SOIL AND FOUNDATION ENGINEERING

INTRODUCTION

- **Soil :-** An unconsolidated material composed of solid particles produced by the disintegration of rocks.
- **Soil mechanics :-** It may be defined as the branch of science which deals with the study of soil, its behaviour and its applications as an engineering material.
- **Soil engineering :-** Soil Mechanics applied to engineering problems is called soil engineering.
- **Foundation engineering :-** The branch of Civil Engineering, which deals with the design, construction, maintenance and renovation of footings and foundations of walls and other structures.

- **Importance Of Soil Studies In Civil Engineering:**

1. **As a foundation material**
   i) In Buildings;
   ii) Roads and
   iii) Other Structures;
2. **As a construction material**
   i) In earthen dams;
   ii) Bricks;
   iii) Embankments and
   iv) Other Structures;

- **GEOLOGICAL CLASSIFICATION OF SOIL :-**

1. **RESIDUAL SOILS :-** Residual soils are those that remain at the place of their formation as a result of weathering of parent rock.
2. **TRANSPORTED SOIL :-** Transported soils are those, which are found at locations far away from their place of formation. Accordingly, transported soils are of following types:

   i. Water transported soils

   (a) Lacustrine soils (b) Marine soils

   ii. Wind transported soils

   (a) Loess (b) Sand dunes

   iii. Glacier transported soils

   (a) Moraines (b) Eskers

   (c) Kames (d) Outwash

   iv. Gravity deposited soils

- **SOIL PROFILE :-** A soil profile is a vertical section through the ground along the line of exploration depicting different soil layers.
- **Major soil deposits of India:**

  1. Marine Deposits
  2. Black Cotton Soils
  3. Lateritic Soils
  4. Alluvial Soils
  5. Dessert Soils

- **LAKE DEPOSITS :-** Lakes are different than marine environments. The sedimentation of lakes is ten times higher than marine environments. Lakes are also smaller, nearly closed systems, and tides lakes are less pronounced. Sedimentation in closed lake systems consists of evaporite minerals, carbonate mud, sands and silts.

- **LOCAL SOILS IN NORTHERN INDIA :-**

  1. **Punjab :-** Loamy, Clayey, Grey and Red soils.
  2. **Haryana :-** Alluvial, Sandy, Loamy and Clayey soils.
  3. **H.P. And J&K :-** Brown hill, Sub-mountain and Red Loamy soils.
  4. **U.P. :-** Sandy, Clayey loam, Red & Black soils.

- **BLACK COTTON SOILS :-** These are residual soil deposits formed from basalt or trap rocks. These are expensive soils which extend nearly over one fifth of our country.

  Properties of black cotton soils :

  (i) These soils chiefly consist of clay mineral montmorillionite.

  (ii) These soils range from light grey to dark grey and black in colour.

  (iii) These are called cotton soils as they are very suitable for growing cotton**.**

  (iv) The underlying bed rock for black cotton soils is basically basalt or trap.

- **NAMES OF ORGANISATIONS DEALING WITH SOIL WORK IN INDIA :-**

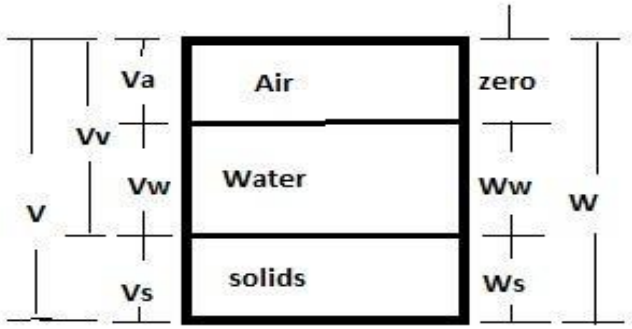
1. Central Soil Salinity Research Institute, Karnal (Haryana).
2. Central Soil and Material Research Station, New Delhi.
3. Central Soil and Water Conservation Research and Training Institute, Dehradun (Uttrakhand).
4. Central Road Research Institute, Okhla (New Delhi).
5. Indian Agricultural Research Institute, New Delhi.

PHYSICAL PROPERTIES OF SOILS

- **Constituents Of Soil :-**

Soil consist of three constituents viz, solid particals, air and water which are blended together to form a complex material.

- **Phase Diagram :-** The diagram which represents the different Constituents of soil separately for easy understanding and convenience is termed as a phase diagram.



