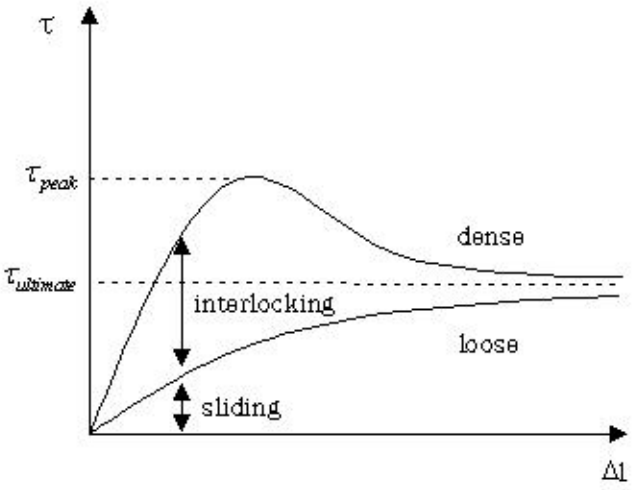
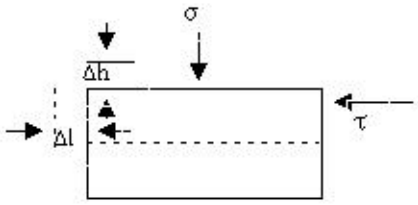
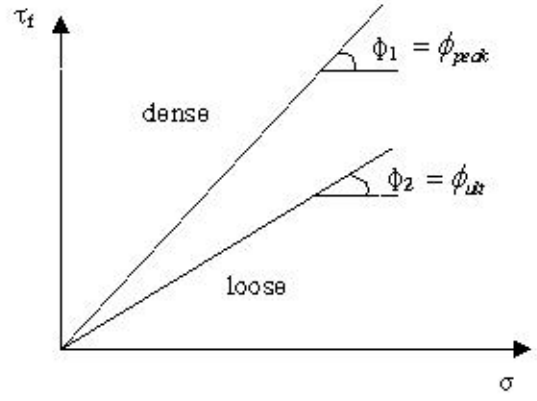
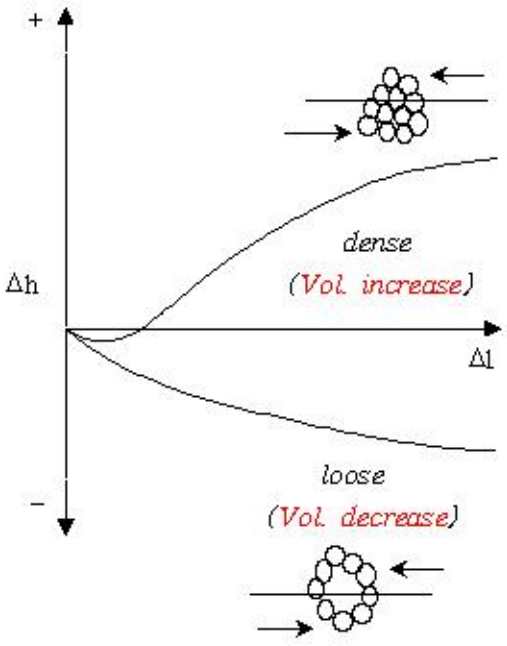
1. Shear strength of sands









V

○ Critical void ratio (e_c)

The e_c of a soil is the void ratio that exists prior to

a (*shearing process*) in which the (*volume*) change is zero.

e_c = f (σ) → therefore, not a (*material constant*)

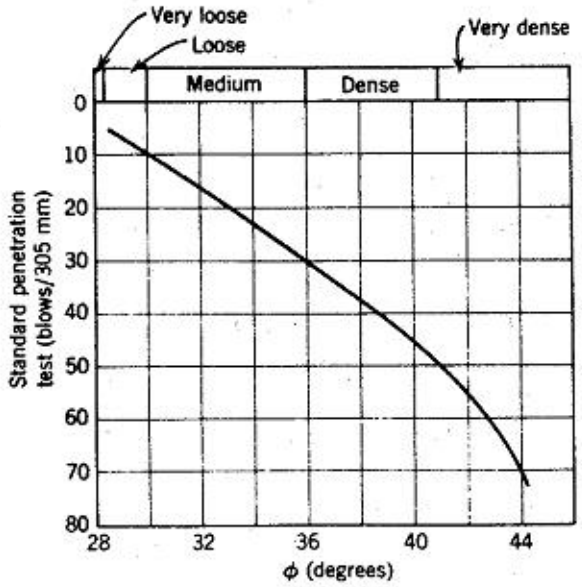
○ Friction angles of sands

[Table 4.1] Friction angles of sands (Sowers and Sowers, 1951)

