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By-Jaspal Sir

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SOIL ENGINEERING

By- JASPAL SINGH
Ex-IES

CONTENT

SOIL MECHANICS & FOUNDATION ENGINEERING

— The Process of formation of Soil is termed as 'PEDOGENESIS'.

— Soil is formed due to the weathering of Rocks.
(weathering → Erosion/wear & Tear)

— Weathering of the Soil Can Occur either Physically (→ Mechanical Disintegration) or Chemically.

— Weathering of Rocks can be done by –

a. Physical
→ Prepact or Grinding of Water, air, Ice or Wind.
→ Splitting action of ice.
→ Gravitational force.
→ Plants and Animals.

b. Chemical
→ Oxidation
→ Reduction
→ Carbonation
→ Hydration
→ Leaching by Organic acid and H_2O.

Note :- Leaching is the process of extracting a Substance from a Solid material, i.e. dissolved in a liquid.

— If the Soil is formed by physical weathering, there is no change in mineral Content of the Soil but if its formed by Chemical Weathering mineral Content of Soil differs from that of rock.

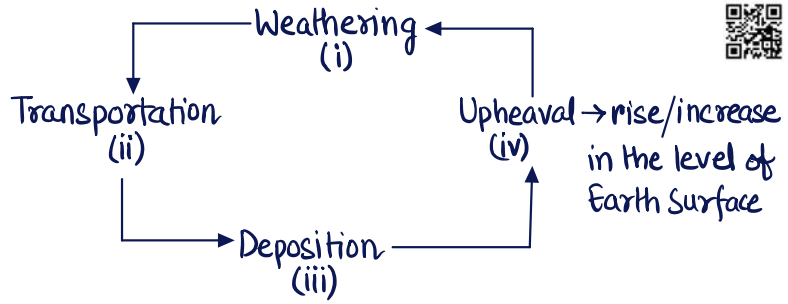
— If the weathered material retains over the Parent rock, it is termed as residual Soil & if it is transported it is termed as transported Soil.

— The characteristics of the Soil : Size of Particle, Shape & Soundness, Surface texture, degree of Sortness depends upon mode / agency of transportation.

Solid Particles → 
Angular → 

Properties	Water	Air	Ice	Gravity	Organism
-Size	Reduction	Considera-ble Reduct-ion	Considera-ble grindi-ng and Impact	Considerable Impact	Minor Abrasion
-Shape & Soundness	Rounding off Sand & Gravel	High degr-ee of Rounding	Angular Solid Particles	Angular, Non -Spherical Particle.	—
-Surface Texture	Smooth, Shine, Polished	Impact Produces Frosted Surface	Striated Surface	Striated Surface	—
-Sorting	Considerable Sorting		Very Little Sorting	No Sorting	Limited Sorting

-General Cycle involved in the formation of Soil,



•• Types of Soil :

— On the basis of mode of transportation.

a. Alluvial Soil : It is the Soil which is deposited from Suspension in Running Water.

- Transported Soil (Water)
- Weathering is Physical.
- Found Alongs the bank of river.

b. Lacustrine Soil : It is the Soil which is deposited from Suspension in fresh Still water of Lake.

c. Marine Soil : It is the Soil which is deposited from Sea Water.

d. Aeoline Soil/Sand dunes : It is the Soil which is transported by blowing wind.

e. Glacial Soil : It is the Soil which is transported by Ice.

f. Colluvial/Talus Soil : It is formed due to transportation by Gravity.

g. Loess Soil : It is Uniformly graded wind blown Silt, Slightly Cemented by Calcium Compound or Montmorillonite. It is also termed as Collapsable Soil.

h. Marl Soil : It is finely grained Calcium Carbonate Soil of Marine Origin which is formed due to the decomposition of plants (Aquatic) & bones of Animals.

i. Tuff Soil : A fine grained Slightly Cemented Volcanic ash transported by wind or water.

j. Bentonite Soil : It is Chemically weathered volcanic ash. It Consist of high % of Montmorillonite. (It is highly plastic posses high Shrinkage and Swelling prop. & low Shear Strength.) It is residual Soil.
- It is used as Lubricants drilling Operations.

k. Black Cotton Soil : It is residual Soil formed from Basalt & have excess of Montmorillonite in it. It is dark in Colour & is Suitable for growing Cotton.

L. Laterite Soil : It is the type of Soil formed due to leaching (Washing out of Silicious Compound & deposition of Fe_2O_3 & Al_2O_3). It is found in hilly Areas.

M. Muck Soil : It is a mixture of five Particle inorganic Soil & Black decomposed Organic matter.
- It is found in Marshy/Swampy/after the Overflow of river.