- **Three Phase Diagram :-** The diagram which represents the three constituents of soil i.e. Solids, air and water is known as three phase diagram.
- **Two Phase Diagram:-** The diagram which represents only two constituents of soil is termed as two phase diagram.

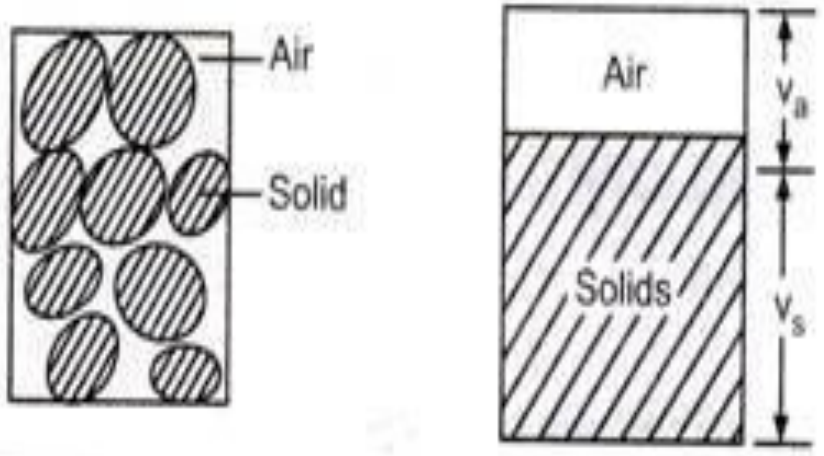


FIG. 2.3 Phase diagram of dry soil (two phase).

- **Important Soil Properties And Their Inter Relationship :-**
- **Void Ratio :-** It is defined as the ratio of volume of voids to the volume of solids in a given soil mass. It is denoted by ‘e’ .
- **Porosity :-** It is defiend as the ratio of volume of voids to the volume of solids in a given soil mass. It is denoted by ‘n’.
- **Degree of Saturation :-** It is defined as the ratio of volume of water to the volume of voids. It is denoted by ‘S’.
- **Water Content :-** It is defined as the ratio of the weight of water to the weight of solids. It is denoted by ‘w‘.
- **Soil Water :-** The water present in the pores of a soil mass is known as soil water. It is of two types ;

(i) Free water or Gravitational water

(ii) Held water

(a) Structural water (b) Absorbed water (c) Capillary water

- **Specific Gravity Of Soil Grains :-** It is defined as the ratio of the weight of a given volume of soil solids to the weight Of an equal volume of water at a particular temperature. It is denoted by ‘G’.
- **Unit Weight :-** It is defined as the ratio of weight of soil per unit volume. It is denoted by ‘Gamma’ and is expressed as g/cc or kN/cubic meter.

  In soil engineering, unit weight is classified as ;

1. Bulk unit weight
2. Dry unit weight
3. Saturated unit weight
4. Submerged unit weight
5. Unit Weight of soil grains

FLOW OF WATER THROUGH SOILS

- **Permeability :-** The property of soil which permits the flow of water through it is called the permeability.
- **Importance of Permeability :-**

1. To calculate the rate of settlement of buildings and other structures.
2. To determine yield of wells.
3. To analyses seepage through dams and levees.
4. To study losses from irrigation canals.
5. To study stability of slopes and drainage of soils.

