Soil classification

○ Particle size analysis

- Sieve analysis/ Hydrometer analysis

○ Atterberg limit tests

- Plasticity to be known

○ Sieve analysis (Table 1.2 : Sieve openings)

- 100㎜, …… , 6.3㎜, No 4, …… , No. 200, ……

○ Hydrometer analysis (Stoke's law)

- $v = \frac{y}{t} = \frac{\gamma_s - \gamma_w}{18\eta} D^2$, $D = \sqrt{\frac{18\eta v}{\gamma_s - \gamma_w}}$ Brownian movement ← 0.0002mm~0.2mm → Excessive turbulence

○ Particle size ranges (Table 1.1 / 보충자료 1)

- Gravel (4.75mm) Sand (0.075mm) Silt (0.002mm) Clay (0.001mm) Collodial particle

○ Simple tests : water content/specific gravity

-water content: $w = \frac{W_w}{W_s} \times 100\ (\%)$

-specific gravity: $G_s = \frac{W_1}{W_1 + W_2 - W_3} = \frac{W_{s\,oil\ paticle}}{W_{water\ at\ 4℃}}$

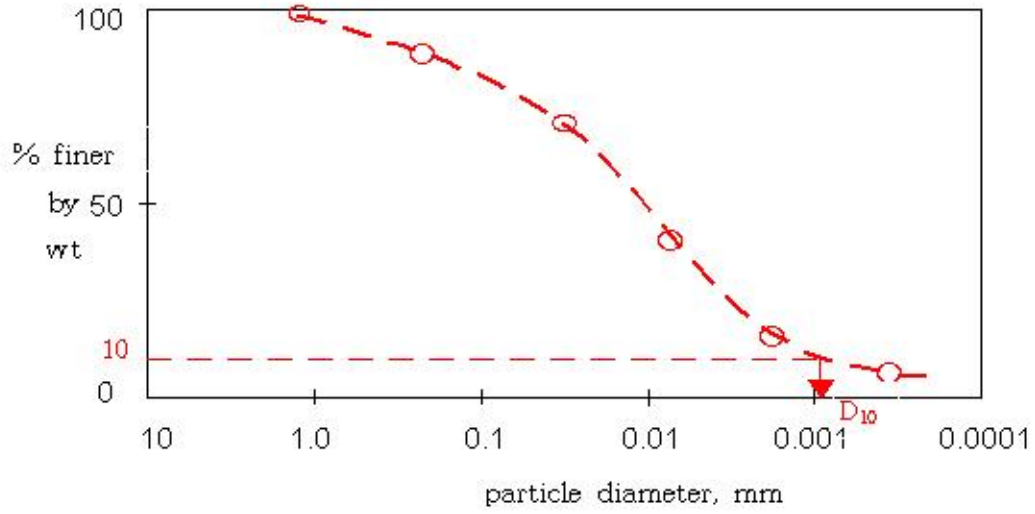
○ Gradation Curve (Sieve Analysis + hydrometer)

- Calculations

① Percentage retained on any sieve = $\frac{wt.\ of\ soil\ retained}{total\ wt.\ of\ soil} \times 100$

② Cumulate percentages retained = sum of % retained on all coarser sieves

③Percentage finer than any sieve size = 100 − ②항

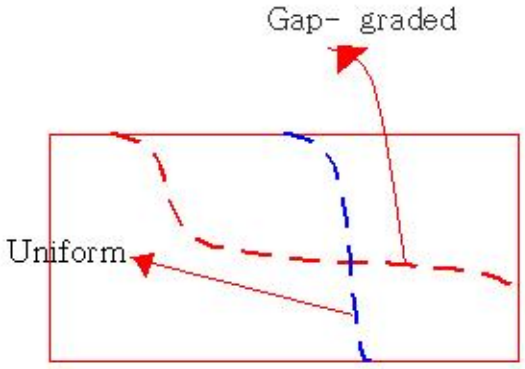


- D_{10} : Effective grain size
- C_u : Coefficient of uniformity ($=D_{60}/D_{10}$)
- C_c : Coefficient of curvature ($=D_{30}^2/(D_{60}D_{10})$)
- well-graded vs. poorly-graded soils