Shape and Grading	loose	dense
Rounded, uniform	30°	37°
Rounded, well graded	34°	40°
Angular, uniform	35°	43°
Angular, well graded	39°	45°

[Table 4.2] Friction angles of sands (Terzaghi & Peck, 1967)

Materials	loose	dense
Rounded, uniform sand	27.5°	34°
Angular, well graded sand	33°	45°
Sandy gravel	35°	50°
Silty sand	27°~ 33°	30°~ 35°
Inorganic silt	27°~ 30°	30°~ 34°



[Fig 4.7] N vs. Φ_{sand}

2. Shear strength of (*saturated*) clays

- Strength = f (*drainage condition, stress history*)
  ↓ ↓
  drained/undrained *NC/OC*

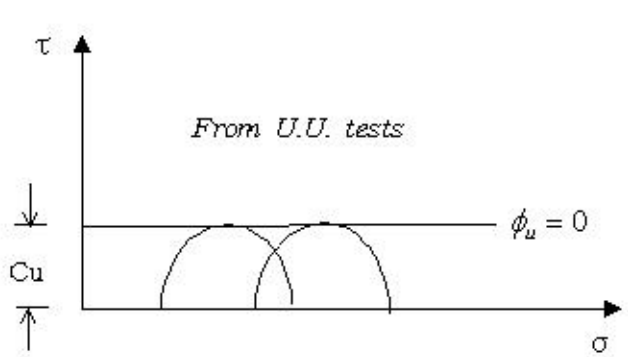
- normally consolidated clay :
  the present effective stress = (*The max. value to which the clay ever been subjected*.)

- Overconsolidated clay :
  the present effective stress < (*the maximum value experienced*.)

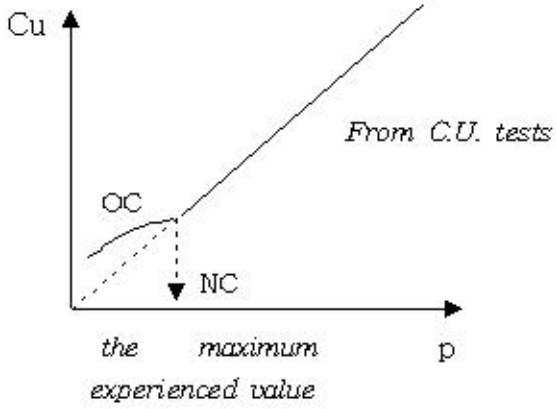
- Overconsolidation ratio

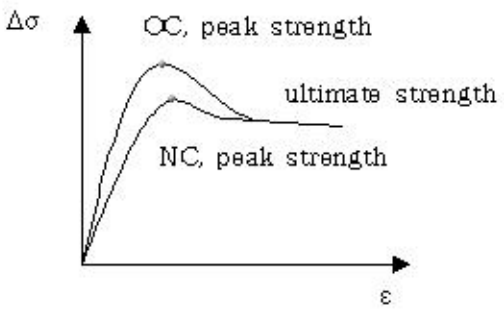
$$= \frac{\textit{the max. experienced value}}{\textit{the present value}}$$

