SOIL MECHANICS (CE-505)

- LECTURE-1:
  - Soil Formation
  - Soil Structure and Fabrics

By

Prof. S. M. Abbas

Department of Civil Engg.

Jamia Millia Islamia

New Delhi, India

SOIL MECHANICS (CE-505)

- BOOKS

1. Soil Mechanics and Foundation Engineering by K R Arora, Standard Publishers Distributor
2. Soil Mechanics and Foundation by Punmia, Jain and Jain; Laxmi Publications (P) Ltd.
3. Engineering Properties of Soils by S K Gulati, Tata McGrawhill

SOIL

An assemblage of discrete solid particles of organic and inorganic composition with air and/ or water occupying the void space amongst the particles.

Soil thus can have THREE PHASES present: Solid, water and air.

If no air present: Saturated Soil

If no water present: Dry Soil

FORMATION OF SOIL

FORMATION OF SOIL

Soils are formed by numerous processes of weathering, both physical and chemical.

- Physical weathering involves reduction of size without any change in the original composition of the parent rock.
- The main agents responsible for this process are exfoliation, unloading, erosion, freezing, and thawing.
- Chemical weathering causes both reductions in size and chemical alteration of the original parent rock. The main agents responsible for chemical weathering are hydration, carbonation, and oxidation.

FORMATION OF SOIL

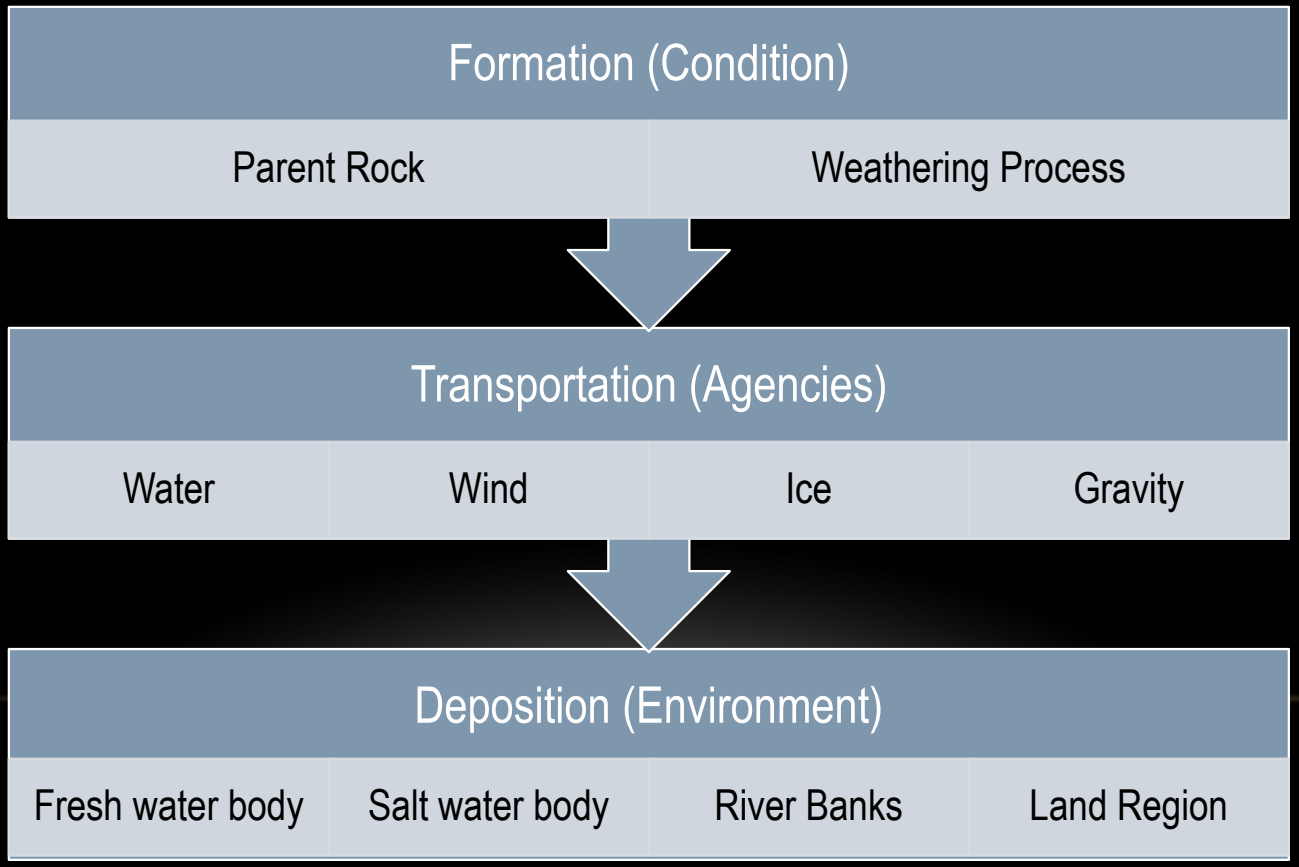
Soils are of two categories :

