1.1.3 Clay Minerals

- Weathering of fedspar + mica
- Small particle size $\rightarrow$ large surface area per unit mass
- Have residual (-ve) charge
- Plastic behavior

- Groups
  * kaolinite
  * montmorillonite
  * illite
  * palygorskite
  * chlorite
  * vermiculite
  * halloysite

- Clay layer-lattice structure (layer silicates)

  o understand properties

structure
- Tetrahedral unit
- Octahedral unit

T. 4 oxygen (or hydroxyls) enclosing a silicon atom

- Combine into a sheet structure
- Each oxygen in the base is shared by two tetrahedral
- Tips are hydroxyls in a silica sheet

O. o Aluminium iron, or magnesium atom enclosed by 6 hydroxyls

  o Combined into sheets

Spacing between T & O sheets

- Small
- Link via mutual oxygen or hydroxyl ions
- Alternate

A. Two-layer lattice:

1. Kaolinite:
   - alternate T & O
   - a series of units linked together to form stacks
   - L & t

     Table 1.3
   - hydrogen bonds between layers → strong
   - stable → water can't enter between sheets to expand unit cells
   - @ water, some hydroxyls dissociate & lose hydrogen atoms → (-ve)
   - low -ve charge

2. Halloysite:
   - similar to Kao
   - more randomly packed
   - may be separated by a single molecular layer of water
   - with water → Tube / rod
   - no water → plate

B. Three-layer lattice

1. Montmorillonite: • 2 T + 1 O

O: - al, Fe, Mg, or comb.

T: some Si (< 15%) may be replaced by Al

⇒ isomorphous substitution

⇒ (-ve) charge

Cations in the water (Na^+, Ca^{++}, K^+): attracted to satisfy the charge

- particle: stack of units
- bond: vander Waals forces
  mutual attraction for the exchangeable cations

⇒ weak → water can enter between sheets
→ expansion
* swelling & shrinkage
(wetting) (drying) --- seasonal rainfall

Engineering properties → size, shape, surface area, -ve charge

- Particle orientation
  - Flocculated (edge-to-face) Natural
  - Dispersed (face-to-face)

F → D by sodium hexametaphosphate.

* plasticity of clay-water mixture --- clay type

* cohesion : internal tension (interparticle attractive forces) at low

* Plasticity Index (PI)

* Activity = $A_c = \frac{PI}{\text{clay content}}$ $\Rightarrow$ colloidal behavior
(% of clay < 2 μ)

size ↓ , surface forces ↑ (specific) surface area ↑

* specific surface = $\frac{\text{surface}}{\text{unit mass}}$
(SS)

	SS
Mont.	800 m^2/g

$\gamma_w = 9.81\ kN/m^3$

$= 62.4\ Lb/ft^3$ (pcf)

$g = 9.81\ m/sec^2$ gravitational acceleration

$= 32.2\ ft/sec^2$

1.3 Soil profile

Def.: Soil profile: - vertical section through a soil deposit, showing thickness and sequence of individual soil strata.

1.3.1 Terminology

- granular (cohesionless) soils
  - gravel
  - sand
- fine-grained soils
  - silt
  - clay - cohesive
- organic soils
  - peat
  - muck
  - organic silt
  - organic clay

Basic Soil Names:

-------- 75 mm

Gravel

-------- 4.75 mm

Sand

AASHTO ---------- 0.075

Silt

.002 -------- silty clay can't be seen by unaided eye

Clay ---------- plasticity

Particle:

Coarse

- Size range
- Color
- Homogeneity

Fine

- Plasticity
- Consistency
- Sensitivity
- w

- Fills : man-made deposits

  - proper placement
  - random

1.3.2 Soil Profile from Site Exploration

- physical properties
- soil profile (idealized)
- soil exploration
  - reconnaissance
  - boring
    - lab tests
    - field tests
- soil investigation program
  - Depth
  - #
  - Location
  - Sample
- groundwater level

void ratio = e = $\frac{V_v}{V_s}$

porosity, n = $\frac{V_v}{V} * 100\%$

degree of saturation, $S_r = \frac{V_w}{V_v} * 100\%$

water content = w = $\frac{W_w}{W_s} * 100\%$

specific gravity = γ_s/γ_w

3.4 Consistency Limits (clay)

LL
PL
SL

LI
P±

A

3.5 Organic

3.6 Soil classification

1. USCS
2. AASHTO

CH. 3

Index Properties of Soils

- water content $w = \frac{M_w}{M_s} * 100$

- capillarity

3.2 Size, shape & packing of soil particles

3.3 Phase relationships

$g_w = \frac{W_w}{V_w}$ unit weight = density * gravitational acceleration

= 9.81 m/sec^2
= 32.2 ft/sec^2

$g_{solid} = \frac{W_s}{V_s}$

$\gamma = W/V$

$\gamma_{sat} = W/V$, $V_a = 0$

$\gamma_{dry} = W_s/V$ $W_w = 0$

$\gamma' = \gamma_{sat} - \gamma_w$

ρ = density = γ/g