- the undrained strength
  by (*U.U*) or (*C.U*) tests

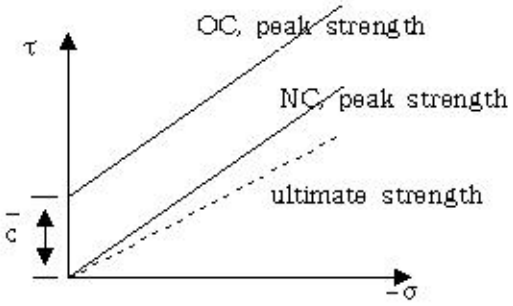


Cu : undrained shear strength

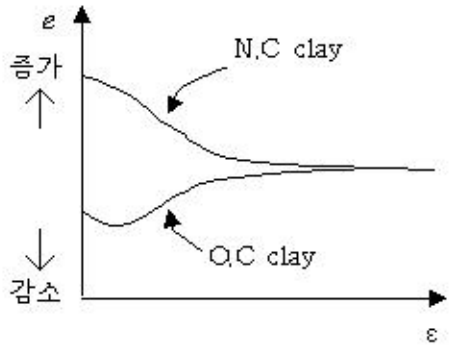




(a) Δσ-ε behavior



(b) Mohr-Coulomb failure envelope



(c) e-ε plot

[Fig. 4.11] Drained test results

○ Sensitivity of clays

- Sensitivity(s) $= \dfrac{\textit{undrained shear strengths(Cu) in the undisturbed state}}{\textit{Cu in the remoulded state}}$

normal, s= (*1 ~ 4*) sensitive, s=(*4 ~ 8*)

extra-sensitive, s= (*8 ~ 16*) quick clay, s=(*16 ~*)

○ Strength in terms of effective stresses

- by (*drained test*) or C.U test w/ (*p.w.p measurements*)

[Table 4.3] Undrained shear strength of clays ($\div 10 \fallingdotseq t/m^2$)

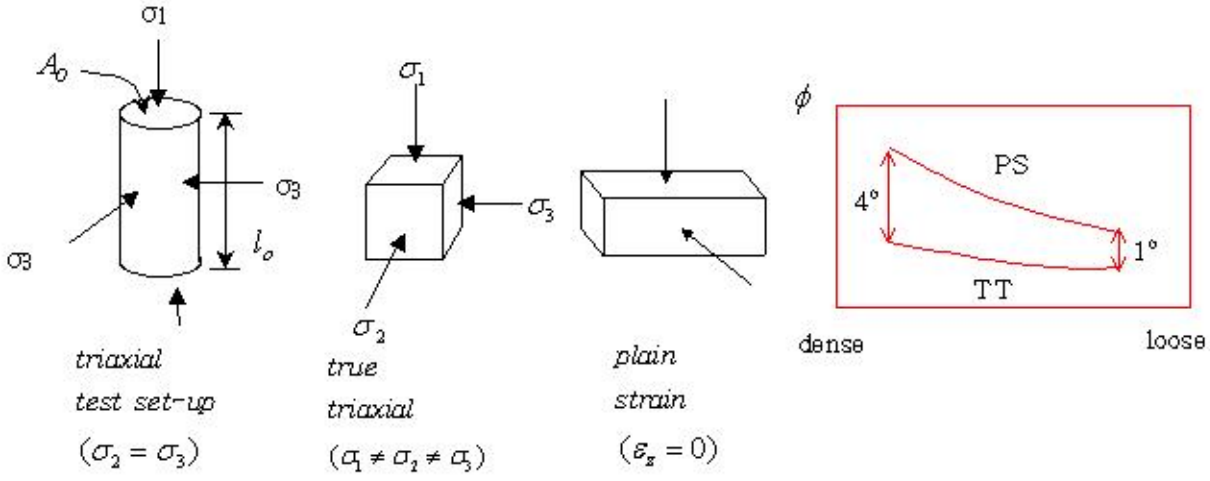
State	Undrained shear strength (kN/m^2)
very hard	>150
hard	100~150
stiff-hard	75~100
stiff	50~75
soft-stiff	40~50
soft	20~40
very soft	<20

○ Shear strength in terms of effective stresses :

- NC : $\bar{c}$=(0) $\bar{\Phi}$= 20 ~ 35°

- OC : (0) < $\bar{c}$ < ($30KN/m^2$) *(the lower $\bar{\phi}$, the higher PI)*

○ Plane strain test $A = A_0 \dfrac{1-\dfrac{\Delta V}{V_0}}{1-\dfrac{\Delta l}{l_0}}$ (if $undrained, \Delta V = 0$)



triaxial test set-up ($\sigma_2 = \sigma_3$)

true triaxial ($\sigma_1 \neq \sigma_2 \neq \sigma_3$)

plain strain ($\varepsilon_z = 0$)