Dynamics Stress Deformation and Strength Characteristics of Soils

● Kondner`s hyperbola

- Proposed hyperbolic equation

$$\sigma_1 - \sigma_3 = \frac{\varepsilon_1}{a + b\varepsilon_1} \quad \ldots ①$$

$\sigma_1 \,\&\, \sigma_3$: the major & minor principal stresses

ε_1 : the major principal strain
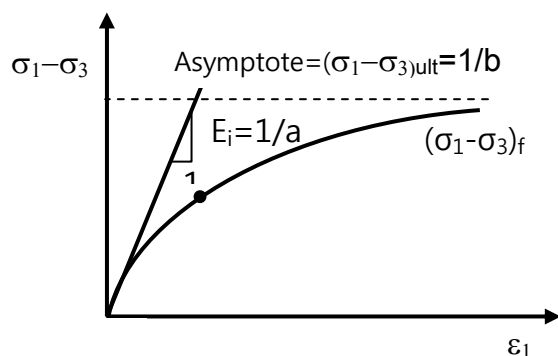
$a \,\&\, b$: constants to be determined experimentally

- Physical meaning (Fig.1)
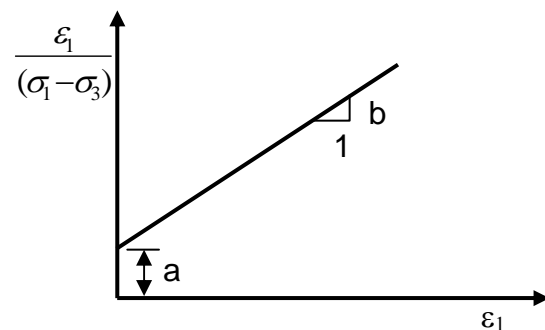
$$a = \frac{1}{E_i} \quad [\text{in Eq.① let } \varepsilon_1 = 0]$$

$$b = \frac{1}{(\sigma_1 - \sigma_3)_{ult}} \quad [\text{in Eq.① let } \varepsilon_1 = \infty]$$

- Eq.① can be rearranged in the form (Fig.2)

$$\frac{\varepsilon_1}{(\sigma_1 - \sigma_3)} = a + b\varepsilon_1 \quad \ldots ②$$

(Fig.1)   (Fig.2)

● Let (Duncan & Chang, 1970)

$$(\sigma_1 - \sigma_3)_f = R_f(\sigma_1 - \sigma_3)_{ult} \quad \text{...③}$$

Where, $R_f \leq 1$ & determined experimentally $[0.75 \leq R_f \leq 1]$

Then, Eq.① w/ Eq.③, we obtain

$$(\sigma_1 - \sigma_3) = \cfrac{\varepsilon_1}{\cfrac{1}{E_i} + \cfrac{\varepsilon_1 R_f}{(\sigma_1 - \sigma_3)_f}} \quad \text{...④}$$

● Ramsberg-Osgood model

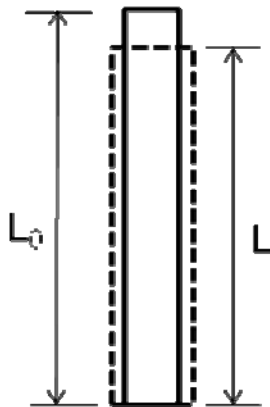$$\bar{\varepsilon} = \frac{\bar{\sigma}}{E} + k\left(\frac{\bar{\sigma}}{E}\right)^m$$

Where, $\bar{\sigma}$ (true stress) $= \dfrac{P}{A} = \dfrac{P}{A_0}\dfrac{A_0}{A}\left[= \sigma(1+\varepsilon)\right]$

$\bar{\varepsilon}$ (true strain) $= \displaystyle\int_{L_0}^{L}\dfrac{dL}{L} = \ln\dfrac{L}{L_0}\left[= \ln(1+\varepsilon)\right]$

A_0, L_0 : initial area, length

$k, \ m$: to be determined experimentally

$$\frac{L}{L_0} = \frac{L_0 \pm \Delta L}{L_0} = 1 \pm \varepsilon$$