$1 < C_c < 3$

Gravel : $C_u > 4$

Sand : $C_u > 6$



○ Atterberg limit tests: Liquid/ Plastic/ Shrinkage

- Plasticity: the ability of a soil to undergo unrecoverable deformation at constant volume without cracking and crumbling

- Liquid Limit (LL, w_l) : the water content at which a soil is practically liquid but possess a certain small shearing strength

- Plastic Limit (PL, w_p) : the smallest water content at which a soil is plastic

- Shrinkage Limit (SL, w_s) : the smallest water content that can occur in a clay sample which is completely saturated

$w_s = \frac{\gamma_w V}{W_s} - \frac{G_w}{G_s}$ ($= \frac{W_w}{W_s}$ at Shrinkage limit)

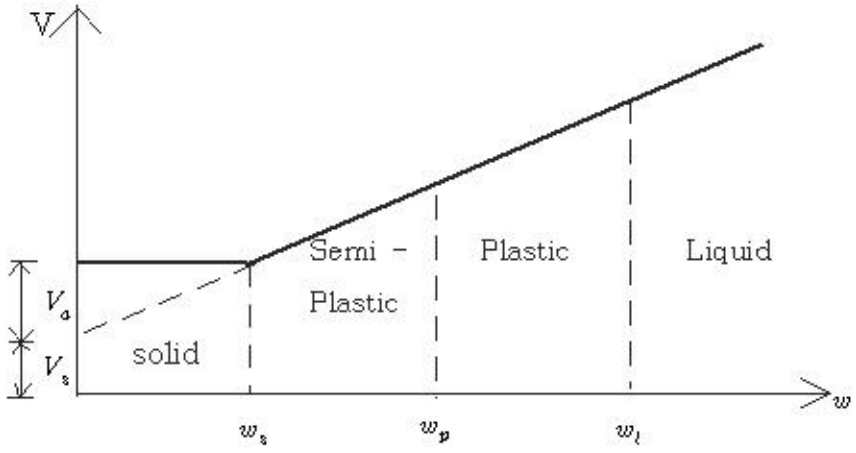
γ_w = Unit weight of water

W_s = Weight of dry soil pat

V = Volume of dry soil pat

G_w = Specific gravity of water at the temperature of test

G_s = Specific gravity of soil grains



○ Indices : plasticity index, liquidity index, flow index, activity

- Plasticity Index : $(P_I, I_P)(= w_l - w_p)$

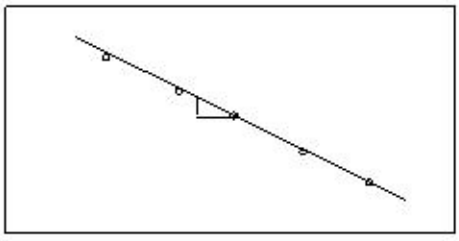
  The range of water content between the liquid and plastic limits, which is an important measure of plastic behaviour

- Liquidity Index : $(I_L = \frac{w - w_p}{I_p})$

  Represents the natural water content of a soil relative to the liquid and plastic limit

- Flow Index: (I_f)

  Expresses the relationship between the change in water content and the corresponding change in the shear strength, i.e., the slope of the flow curve



- Activity : (I_a)

(Plasticity index/percentage of clay size fraction) expresses the degree of plasticity of the clay size fraction of a soil

Minerals	Activities
Kaolinite	0.40
Illite	0.90
Montmorillonite	> 1.25

○ Soil classification (Table 1.5 - 보조자료1 / 보충자료2)

Primary letter (Particle Size)	Secondary letter (Gradation/Plasticity)
G : Gravel	W : Well-graded
S : Sand	P : Poorly-graded
M : Silt	M : Non-plastic fines
C : Clay	C : Plastic fines
O : Organic	L : Low plasticity (LL<50)
Pt : Peat	H : High plasticity (LL>50)

○ Field identification procedures for fine grained soils

- Dilatancy(reaction to shaking) test - Determine characteristics of fine particles

  Fine sands → Silts → Clays

- Dry strength(crushing characteristics) test - Determine Characteristics and percentage of colloidal fraction

  CH → Silts → Fine sands

- Toughness(consistency near plastic limit) test - Determine Types of clay minerals, organic soils(weak, spongy)

  Kaolinite - cohesiveness reduced quickly when $w < w_p$