- Residual Soils: Found at the location where they have been formed.
- Transported Soils: Formed at one location and are transported at new location where they are deposited.

TRANSPORTED SOILS

The characteristics of transported soil are determined by three factors:

- Condition at formation
- Transporting Agents
- Environment in which the soil is finally deposited



TRANSPORTED SOILS

Currently, many soil descriptions and soil types are in usage. A few of these are listed below.

- *Alluvial soils* are fine sediments that have been eroded from rock and transported by water, and have settled on river and stream beds.
- *Calcareous soil* contains calcium carbonate and effervesces when treated with hydrochloric acid.
- *Caliche* consists of gravel, sand, and clay cemented together by calcium carbonate.
- *Collovial soils (collovium)* are soils found at the base of mountains that have been eroded by the combination of water and gravity.
- *Eolian soils* are sand-sized particles deposited by wind.

TRANSPORTED SOILS

- *Expansive soils* are clays that undergo large volume changes from cycles of wetting and drying.
- *Glacial soils* are mixed soils consisting of rock debris, sand, silt, clays, and boulders.
- *Glacial till* is a soil that consists mainly of coarse particles.
- *Glacial clays* are soils that were deposited in ancient lakes and subsequently frozen. The thawing of these lakes revealed soil profiles of neatly stratified silt and clay, sometimes called *varved clay*.
- *Gypsum* is calcium sulphate formed under heat and pressure from sediments in ocean brine.
- *Lacustrine soils* are mostly silts and clays deposited in glacial lake waters.

TRANSPORTED SOILS

- *Lateritic soils* are residual soils that are cemented with iron oxides and are found in tropical regions.
- *Loam* is a mixture of sand, silt, and clay that may contain organic material.
- *Loess* is a wind-blown, uniform, fine-grained soil.
- *Marine soils* are sand, silts, and clays deposited in salt or brackish water.
- *Mud* is clay and silt mixed with water into a viscous fluid.
- *Marl (marlstone)* is a mud cemented by calcium carbonate or lime.

SOIL STRUCTURE AND FABRIC

SOIL STRUCTURE AND FABRIC

- **Soil Structure:**
  - Refers geometric arrangement of particles or mineral grains as well as inter-particle forces which may act between them

- **Soil Fabric:**
  - Refers only the geometrical arrangement of the particles

SOIL STRUCTURE

- The deep understanding of soil structure demands consideration of mineralogical composition, shape and orientation of soil particles; the nature and properties of soil water, and the forces of interaction between soil particles and soil water.
- The engineering behavior of soils is influenced by soil structure to varying degrees

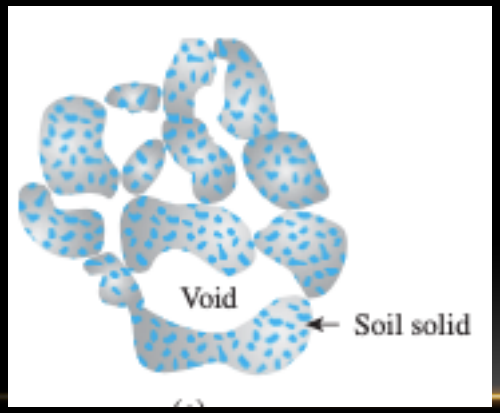
Assignment 1: Clay Minerals and their structures

