SOIL MECHANICS II
CIVL 311
COURSE NOTES
2011

Module 3
Response of soils to Shearing

(Review of content from CIVL 210: Soil Mechanics I provided by Dr. Mahdi Taiebat)

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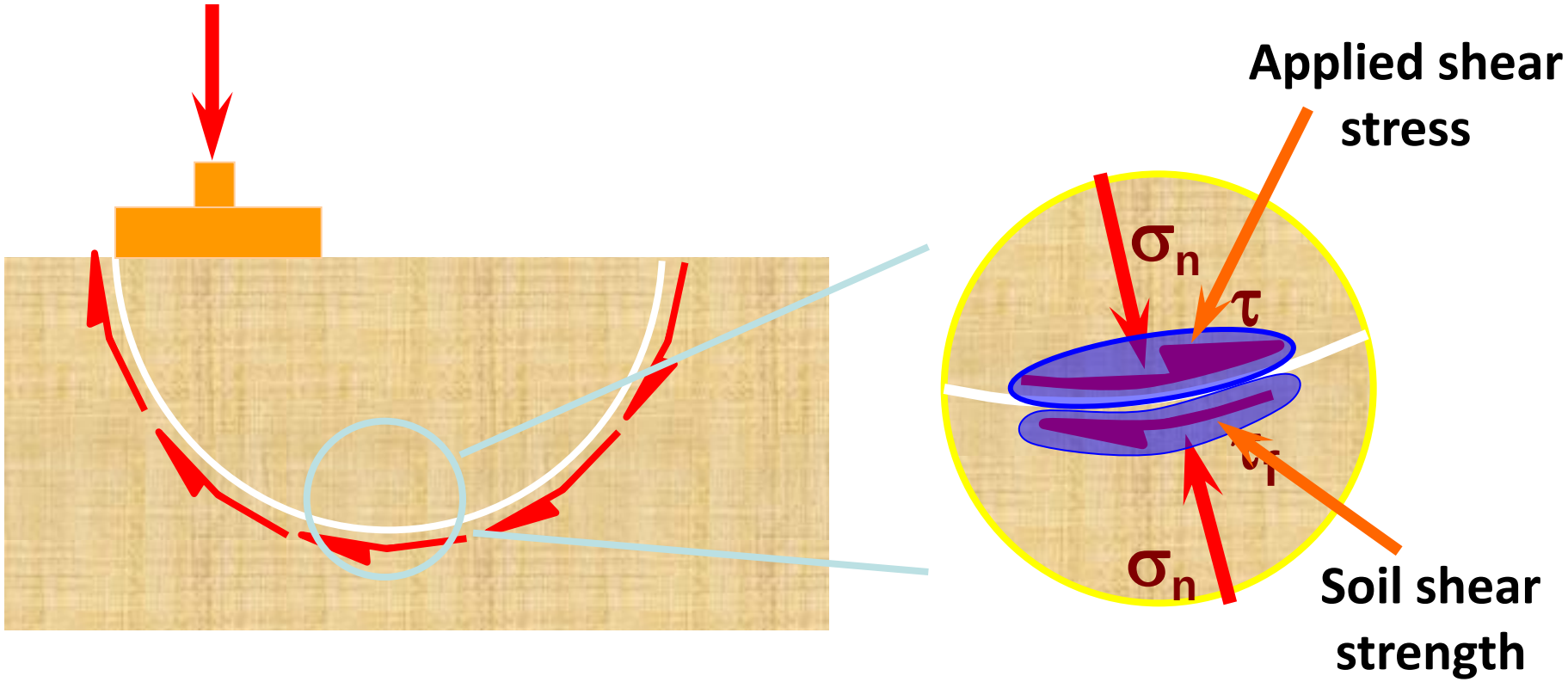
Shear strength

