b) K_0 – consolidation condition

In field → K_0 – state
In lab → Generally isotropic state (triaxial test) to simplify the field conditions

< For sedimented soils>

* Field : During sedimentation and subsequent loading (no lateral strain), soil structure is formed to resist efficiently to vertical loading.
(→ anisotropy)

* Lab : During consolidating for undisturbed anisotropic samples isotropically, soil structure can be altered to have isotropic-inclined characteristics. And total confining stress $p' = (\sigma_1' + \sigma_2' + \sigma_3')/3$ is different from (larger than) that in field.

- The effect of **isotropic consolidation** on undrained behavior of N.C. or lightly O.C. clays. ($K_0 < 1 \rightarrow p'_{iso} > p'_{Ko}$ and rearrangement of soil structure during isotropic consolidation (more isotropic structure))

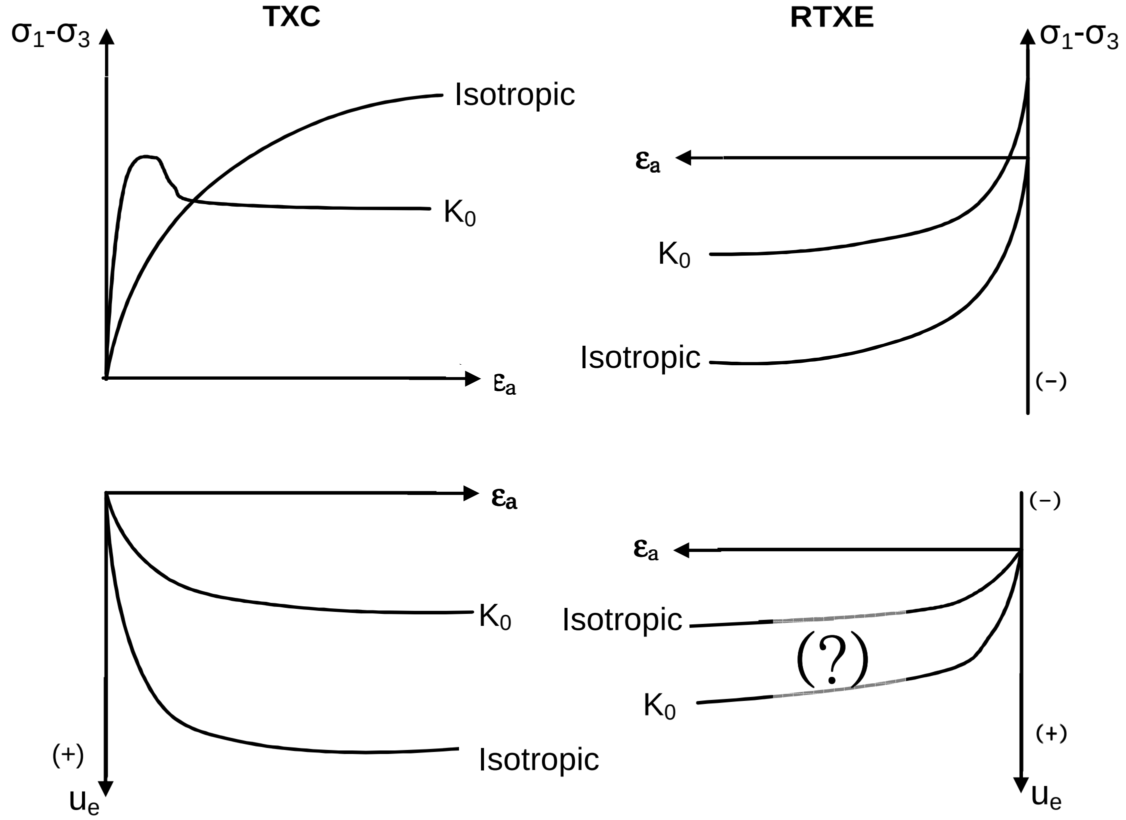
  ⇒ Comparing the shear behaviors under isotropic consolidation with those under K_0-consolidation

  ⇒ Subsequent shearing also induces structure rearrangement to activate the effective resistance to the given shearing mode.

  (1) Compression shearing
  - Soil structure: needs more strain to the peak and develops higher excess pore pressure and lower s_u.
  - Higher p' induces higher s_u and possibly higher excess pore pressure during shearing.

  (2) Extension shearing
  - Soil structure: increases s_u, and possibly (but not significantly) less strains to the peak and lower excess pore pressure.
  - Higher p' induces higher s_u and higher excess pore pressure.

  (3) Isotropic consolidation has no effect on ϕ'.


