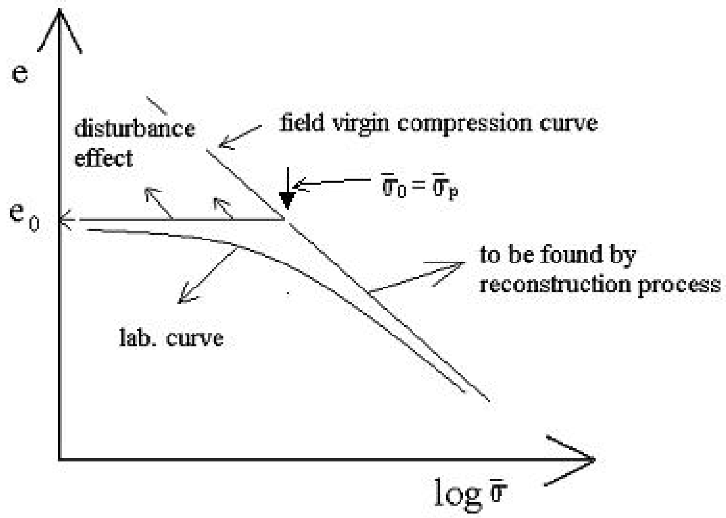
5. Calculation of consolidation settlement

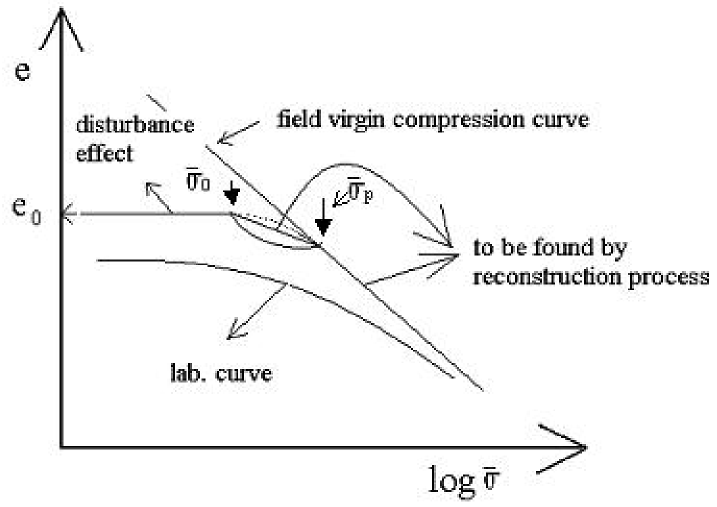
i) Magnitude of settlement

① Reconstruction of field compression relation

- Effect of sample disturbance on compressibility

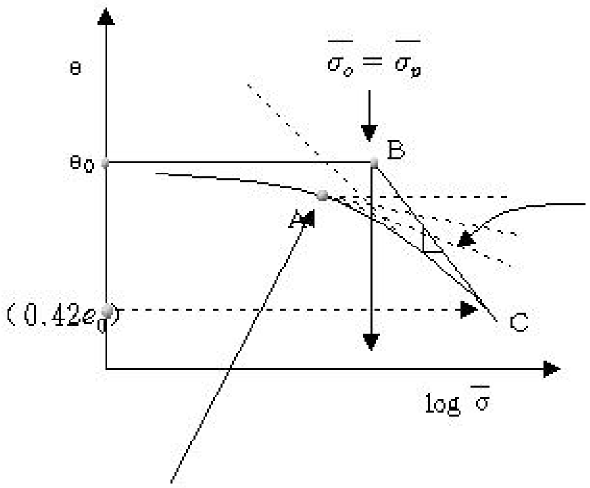


(NC Clays)



(OC clays)

- NC clays



a. Find pt. B ($\log\overline{\sigma_p}$, e_0)

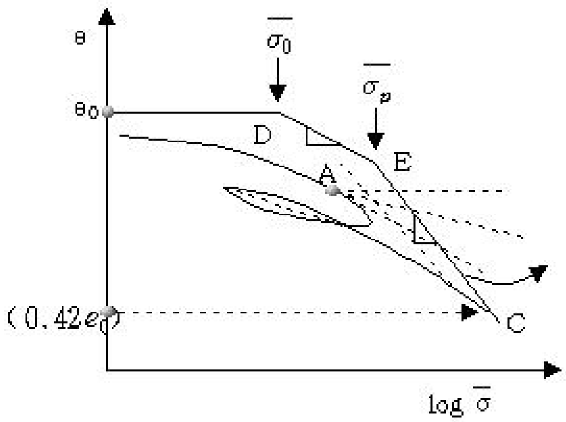
b. Find pt. C
(lab. curve, $0.42e_0$ (empirical))

c. Connect pts B & C.

$$C_c = -\frac{de}{d\log\overline{\sigma}}$$

pt. of max ciurvature > having min. radius

- OC clays



a. Find pt. D ($\log\overline{\sigma_0}$, e_0)

b. Find pt. E ($\log\overline{\sigma_p}$, ?)

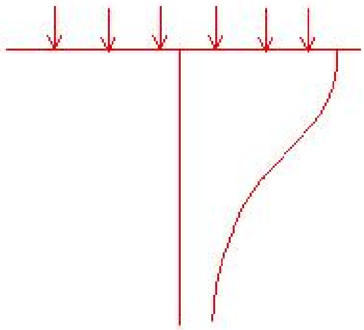
to the mean slope of rebound curve (C_s)

c. Connect pts E & C

to obtain C_c

C_s (very small) $\fallingdotseq \frac{1}{10} C_c$

② Calculation of Settlement



- Divide the compressible strata into thin layers

(∵ $\Delta\sigma \neq$ constant thru the thickness)

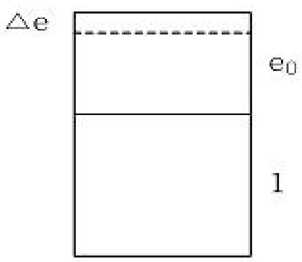
- NC Clay :

Consolidation Settlement of i^{th} layer

$$\Delta S_{ci} = \frac{\Delta e_i}{1+e_{0i}} H_i$$

H_i → thickness of i^{st} layer

$\frac{\Delta e_i}{1+e_{0i}}$ → Strain term



$$S_c = \sum_{i=1}^{n} \Delta S_{ci} = \sum_{i=1}^{n} \frac{\Delta e_i}{1+e_{0i}} H_i$$

↑ total settlement

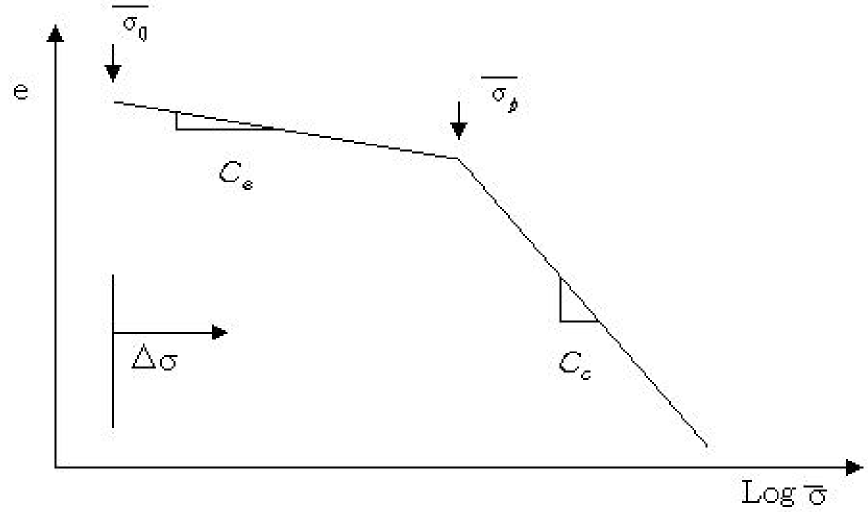
where $\Delta e_i = C_{c_i} \log\left(\frac{\overline{\sigma_0} + \Delta\sigma}{\overline{\sigma_0}}\right)$, $\Delta\sigma$: **Stress increment due to the surface load**

$\left(C_c = \frac{\Delta e}{\log(\overline{\sigma_0} + \Delta\sigma) - \log(\overline{\sigma_0})} \right)$ $\leftarrow \Delta e = C_c [\log(\overline{\sigma_v} + \Delta\sigma) - \log\overline{\sigma_0}\,]$

finally,

$$S_c = \sum_{i=1}^{n} \frac{H_i}{1+e_{0i}} \left[C_c \log\left(\frac{\overline{\sigma_0} + \Delta\sigma}{\overline{\sigma_0}}\right)\right]_i \cdots\cdots\cdots \text{Eq. ①}$$

- OC Clay



Case 1 : $\Delta\sigma \leq (\overline{\sigma_p} - \overline{\sigma_0})$

Use Eq. ① with C_e substituted in stead of C_c ⋯⋯⋯⋯ Eq. ①′

Case 2 : $\Delta\sigma > (\overline{\sigma_p} - \overline{\sigma_0})$

use Eq. ①′ for $(\overline{\sigma_p} - \overline{\sigma_0})$, and

use Eq. ① for $\Delta\sigma - (\overline{\sigma_p} - \overline{\sigma_0})$

③ Secondary Compression Settlement

$S_S = -C_s \log \frac{t}{t_1}$, t_1 : the time at the end of primary consolidation

t : the time when the secondary compression settlement to be estimated

* This time-dependent settlement is considered to occur at 'essentially' constant effective stress, and the rate of vol. change is not controlled by the rate of pore water dissipation, but controlled by, maybe, inelastic properties of soils (e.g. plastic flow), thus, independent of thickness.

ii) Settlement times

since,

- $T = \dfrac{C_v t}{H^2}$ $\left(\leftarrow \; T = \dfrac{t}{\tau}, \;\; \dfrac{C_v \bullet \tau}{H^2} = 1, \;\; \tau = \dfrac{H^2}{C_v}\right)$

$$t = \frac{TH^2}{c_v}$$

there are unique relationships

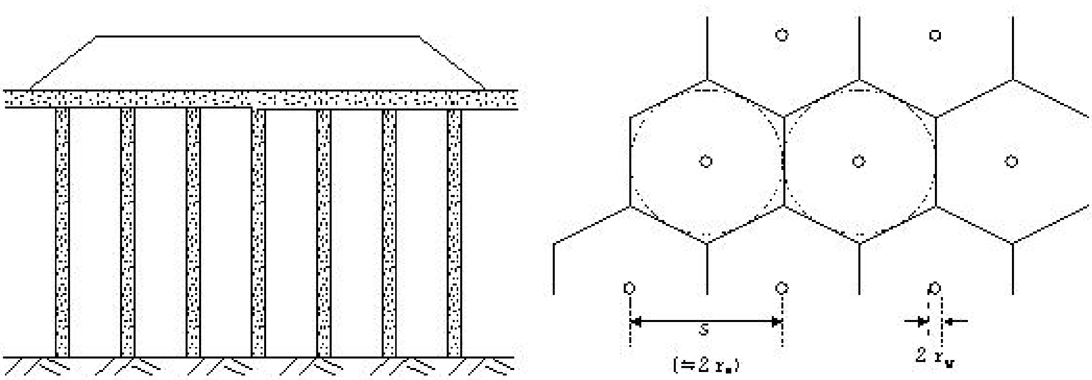
EX. Given : H, C_v & $\overline{U_x}$ (i.e., T_x)

Q : Calculate t to achieve $\overline{U_x}$

6. Fast Drainage Methods

1) Concept

- Shorten the drainage path to accelerate the rate of consolidation



$r_{equivalent}$ (r_e) : max. radial drainage path

2) Settlement times

$$T_h = \frac{C_h t}{{r_e}^2}, \quad C_h = \frac{k_h(1+e_0)}{a_v \cdot \gamma_w}$$

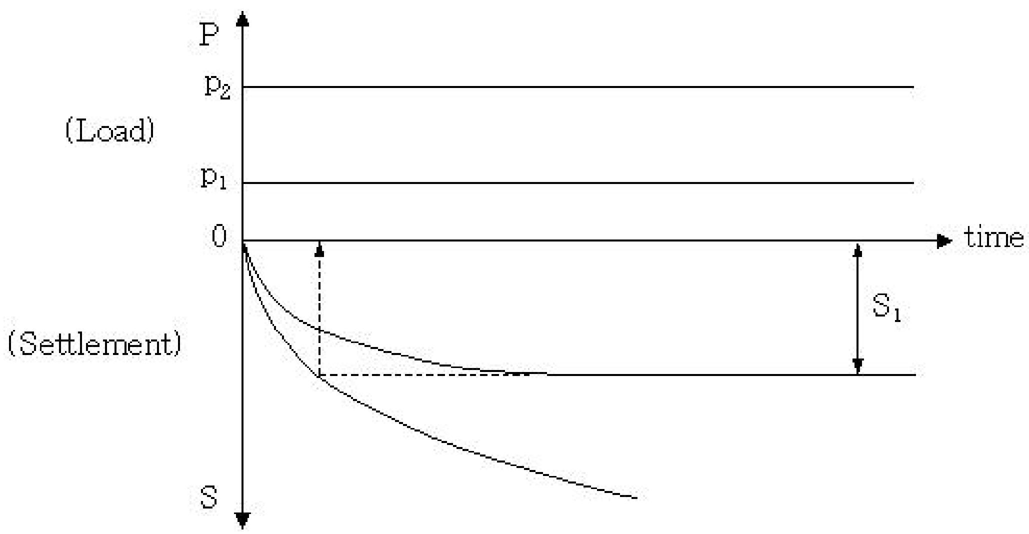
$$\overline{U} = 1 - [1-\overline{U_h}][1-\overline{U_z}]$$

(attimet ($\neq$ T)
$\because T_h \neq T_v$ always)

3) Types of Drains (보충자료 #1)

- Sand drains / PVD

4) Preloading



* Smearing effect :

Installation of Sand drains disturbs the periphery of the well → smear

i) $(v_w)_{mod} = \frac{1}{2} v_w$ (Leonards, 1962)

ii) $C_h = C_v$