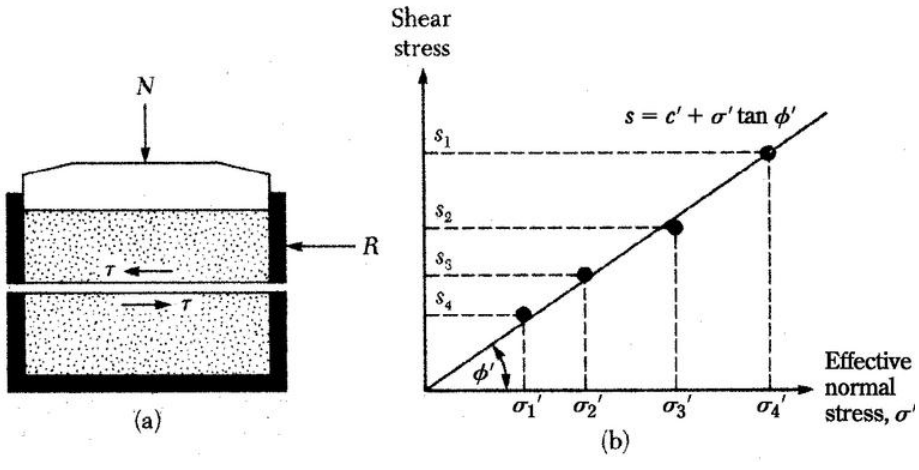
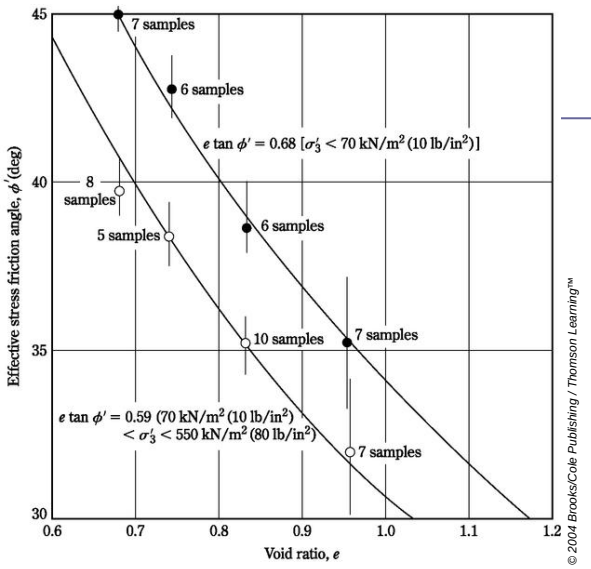
Shear Strength of Soil

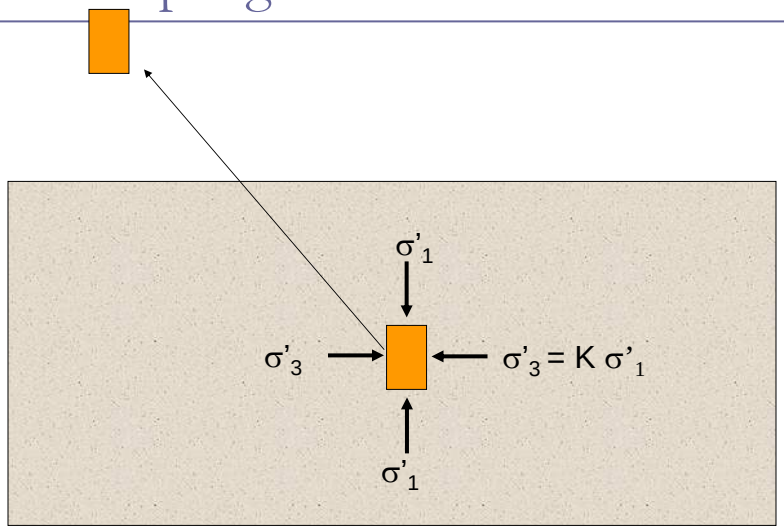


Direct shear test in sand: (a) schematic diagram of test equipment; (b) plot of test results to obtain the friction angle ϕ'