TXC
RTXE
σ1-σ3
Isotropic
K0
εa
σ1-σ3
εa
K0
Isotropic
(−)
εa
K0
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εa
Isotropic
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K0
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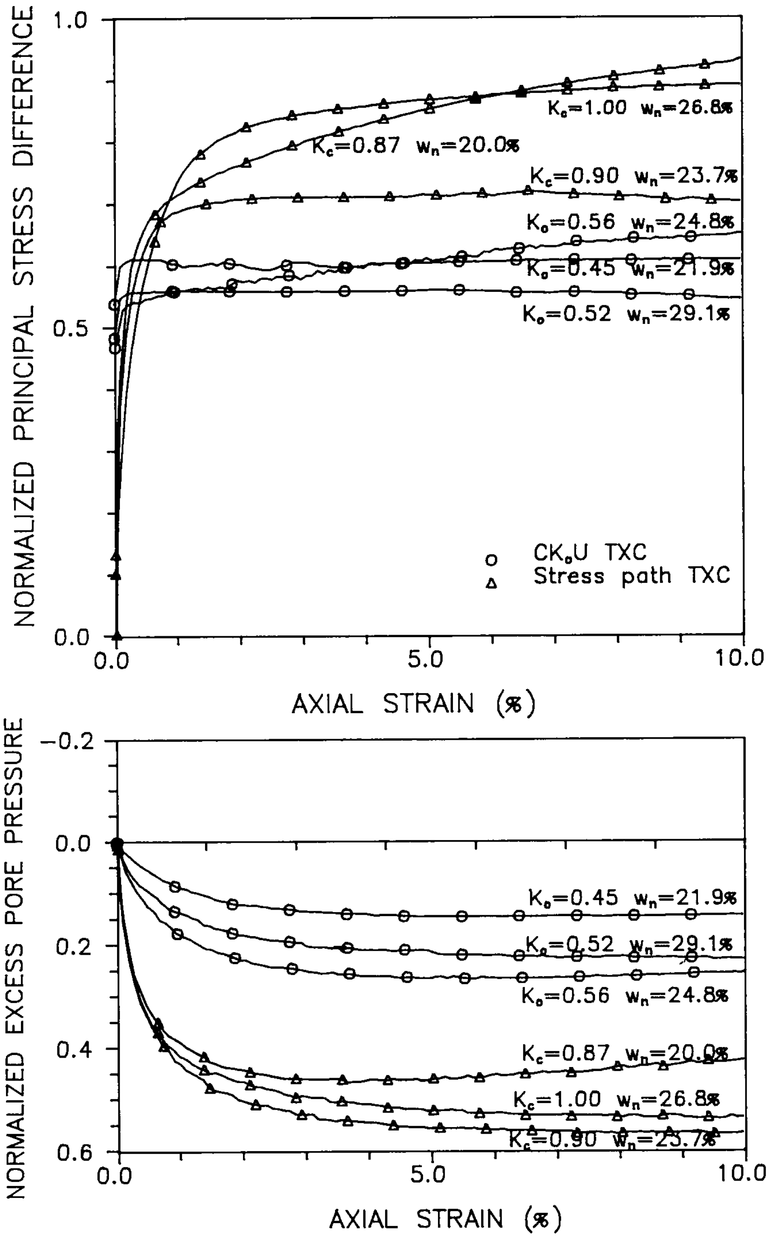

Fig 1-6. Consolidation Stress Ratio Effects on Stress-strain and Pore Pressure - Strain Response for Normally consolidated Clays: Compression