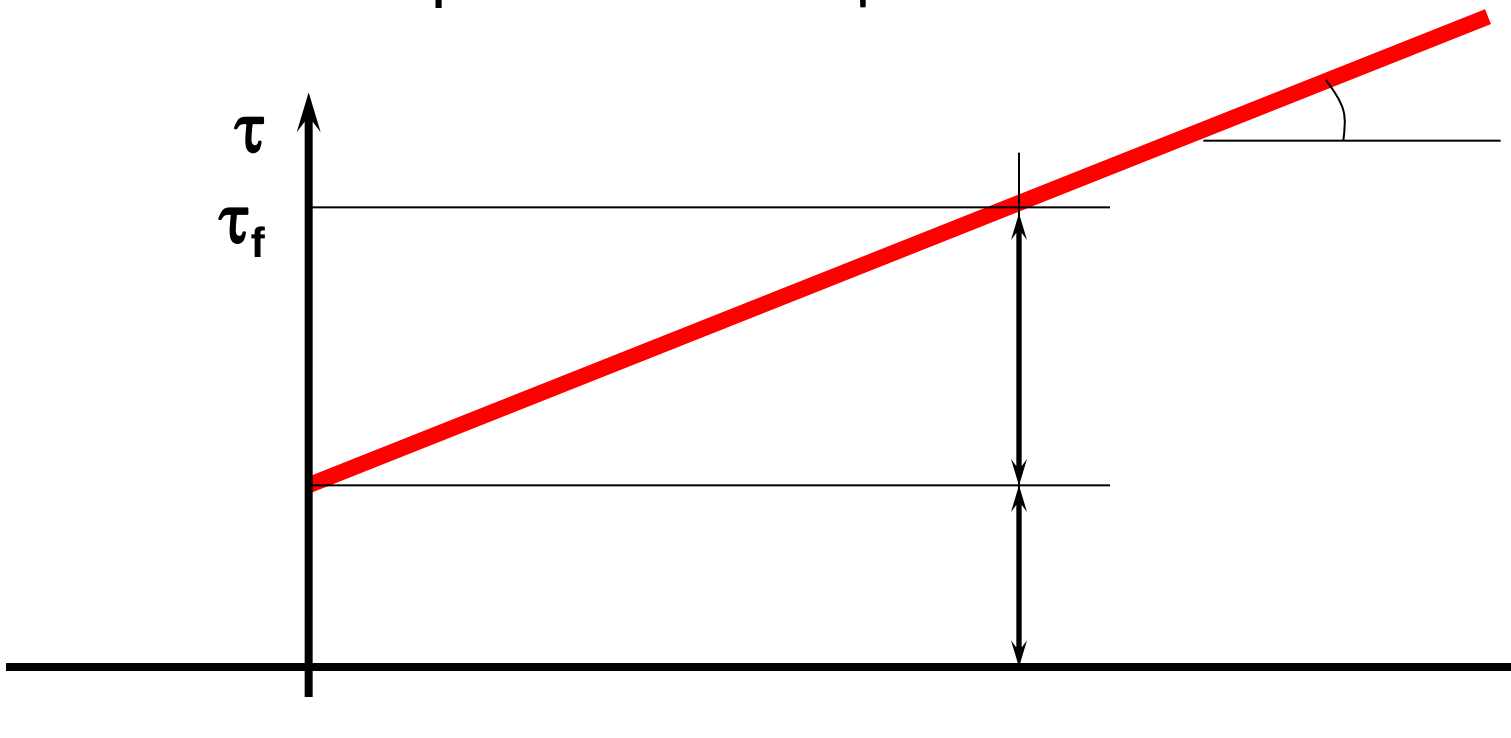
- Soil strength needs to be evaluated in many problems. Soil generally fails in shear.