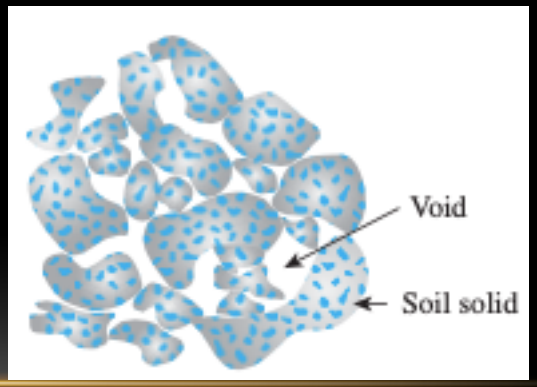
TYPES OF SOIL STRUCTURE/ FABRIC

- Following are the types of the soil structure in different soil deposits
  - Single grained structure *(coarse grained soil deposits: >0.02mm)*
  - Honeycomb structure *(silt deposits: 0.02-0.002mm)*
  - Flocculated structure *(clay deposits: <0.002mm)*
  - Dispersed structure *(clay deposits : <0.002mm)*
  - Coarse grained skeleton structure *(composite soils)*
  - Cohesive matrix structure *(composite soils)*

SINGLE GRAINED STRUCTURE

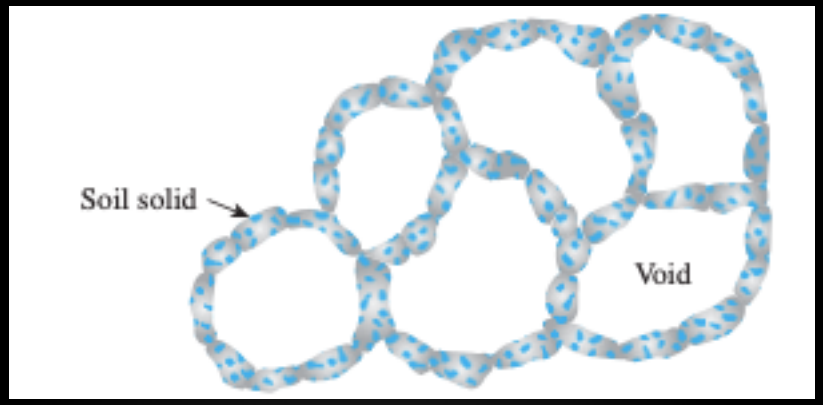
- This type of structure is found in coarse grained soil deposits.
- The particles settle independently when such soils settle out of suspension in water
- The major force causing their deposition is gravitational and the surface forces are too small to produce any effect.
- There is particle-to-particle contact in the deposit.