- **Types of Flow :-**

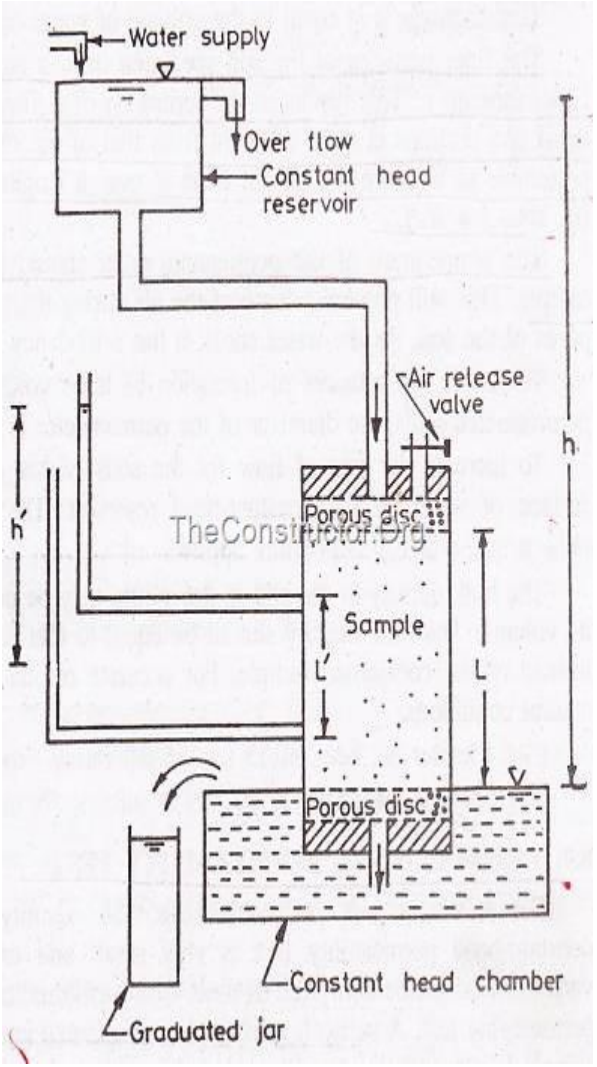
1. Laminar Flow
2. Turbulent Flow

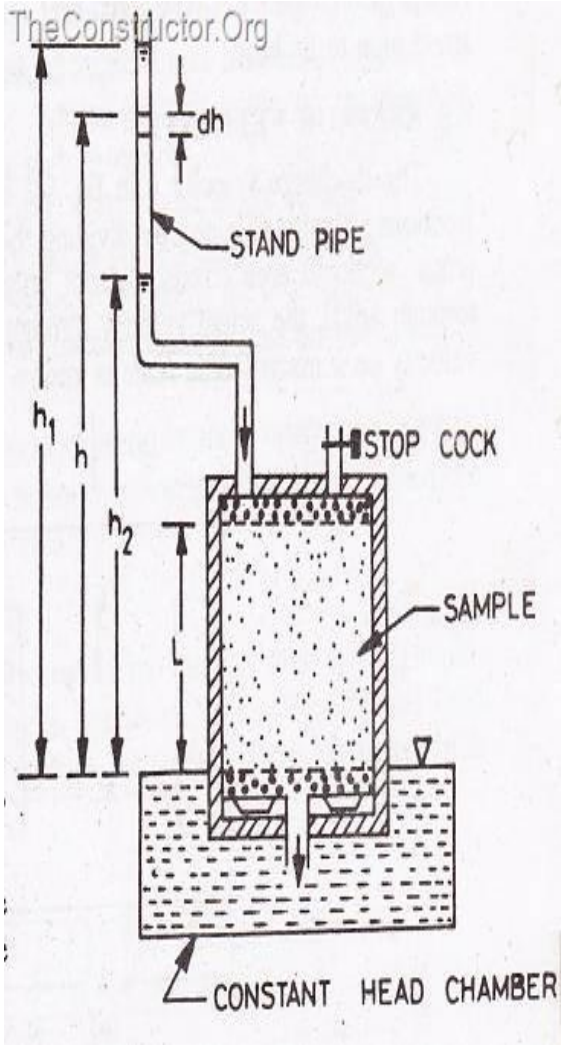
- **Hydraulic Gradient :-** It is defined as the loss of head (h) Per unit length of flow of water through the soil. It is denoted by ‘i’.
- **Darcy‘s Law :-** This law states that ‘‘For a laminar flow in soils, the velocity of flow is proportional to its hydraulic gradient’’.
- **Seepage Velocity :-** It is defined as the rate of discharge of percolating water per unit cross-sectional area of voids perpendicular to the direction of flow.
- **Factors affecting Permeability:-**

1. Void ratio
2. Particle size
3. Structure and stratification of soil
4. Shape of particles
5. Temperature
6. Degree of Saturation
7. Water impurities.

- **Measurement Of Permeability Of Soil In The Laboratory :-**

1. Constant Head Permeability method
2. Falling Head Permeability method.





- **Comparison Of Permeability Of Different Soils As Per BIS :-**

S.NO.	Permeability in cm/sec	Soil Classification
1.	Less than 0.0001	Impervious
2.	Greater than 0.0001 and less than 0.10	Semi-previous
3.	Greater than 0.10	Previous