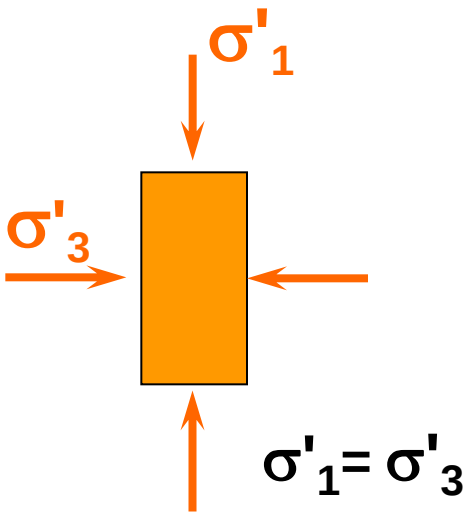
A failure : $\tau = \tau_f$

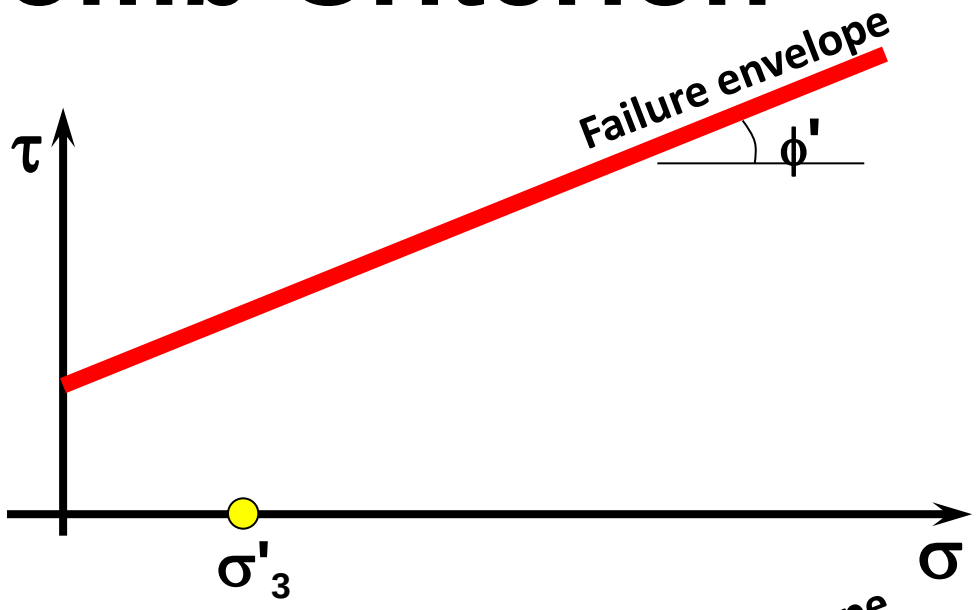
Coulomb and Mohr-Coulomb Failure Criteria

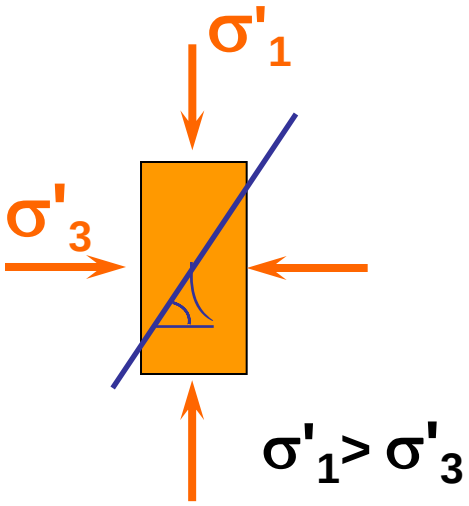
- Shear strength of soil can be modeled using 2 components:
  - Friction
  - Cohesion $\tau_f = c' + \sigma' \tan \phi'$

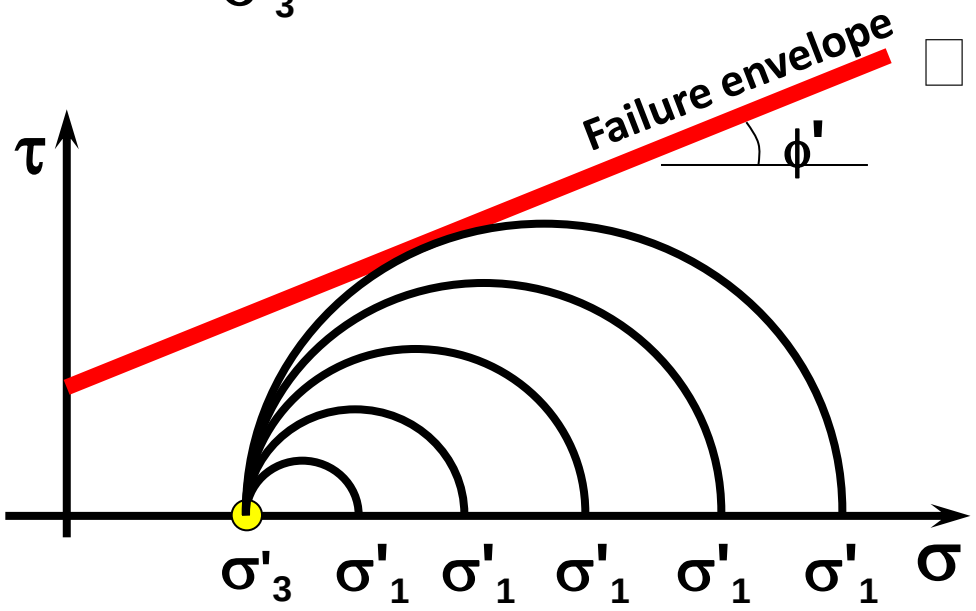


Mohr-Coulomb Criterion







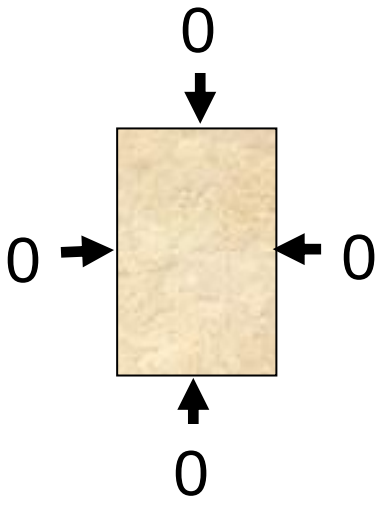


Loading in Drained and Undrained conditions

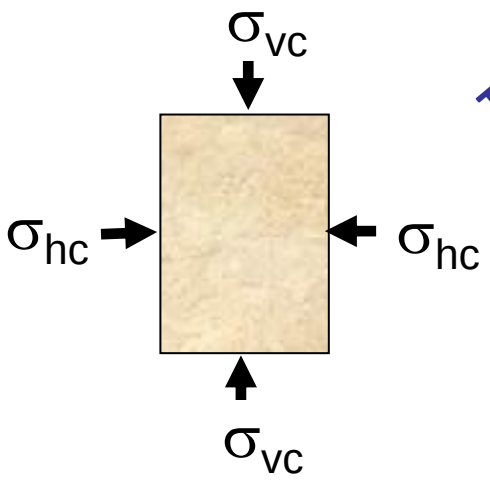
- Drained
  - When the excess pore water pressure developed during loading of a soil is allowed to dissipate, i.e., $\Delta u=0$;
- Undrained or partially drained
  - When the excess porewater pressure cannot dissipate, or cannot drain quickly enough, from the soil, i.e., $\Delta u \neq 0$.
  - The undrained and drained strengths generally provide the two extremes of soil shear strength.
  - Undrained and drained strength parameters can be obtained from laboratory tests.

Laboratory Testing of Soils

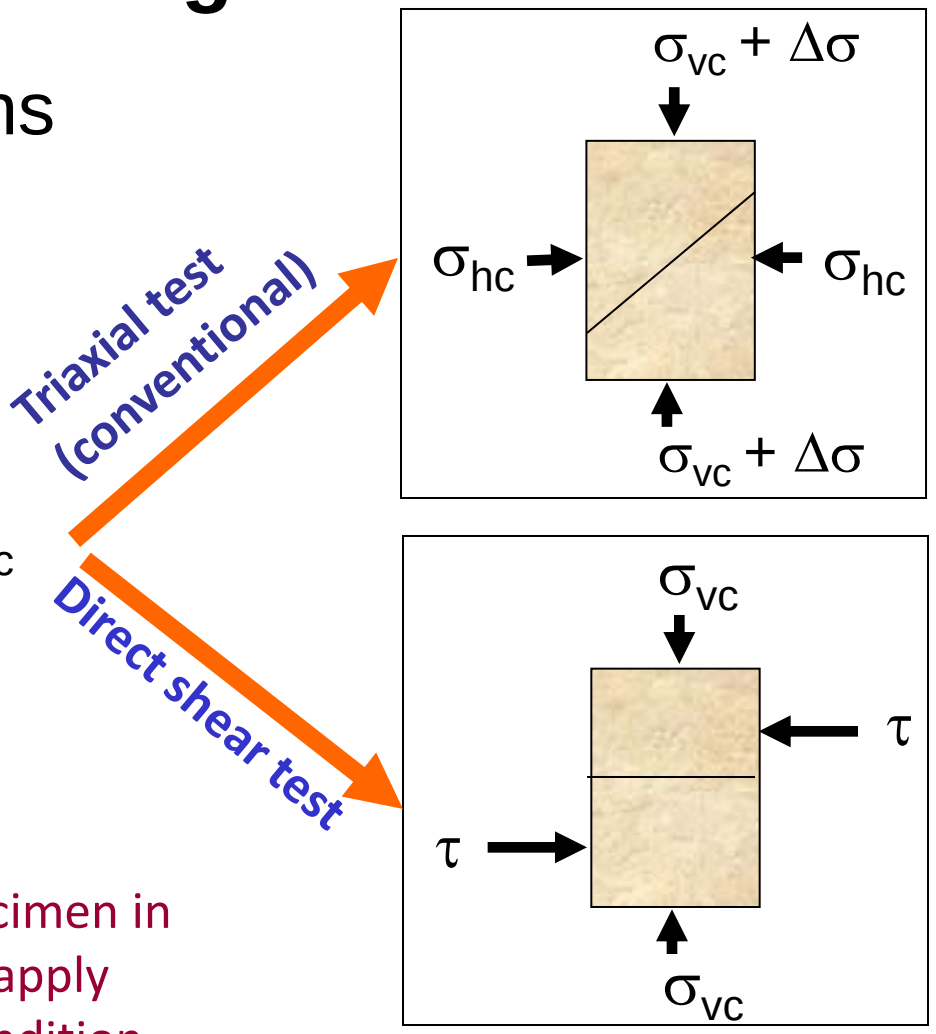
- Simulating field conditions in the laboratory



Representative soil sample taken from the site



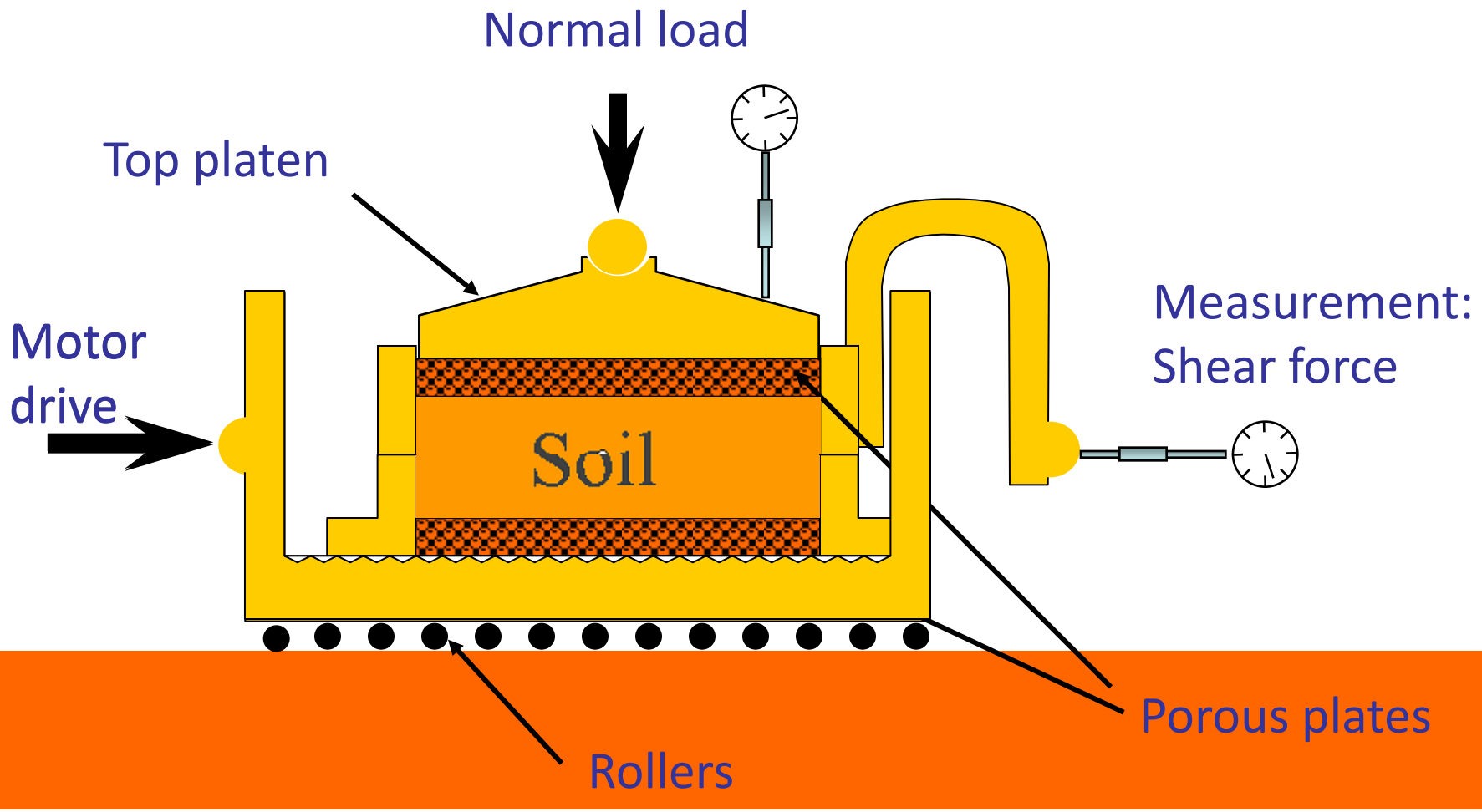
Step 1: Set the specimen in the apparatus and apply the initial stress condition



Step 2: Apply the corresponding field stress conditions

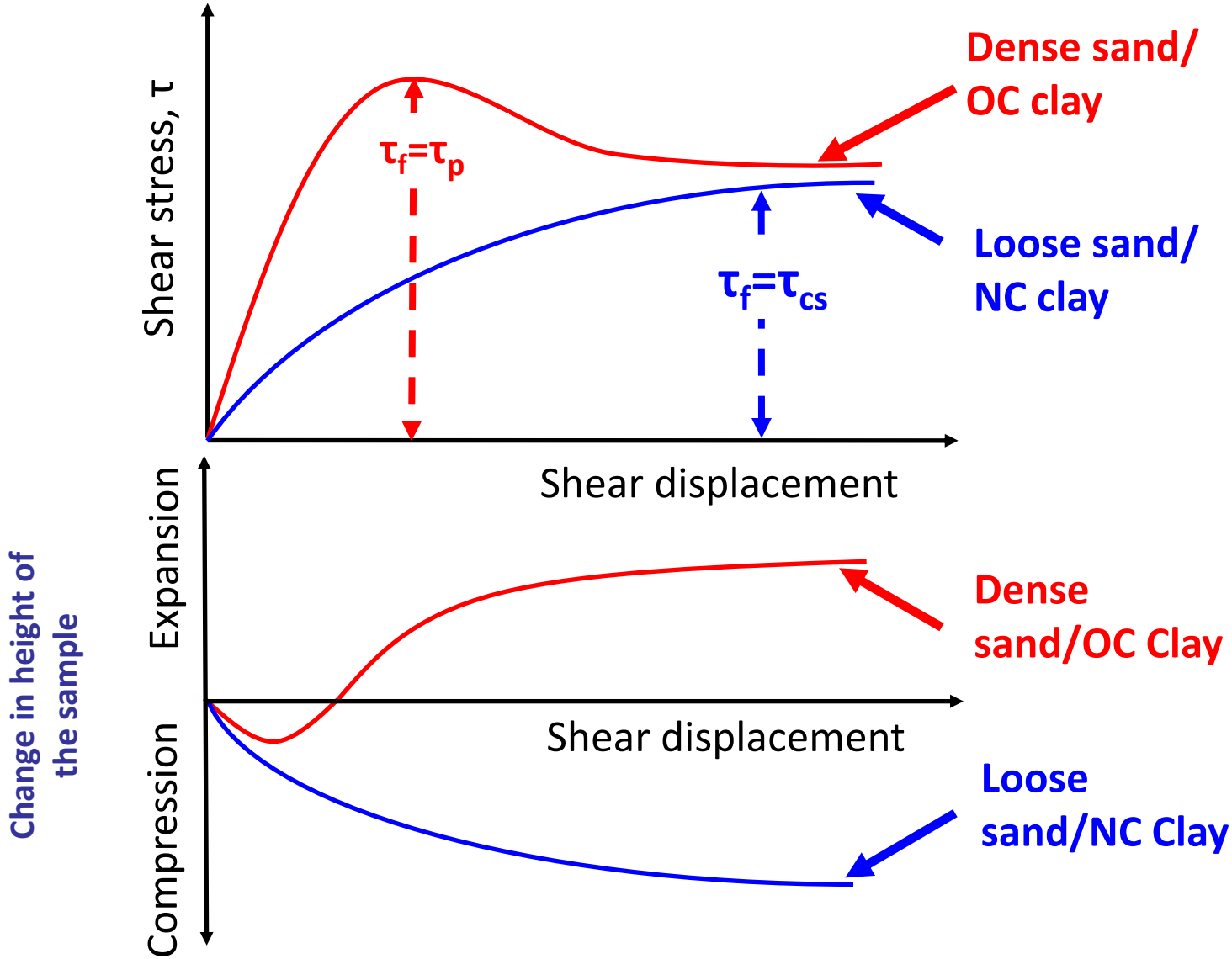
Direct Shear Test Apparatus

Tests conducted under different normal effective stresses



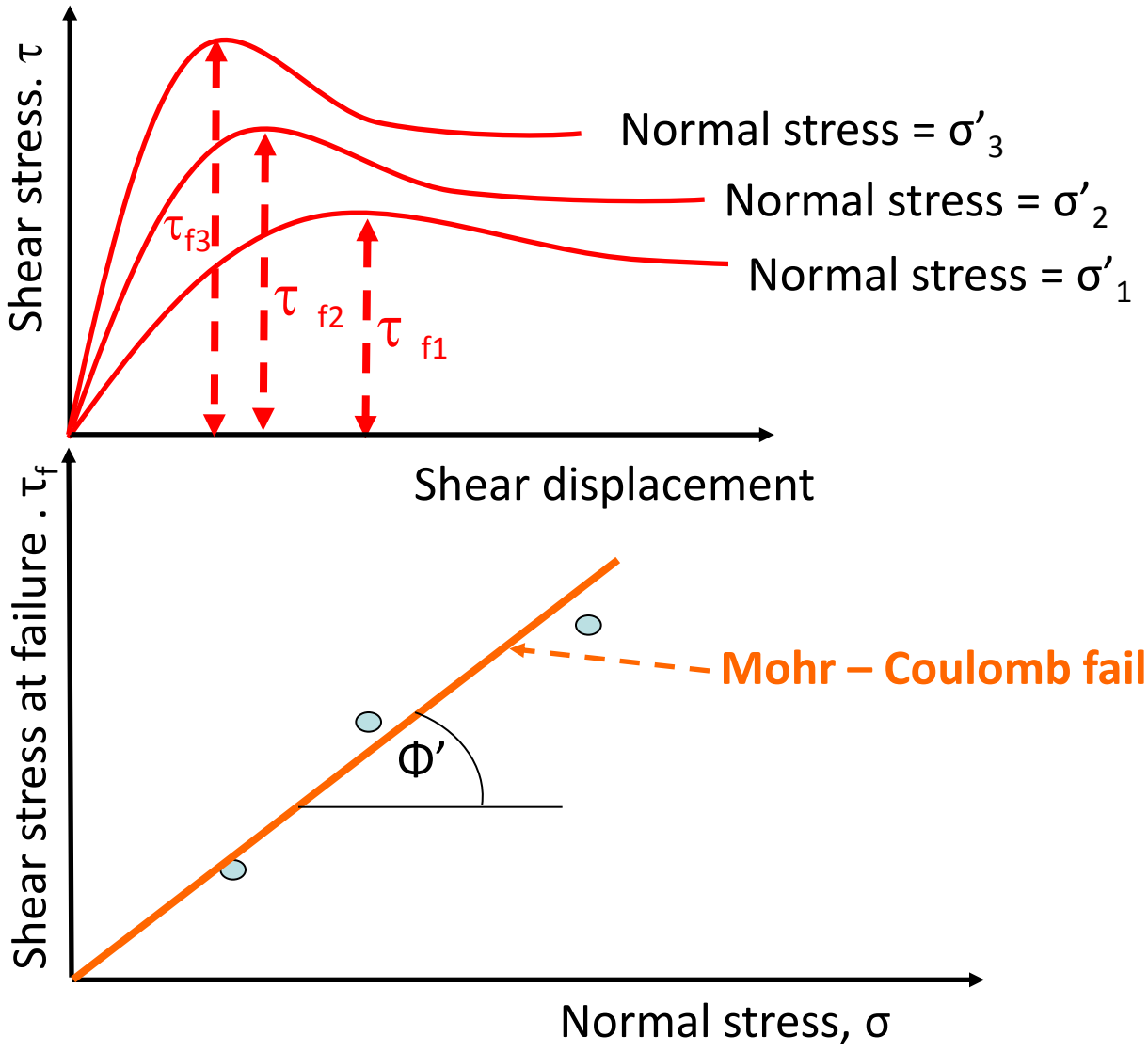
Typical Results from Direct Shear Tests on Sands