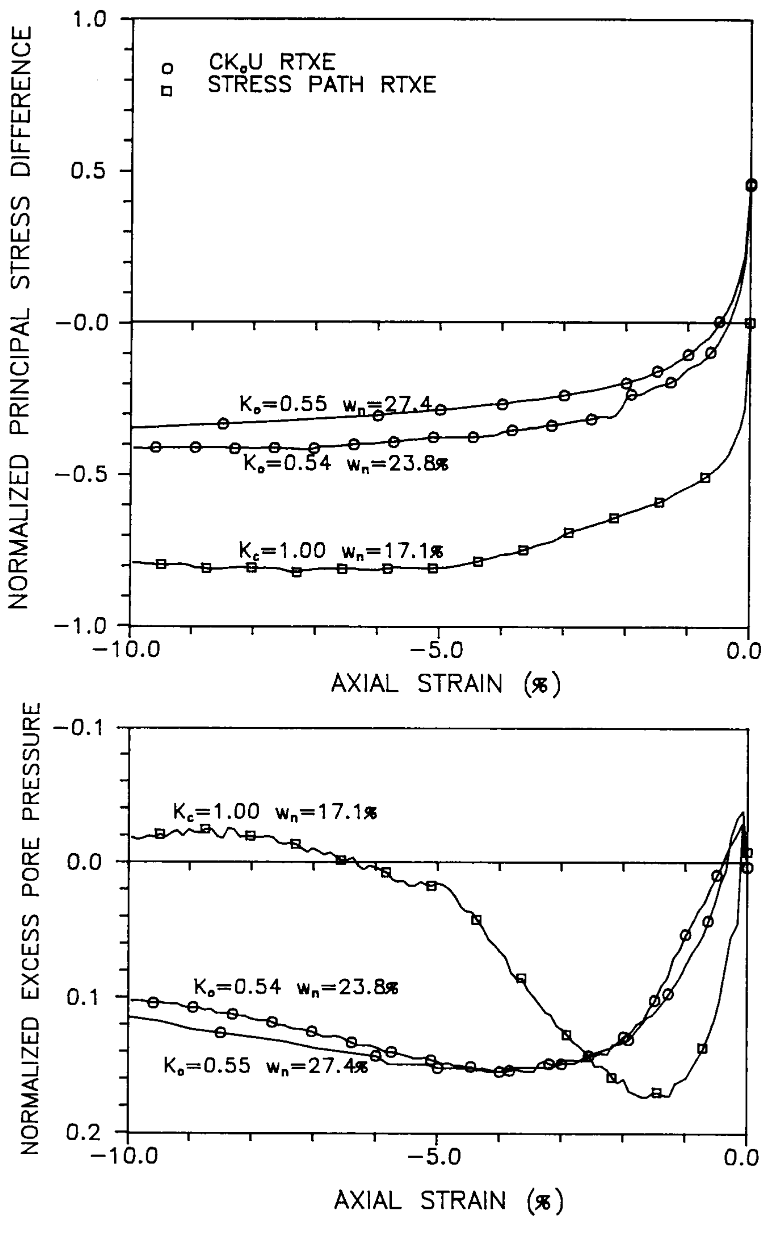

Fig 1-7. Consolidation Stress Ratio Effects on Stress-strain and Pore Pressure-Strain Response for Normally consolidated Clays: Extension

＊ The Effect of Isotropic Consolidation on Shearing Behavior

	Triaxial Compression	Trialxial Extension
Soil Structure Change	s_u ↓ (Stiffness ↓) (u_e ↑)	s_u ↑ (Stiffness ↑) (u_e ↓)
Increasing p'	s_u ↑ u_e (↑)	s_u ↑ u_e(↑)

＊ Anisotropy of s_u (for NC or lightly OC clays)

$$\left(\frac{(s_u)_E}{(s_u)_C}\right)_i > \left(\frac{(s_u)_E}{(s_u)_C}\right)_{Ko}$$

* Mayne (1985), for 42 soil types,

For comp. , $\left(s_u/\sigma'_{vc}\right)_{Ko} \approx 0.87\left(s_u/\sigma'_{vc}\right)_{iso}$

For ext. , $\left(s_u/\sigma'_{vc}\right)_{Ko} \approx 0.60\left(s_u/\sigma'_{vc}\right)_{iso}$

* Sivakugan and et al.

Based on K_0 (=1-sinϕ') and pore pressure parameter at failure, A_f for isotropic and K_0 – consolidation;

$$\frac{\left(\dfrac{s_u}{\sigma'_{vc}}\right)_{CKoUC}}{\left(\dfrac{s_u}{\sigma'_{vc}}\right)_{CIUC}} = \frac{K_0 + 2(1-K_0)A_{f,i}}{K_0 + 2(1-K_0)A_{f,Ko}}\left(A_{f,i}(1-K_0)+K_0\right)$$

* Wroth

$$\frac{\left(\dfrac{s_u}{\sigma'_{vc}}\right)_{CKoUC}}{\left(\dfrac{s_u}{\sigma'_{vc}}\right)_{CIUC}} = \frac{3-2\sin\phi'}{3}\left(1-a^2\right)^{\Lambda}$$

where $a = \dfrac{3-\sin\phi'}{2(3-2\sin\phi')}$, $\Lambda = 1-\dfrac{C_r}{C_c}$

* For heavily OC clays

$K_0 = (1-\sin\phi)(OCR)^{\sin\phi} \Rightarrow For\ \ OCR = 4,\ K_0 \approx 1$

So, the higher OCR (<4), the lower anisotropy.