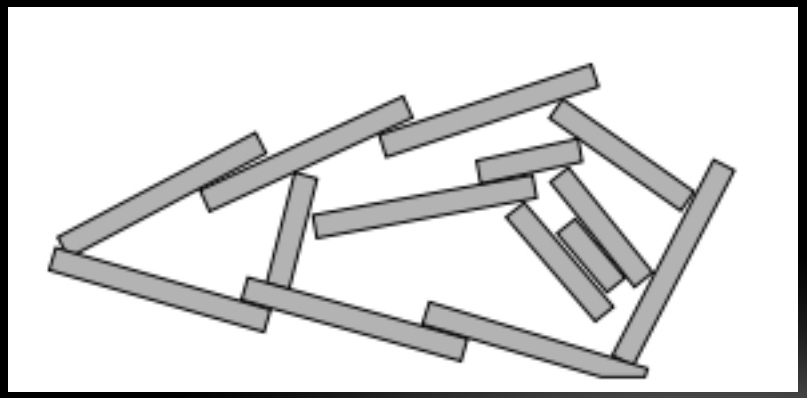
HONEYCOMB STRUCTURE

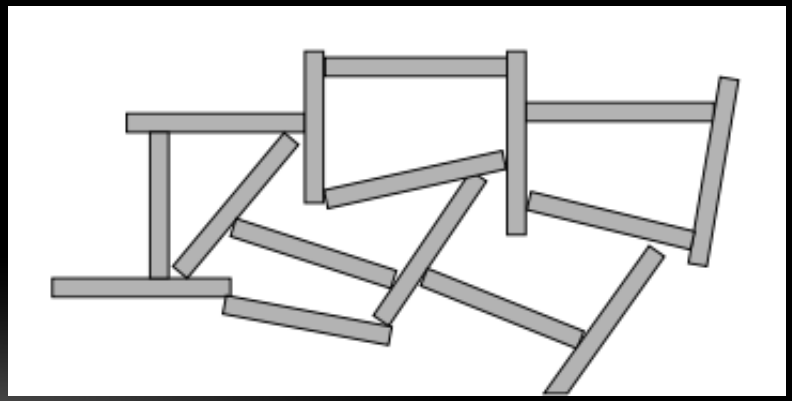
- This type of structure is associated with silt deposits.
- Surface forces play a significant role in addition to gravitational force when silt particles settle out of suspension.
- When particles approach the lower region of suspension they are attracted by particles already deposited leading to the formation of arches.
- The combination of a number of arches leads to the honeycomb structure.



FLOCCULATED STRUCTURE

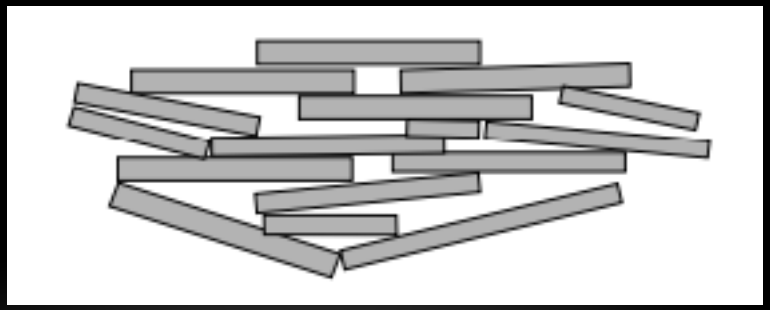
- This is one of the two types of structures found in clay deposits.
- E***dge to edge*** and ***edge to face*** contact between the particles.
- Due to the net electrical forces between the adjacent particles.
- The concentration of dissolved minerals in water leads to formation of flocculated structure with very high void ratio as in the case of marine deposits





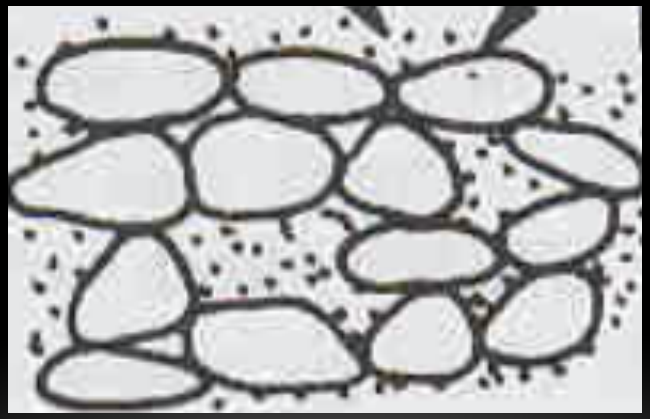
DISPERSED STRUCTURE

- In the dispersed or oriented structure, the particles have face to face contact.
- This type of formation is due to net electrical forces between adjacent soil particles.
- This type of structure is common in fresh water deposits.
- Clay with flocculated structure will have relatively high void ratio.



COARSE GRAINED SKELETON STRUCTURE

- The coarse grained skeleton structure can be found in the case of composite soils in which the coarse grained fraction is greater in proportion compared to fine grained fraction.
- The coarse grained particles form the skeleton with particle to particle contact and the voids between the particles are occupied by the fine grained particles.



COHESIVE MATRIX STRUCTURE

- The cohesive matrix structure can be found in composite soils in which the fine-grained fraction is more in proportion compared to coarse grained fraction.
- In this case the coarse grained particles are embedded in fine grained fraction and are prevented from having particle to particle contact.
- This type of structure is relatively more compressible compared to the more stable coarse grained skeleton structure.