N. Peat Soil : It is highly Organic Soil which almost entirely Consist of black decomposed Vegetative matter in different Stages. It is highly fibrous, Compressible.

Note : Muck Soil + Peat Soil ⟶ Cumulose Soil (Found Near the river.)

o. Loam Soil : It is a mixture of Clay, Sand & Silt.

P. Gumbo Soil : It is a black Coloured, Sticky, highly Plastic Soil.
- It Can be formed either by Physical weathering or

by Chemical Weathering.

•• PROPERTIES OF SOIL

— Soil is a 3-Phase System which Consists of Solid, liquid and gaseous matter that do not Occupy Seperate Spaces but are blended with each other in definite proportion, which in turn govern the Property of Soil.

Solids → Inorganic Matter
Solids → Organic Matter

Liquid → Water
Gaseous → Air Matter

$\Rightarrow V = V_v + V_s$

$V = (V_a + V_w) + V_s$

$W = W_v + W_s$

$W = (W_a + W_w) + W_s$

$\rho_{air} \simeq 1.2\ Kg/m^3$

$\rho_{water} \simeq 1000\ Kg/m^3$

$\rho_{solids} \simeq 2600\ Kg/m^3$

$W_{air} <<< W_w$ or W_s

Hence, it can be neglected

$V_{air} \not< V_w$ or $V_s \rightarrow$ but

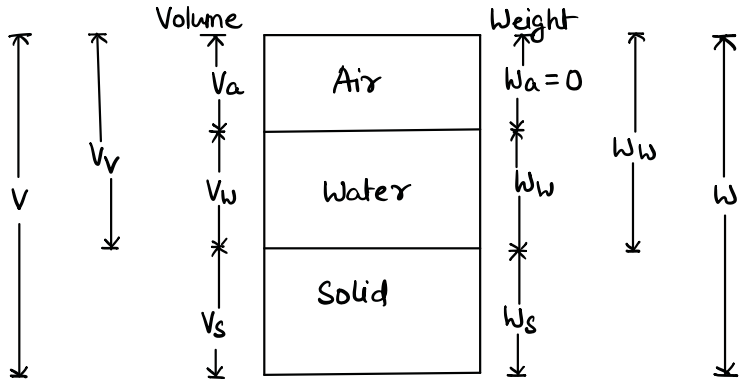
Volume of air cannot be neglected.

$W_{soil} = W_w + W_s$

but,

$V_{soil} = V_w + V_s$

→ In Some limiting Case, It can be represented as 2-phase System also.



•• PROPERTIES OF SOIL

1. Water Content (w): It is defined as the weight of water to the weight of Solids present in the given Soil mass.

$$w = \frac{W_w}{W_s} \times 100 \quad **$$

— Water Content can be equal to Zero but it has no upper limit.

$$w = \frac{W_s}{W_w} \Rightarrow w+1 = \frac{W_s}{W_w} + 1$$

$$\Rightarrow w+1 = \frac{W_w + W_s}{W_s}$$

$$= \frac{W'}{W_s}$$

$$\boxed{W_s = \frac{W'}{1+w}} \quad **$$

$W' \rightarrow$ Weight of Soil.

– Water Content can also be Reported in terms of the total Weight of the Soil.

$$w'' = \frac{\text{Weight of Water}}{\text{Weight of Soil}} = \frac{W_w}{W'} \times 100$$

– w'' Can be equal to Zero but Cannot be equal to 100 %.

$$0 \leq w'' < 100\ \%$$

$$w'' = \frac{W_w}{W'} = \frac{W_w}{W_w + W_s} = \frac{W_w/W_w}{W_w/W_w + W_s/W_w}$$

$$w'' = \frac{1}{1 + 1/w} = \frac{w}{1+w}$$

$$\boxed{w'' = \frac{w}{1+w}} \quad ** \qquad \boxed{w = \frac{w''}{1-w''}} \quad **$$

Note: Weight of Solid is Comparatively Stable in Comparison to weight of Soil as it does not Changes with Change in water, hence engineering Significance of 'w' is more than 'w''.

2. **Void Ratio (e):** It is defined as the ratio of Volume of Voids to Volume of Solids in given Soil mass.

$$\boxed{e = \frac{V_v}{V_s}} \quad ** \qquad \boxed{e > 0}$$

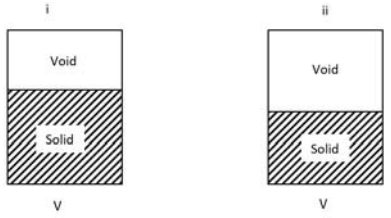
– Volume of Void Cannot be Zero for Soil as it is a 2-phase System, however it can be Zero for Rocks.

$$e = \frac{V_v}{V_s} \Rightarrow e+1 = \frac{V_v}{V_s} + 1$$

$$\Rightarrow e+1 = \frac{V_v + V_s}{V_s} = \frac{V}{V_s}$$

$$\boxed{V_s = \frac{V}{1+e}} \rightarrow \text{Volume of Soil.}$$

– Void ratio can also be Used to represent degree of denseness of Soil.



