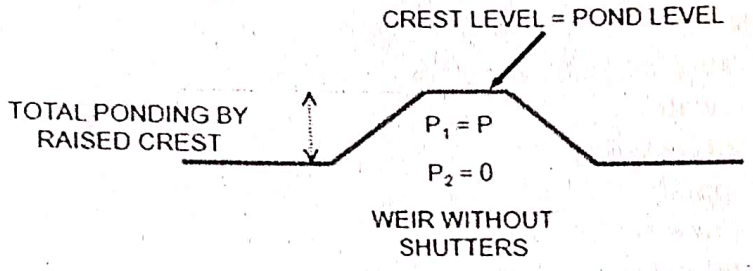
# Irrigation may lead to marshy land and breeding o mosquitoes, causing out break of diseases like malaria and dengu.

# INTRODUCTION TO HYDRAULIC STRUCTURE

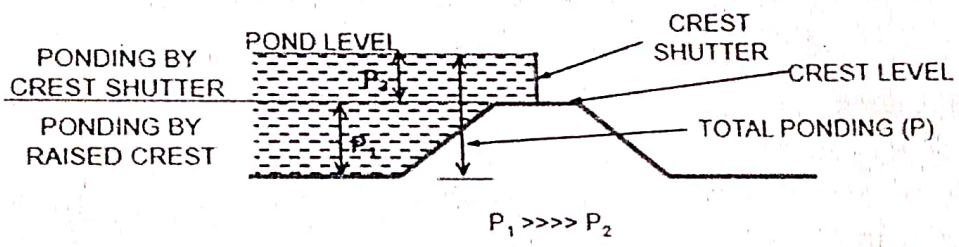
- A **hydraulic structure** is a structure submerged or partially submerged in any body of water, which disrupts the natural flow of water. They can be used to divert, disrupt or completely stop the flow. An example of a hydraulic structure would be a dam, which slows the normal flow rate of the river in order to power turbines. A hydraulic structure can be built in rivers, a sea, or any body of water where there is a need for a change in the natural flow of water.
- Hydraulic structures are siphons, weirs and dams etc.

## WEIRS:

A weir is an impervious barrier constructed across a river to raise the water level on the upstream side. The water is raised up to the required height and the water then flows over the weir. In a weir the water overflows the weir, but in a dam the water overflows through a special place called a spillway. Weirs have traditionally been used to create mill ponds. They are also used to prevent flooding, measure discharge, and help render a river navigable.



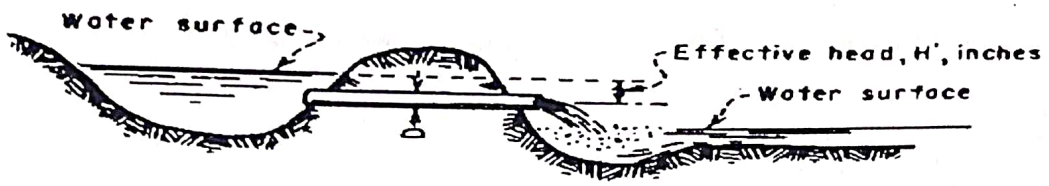

**(a) Fig: Weir without shutters**



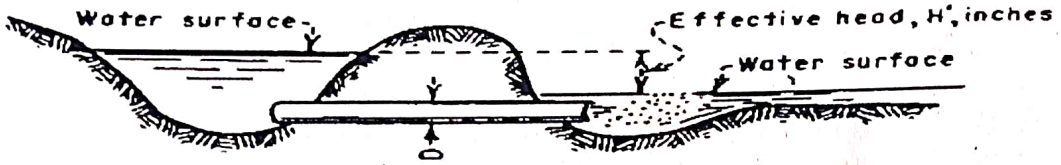

**(b) Fig: Weir with shutters**

## Siphon

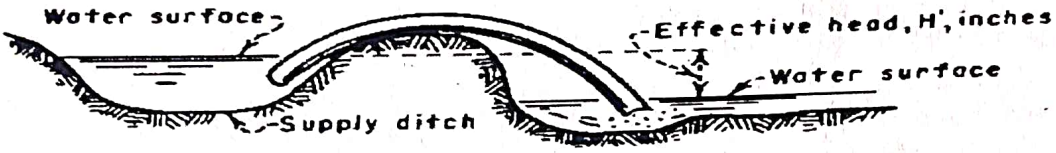
- **Siphon tubes** are a basic implement used in irrigation to transfer water over a barrier (such as the bank of a raised irrigation canal), using the siphon principle.
- At the simplest they consist of a pipe with no working parts. To work they rely on the water level in the canal being at a higher level than the water level in the field being irrigated.
- Like any siphon they must be primed (that is, filled with water) before they will start reliably transferring water. However, once primed and positioned correctly, they will continue transferring water from the source to the destination.




FREE-DISCHARGING PIPE




SUBMERGED PIPE




SIPHON

## DAM:

A dam is a high impervious barrier constructed across a river valley to form a deep storage reservoir. The surplus water is not allowed to flow over the dam, but it flows through the spillways provided at some level built into the dam.