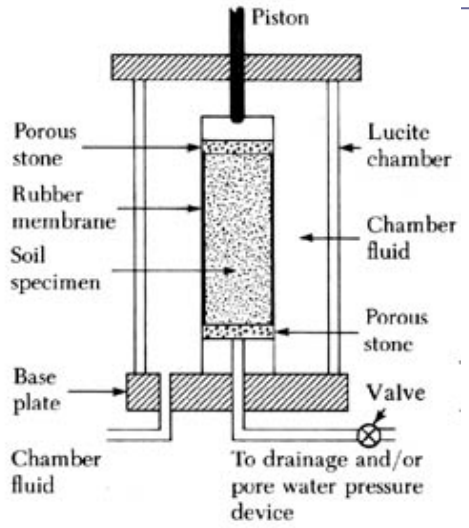


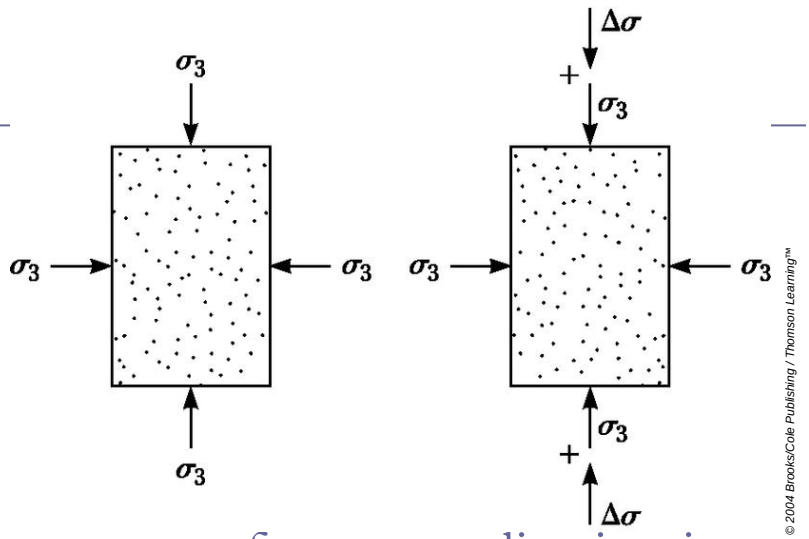
Variation of friction angle ϕ' with void ratio for Chattachoochee River sand (after Vesic, 1963)

Soil Sampling

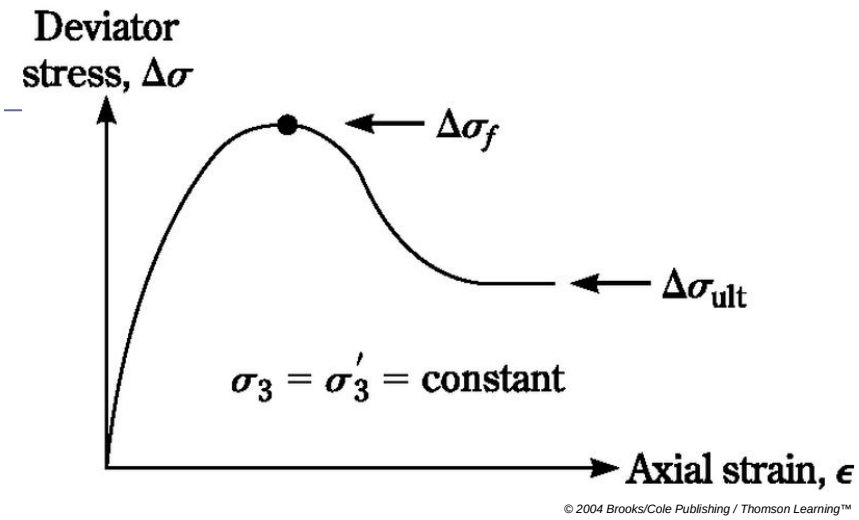


Triaxial Test Equipment





Sequences of stress application in triaxial test



Plot of deviator stress vs. axial strain-drained triaxial test

Triaxial Testing

- Application of cell pressure (sigma 3):
  - UNCONSOLIDATED (U) –
    - No drainage allowed
    - e constant (fixed) if Sr =1
  - CONSOLIDATED (C) –
    - Drainage allowed when applying cell pressure
    - e decreases due to sample consolidation.

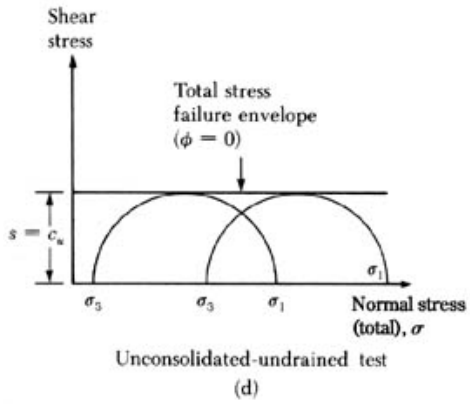
Triaxial Testing

- Application of deviatoric stress (σ_1):
- Deviator stress = $\sigma_1 - \sigma_3$
  - Undrained (U)
    - No drainage allowed
    - e constant (fixed) if Sr =1
  - Drained (D)
    - Drainage allowed when applying cell deviator stress
    - e decreases due to consolidation.
    - Stress applied so slow no excess pwp

Triaxial Tests

- UU – Unconsolidated Undrained
- UD – Unconsolidated Drained
- CU - Consolidated Undrained
- CD - Consolidated Drained

Undrained Soil Strength Parameters (Su, $\phi = 0$)



Unconsolidated-undrained test
(d)

Note: Always test soil at void ratio on the field

Skempton's Porewater Coefficients

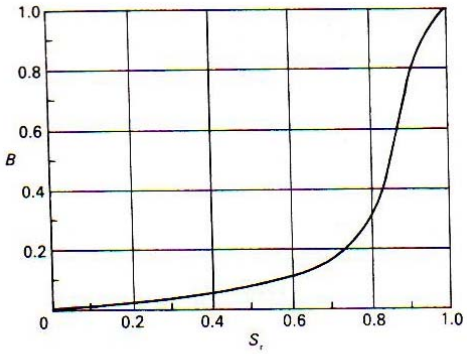
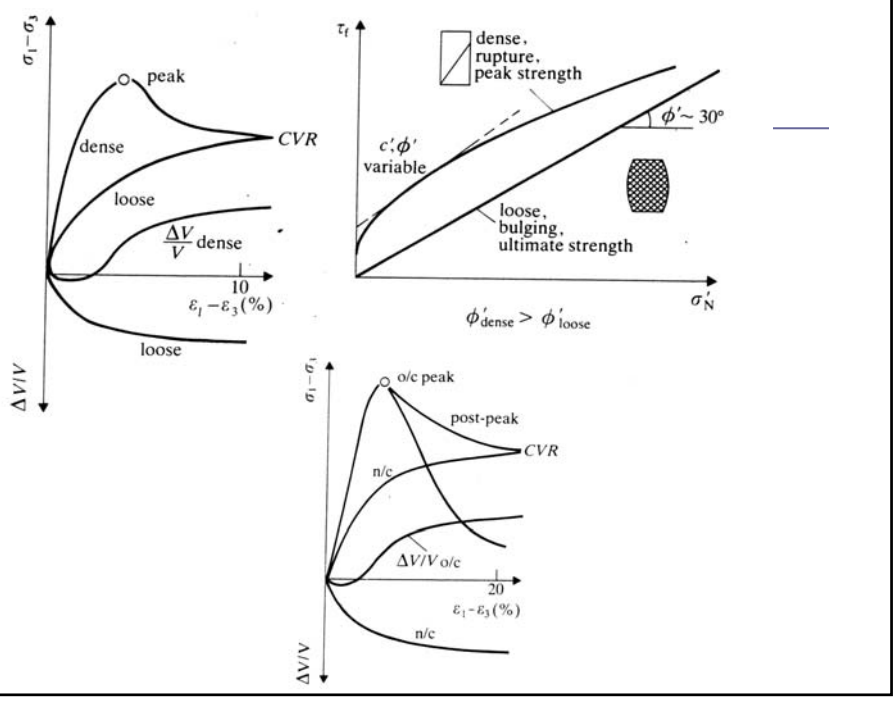
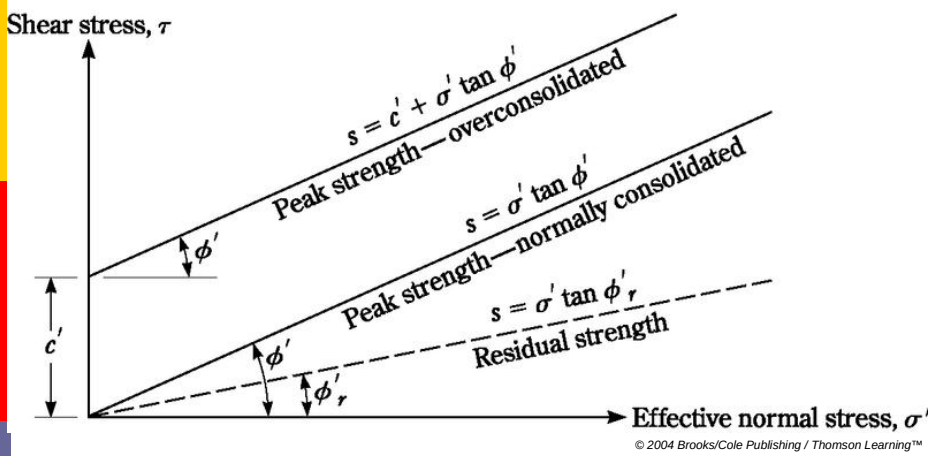


Fig. 4.9 Typical B/S_r relationship

$$B = \frac{\Delta\mu}{\Delta\sigma_3}$$

Developed "B" for a measure of degree of Water saturation

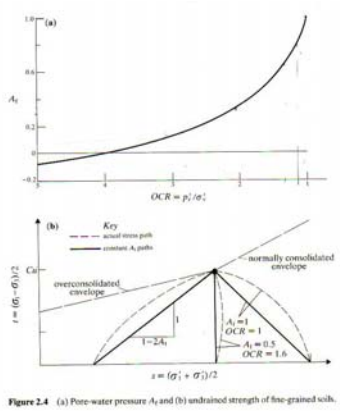




Peak- and residual-strength envelopes for clay

Skempton's Porewater Coefficients

- Developed "A" parameter for indication of sample OCR



$$A = \frac{\Delta\mu_i}{(\sigma_1 - \sigma_3)_i}$$

where:

$\Delta\mu_i = (\mu_i - \mu_o)$

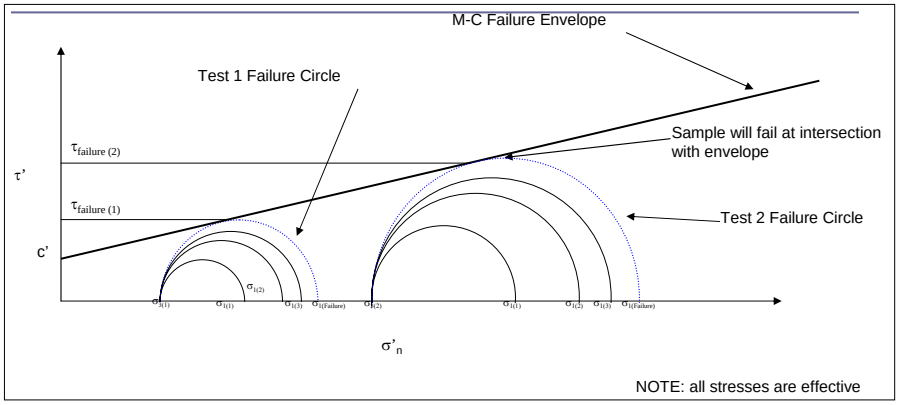
μ_o = initail pore pressure

μ_i = pore pressure at point of interest

$(\sigma_1 - \sigma_3)_i$ = deviatoric stress at point of interest

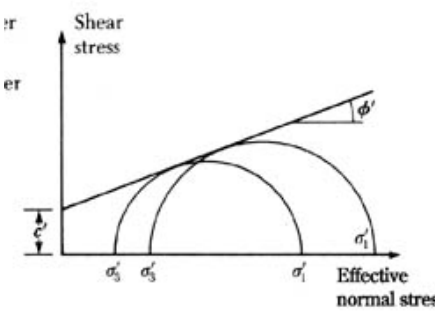
What about negative values of A_f

Soil Strength

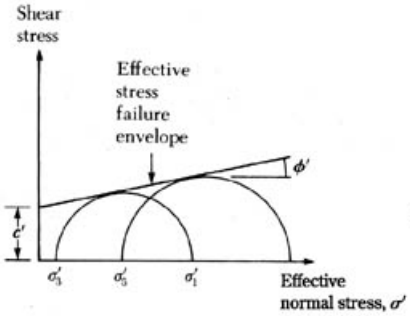


Each test is performed at a set void ratio

Drained Soil Strength Parameters (c', ϕ')

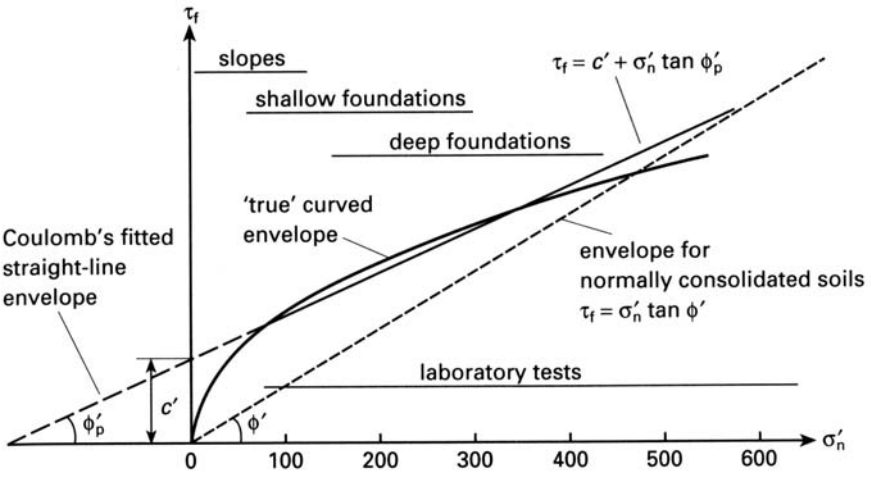


Consolidated-drained test
(b)

