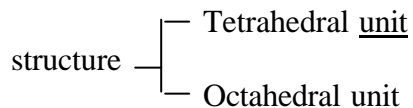


1.1.3 Clay Minerals

- Weathering of feldspar + mica
- Small particle size → 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



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)

$$* \text{ Activity} = A_c = \frac{\text{PI}}{\text{clay content}} \Rightarrow \text{colloidal behavior}$$

(% of clay < 2 μ)

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

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

(SS)

Mont. SS
 800 m²/g

$$\gamma_w = 9.81 \text{ kN/m}^3$$

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

$$g = 9.81 \text{ m/sec}^2 \quad \text{gravitational acceleration}$$

$$= 32.2 \text{ ft/sec}^2$$

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

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

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

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

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

$$\text{specific gravity} = \gamma_s / \gamma_w$$

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

$$\begin{aligned} g_w &= \frac{W_w}{V_w} && \text{unit weight} = \text{density} * \text{gravitational acceleration} \\ & && = 9.81 \text{ m/sec}^2 \\ & && = 32.2 \text{ ft/sec}^2 \end{aligned}$$

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

$$\gamma = W/V$$

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

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

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

$$\rho = \text{density} = \gamma/g$$