

Chapter 1. Basic Characteristics of Soils

- ⊙ Rock: Hard rigid coherent deposit forming part of the earth's crust, which may be of igneous, sedimentary, or metamorphic origin.

- ⊙ Weathering:
 - chemical - clay minerals (clay soils)
kaolinite/ illite/ montmorillonite

 - physical - single grain structures (granular soils)

- ⊙ Soil: Any uncemented or weakly cemented accumulation of mineral particles formed by the weathering of rocks, the void space between the particles containing water and/or air.

- ⊙ Residual vs. Transported Soils
 - Residual soil - formed by the weathering products at their place of origin

 - Transported soil - formed by transportation and deposition of the weathering products by glaciers, water, wind, or gravity.

1. Glacial soils: formed by transportation and deposition of glaciers → moraine(冰堆石) ← boulder clay
2. Alluvial soils: transported by running water & deposited along streams/ well sorted & abraded/ Gravel (flood plain) - fine sand & silts (delta) - clay particles (sea or lake)/ uniformly graded
3. Aeolian soils: transported by wind. Loess is a fine wind blown dust (0.01~0.05mm) in hot arid climates, true loess never been saturated. On saturation, bond weakened & collapse.
4. Colluvial soils: formed by movement of soils from its original place by gravity such as during landslides & collapse.

* Diluvial Soils: formed by transportation at the Deluge (Noah)

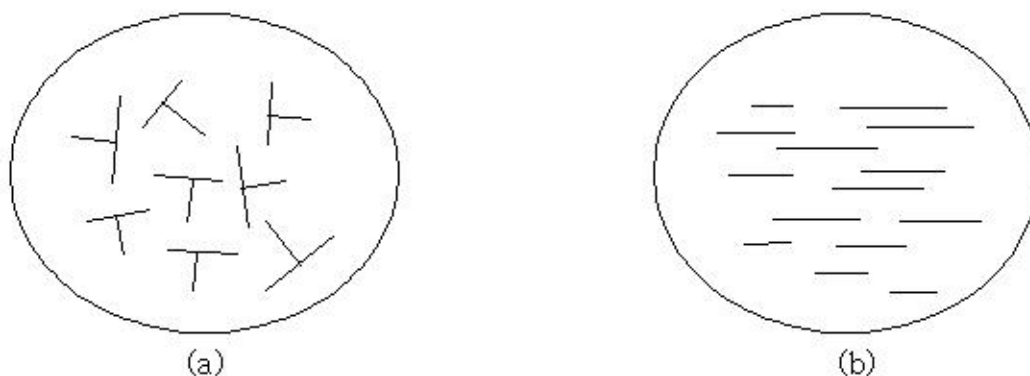
⊙ Clay minerals: Kaolinite/ Illite/ Montmorillonite

- unit elements $\left[\begin{array}{l} \text{silica tetrahedron } (O^{2-}) \\ \text{alumina octahedron } ((OH)^{-}) \end{array} \right.$
- structures by the minerals
- specific surface (S_s) - the ratio of surface area per gram of mass

| mineral | S_s (m^2/g) |
|--------------------|-------------------|
| Quartz sand(0.1mm) | 0.02 |
| Kaolinite | 20(15) |
| Illite | 80 |
| Montmorillonite | 800 |

- Adsorbed water
 1. Water molecules tightly adhering to the mineral surface forming a layer
 2. To expel all the adsorbed water, dry them at 105°C
 3. Approximate adsorbed water content $\approx 0.05 S_r$

- Flocculation & Dispersion
 1. Clay particles under attractive (Van der Waals) force as well as repulsive force.
 2. When the adsorbed water layer thin \rightarrow attractive force dominant \rightarrow edge to edge contact \rightarrow group formed \rightarrow settles together
 3. Marine clays : 1) high concentration of cations 2) thin a.w. layer 3) flocculent str.
Fresh water clays : dispersed structure
 4. Flocculent structure display high liquid limit



[Fig. 1] Particulate Structures in clay
(a) Flocculent (b) Dispersed

- swelling & shrinkage

1. The inter-particle and adsorbed water layer forces are in equilibrium under ambient pressure and temperature, by the movement of water molecules in & out of the a.w. layer
2. Any change in the ambient conditions → change in moisture content occurs → If water taken: swell, if water forced out: shrink
3. Swelling potential: montmorillonite(v. high), illite(f. high)

- plasticity & cohesion

1. Plasticity: the most characteristic property of clay soils ← size & nature of clay mineral particles & a.w. layer
2. A, S, \uparrow (e.g. montmorillonite) → Plasticity v. high & extremely compressible
3. At low moisture content - water \rightleftharpoons adsorbed water → strong attractive force between clay particles, called cohesion.
As m.c. \uparrow particles slide each other w/o crumbling (plastic lim.)
As m.c. \uparrow suction(binding effect) reduced to nothing → liquid behavior(liquid lim.)

- ⊙ Organic Soils

1. A mixture of mineral grains and organic material of mainly vegetable origin (lakes, bays, estuaries, harbours, reservoirs)
2. Smooth to the touch, dark coloured, odour

⊙ Other Terminologies

- Hardpan:** A soil of dense well-graded somewhat cohesive aggregates of mineral particles. Offering an exceptionally great resistance to drilling.
- Peat:** True peat is made up entirely of organic matter. Spongy, highly compressible, combustible.
- Boulder clay(Till):** A soil of glacial origin consisting of a very wide range of particle sizes from finely ground rock flour to boulders
- Drift:** A geological term to describe superficial unconsolidated deposits of recent origin: Alluvium, glacial moraines & boulder clay, wind blown sands, loess, etc.
- Marl:** A f, stiff or v, stiff marine calcareous clays of greenish colour
- Varved clay:** A clay of alternating layers of medium gray inorganic silt and darker silty clay. The layer thickness $< \frac{1}{2}$ " . Transported into fresh water lakes by melt water of glaciers. The undesirable properties of silt and soft clay combined.
- Bentonite:** A clay with high content of montmorillonite formed by chemical alteration of volcanic ash. It swells more, and shrinks more.

Loam:

