CAM CLAY MODEL : NC SOIL

* Associated plastic flow rule

$$\dot{\varepsilon}_p = \Lambda \frac{\partial f}{\partial \sigma}$$

$\begin{cases} \dot{\varepsilon}_p: \text{plastic strain increment tensor} \\ \sigma': \text{effective stress tensor} \\ \Lambda: \text{plastic multiplier, } >0, \text{ at the time of loading} \end{cases}$

- To express this isotropic nature of f in a way that is easier to understand:

$$\begin{cases} \dot{\varepsilon}_v^p = \Lambda \frac{\partial f}{\partial p} \\ \dot{\varepsilon}_s^p = \Lambda \frac{\partial f}{\partial q} \end{cases}$$

- Volumetric strain at critical state: $\dot{\varepsilon}_v^p = 0$ at $q = Mp'$

Original Cam clay:

$$\dot{\varepsilon}_v^p = 0 \Rightarrow \frac{\partial f}{\partial p} = 0 \Leftrightarrow \left\{ f = \frac{-T+N}{v_0}\frac{q}{Mp} + \frac{\lambda-K}{v_0}\ln\frac{p}{p_0} - \varepsilon_v^p \right.$$

$$\Leftrightarrow \frac{N-T}{M}\left(\frac{-q}{p^2}\right) + (\lambda-K)\frac{1}{p} = 0$$

$$\Leftrightarrow N-T = M\frac{p}{q}(\lambda-K) \quad \left(\frac{p}{q} \to 1\right)$$

$$\Leftrightarrow N-T = \lambda-K$$

Modify Cam clay:

$$\dot{\varepsilon}_v^p = 0 \Leftrightarrow \frac{\partial f}{\partial p} = 0 \quad \left\{ f = \frac{1}{v_0}\left[\frac{N-T}{\ln 2}\ln\left\{1+\left(\frac{q}{Mp}\right)^2\right\} + (\lambda-K)\ln\frac{p}{p_0}\right] - \varepsilon_v^p \right.$$

$$\Leftrightarrow \frac{N-T}{\ln 2}\frac{1}{1+\left(\frac{q}{Mp}\right)^2} 2\frac{q}{Mp}\frac{q}{Mp}\cdot\frac{1}{p} + (\lambda-K)\frac{1}{p} = 0$$

$\left(\frac{q}{Mp} \to 1\right)$

$$\Leftrightarrow N-T = \ln 2\,(\lambda-K)$$