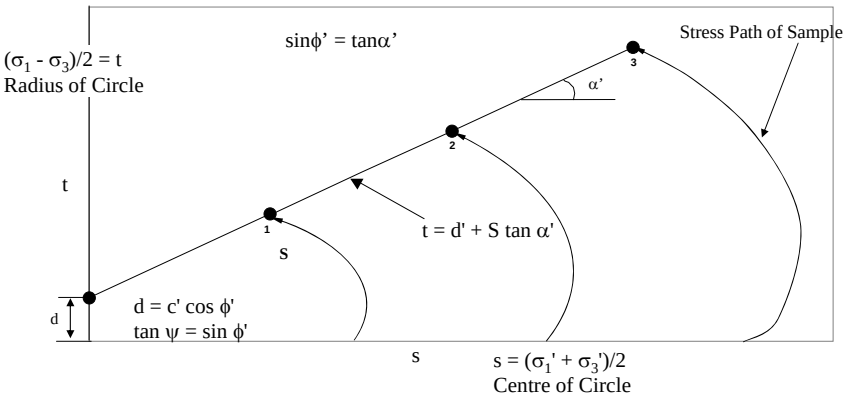


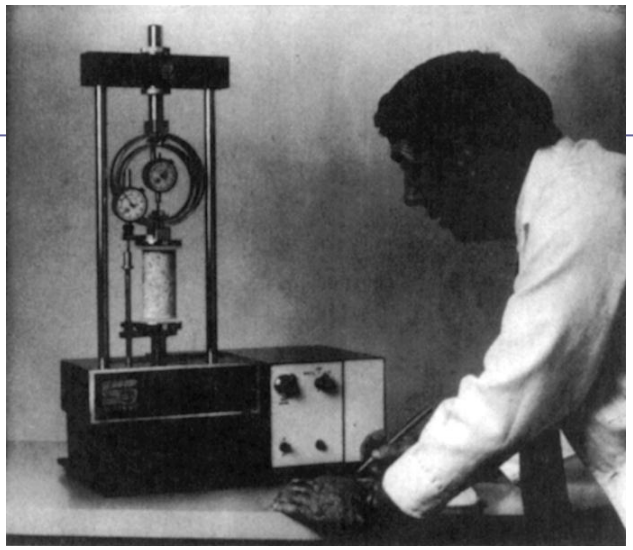
Consolidated-undrained test
(c)

Soil Strength Envelope

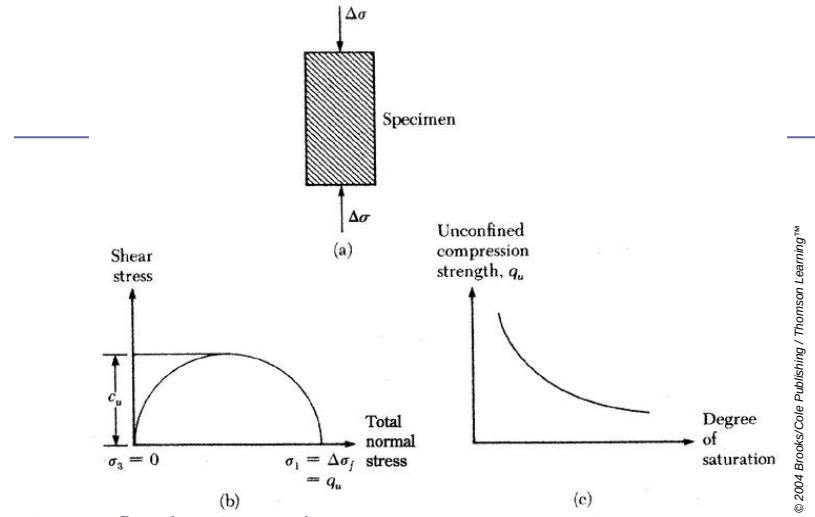


Soil Strength

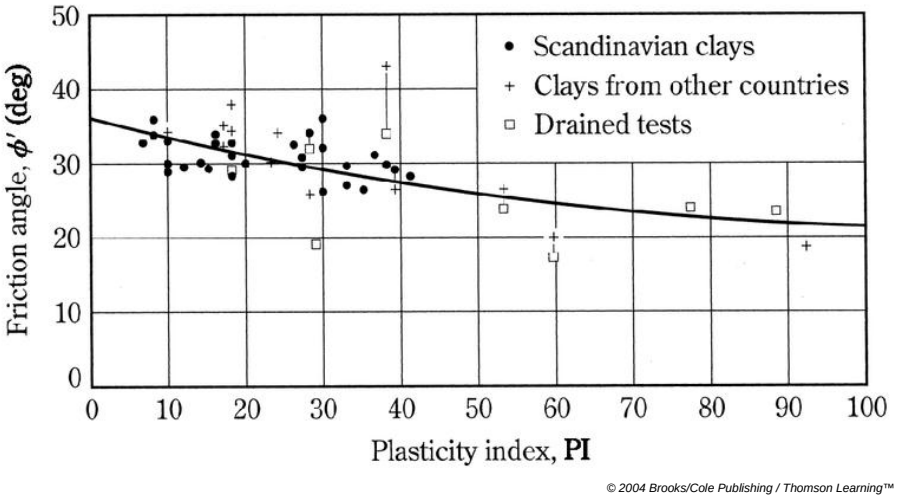




Unconfined compression test in progress (courtesy of Soiltest, Inc., Lake Bluff, IL)



Unconfined compression test:
(a) soil specimen; (b) Mohr's circle for the test; (c) variation of q_u with the degree of saturation



Variation of friction angle ϕ' with plasticity index for several clays (after Bjerrum and Simons, 1960)