FOUNDATION ENGINEERING

By-Jaspal Singh
Ex-IES

CONTENT

FOUNDATION ENGINEERING

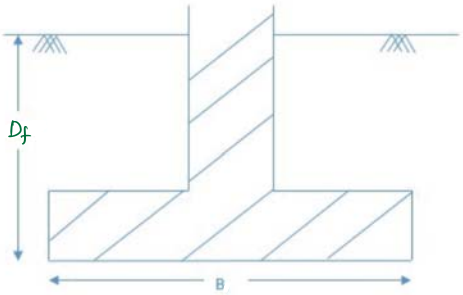
→ Structure foundations are the Substructure elements which transmit the structural load to the earth in such a way that the Supporting Soil is not overstressed & not undergo deformation that would cause excessive Settlement of the Structure.

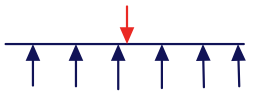
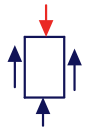
→ Here, the properties of the Supporting soil must be expected to affect the choice of type of Structural foundation Suitable for the Structure.

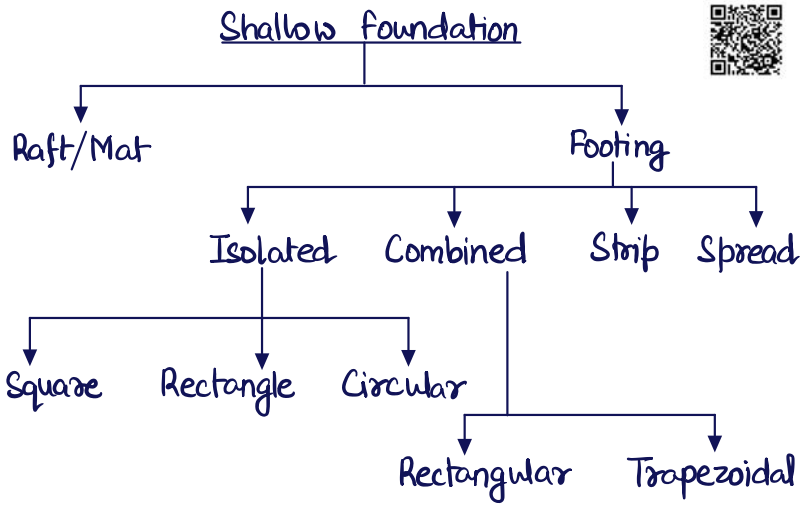
→ The failure of foundation may be due to
(i) Settlement of Soil / foundation (It is called as Settlement failure).
(ii) Sliding / Slipping of Soil foundation (It is Called as Shear failure).

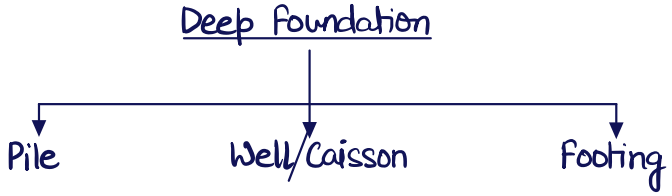
→ The foundation Shoud be Safe in Shear Criteria as well as Settlement Criteria.

- Types of foundations



Shallow Foundation	Deep Foundation
(a) Terzaghi, $\frac{D_f}{B} \leq 1$	(a) Terzaghi, $\frac{D_f}{B} > 1$
(b) Carries the load due to Base Resistance.	(b) Carries the load due to Base & Side Resistance.
	





Note: As per Skempton,
for Shallow foundation, $\frac{D_f}{B} \leq 2.5$.

(a) Shallow foundation

→ A Shallow foundation transmit Structural load to the Soil Strata at a relatively small depth by the action of end Bearing.

→ As per Terzaghi if $\frac{D_f}{B} \leq 1$, it is termed as Shallow foundation.

Note: $\frac{D_f}{B} = 1 - 15$, it is termed as Moderate deep foundation.

→ It is further classified into Raft/Mat & footing.

(b) Deep foundation

→ If $\frac{D_f}{B} > 1$, it is termed as Deep foundation.

→ If $\frac{D_f}{B} > 15$, it is termed as Very deep foundation.

→ In deep foundation load is supported partly by frictional resistance around the surface and rest by bearing at the base of foundation.

→ While constructing Shallow foundation in open excavation, the disturbance in Soil is minimal.