- Stress-strain relationship (same vertical stress)



Typical Results from Direct Shear Tests on Sands

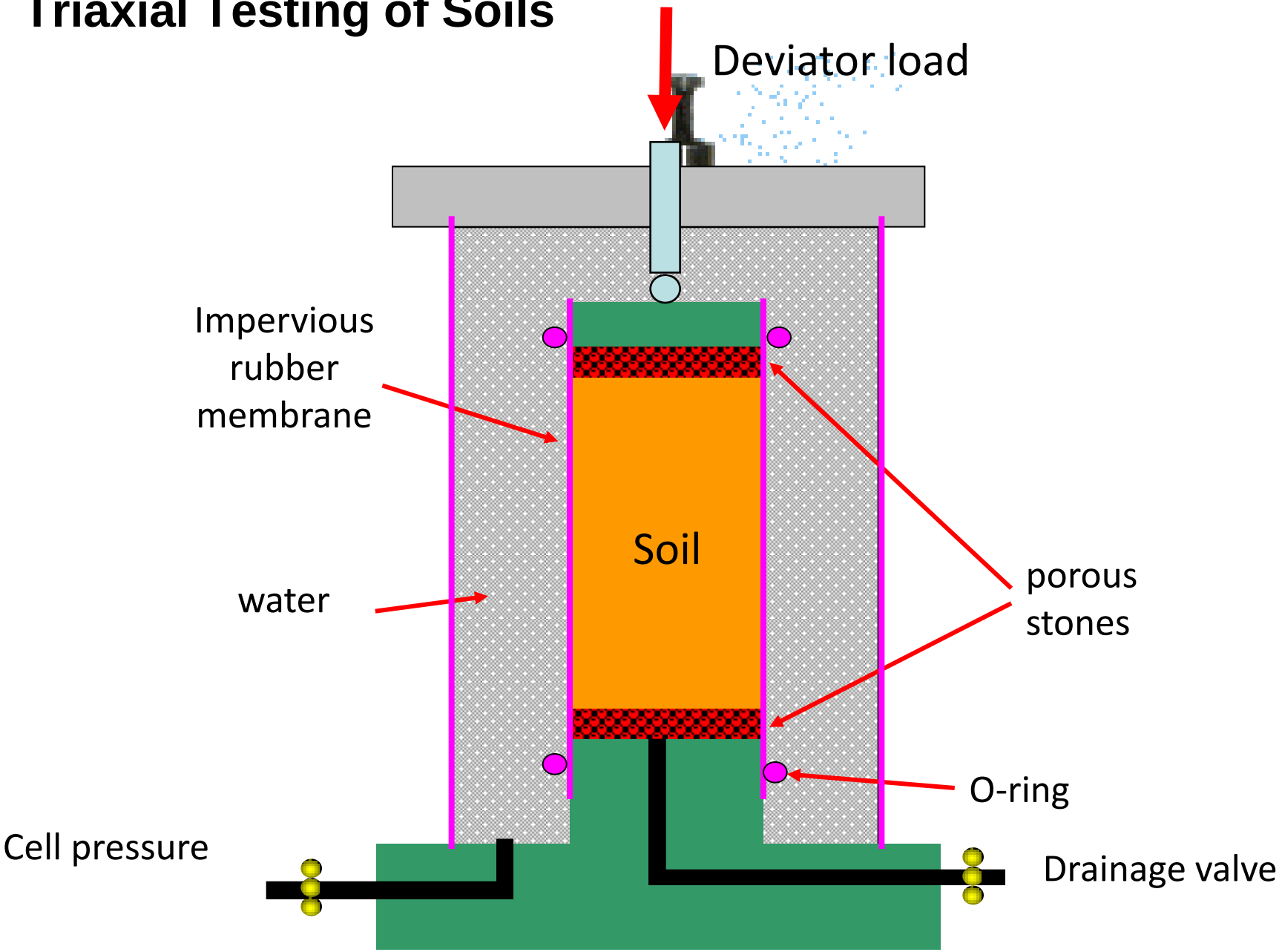
- How to determine strength parameters c' and φ'



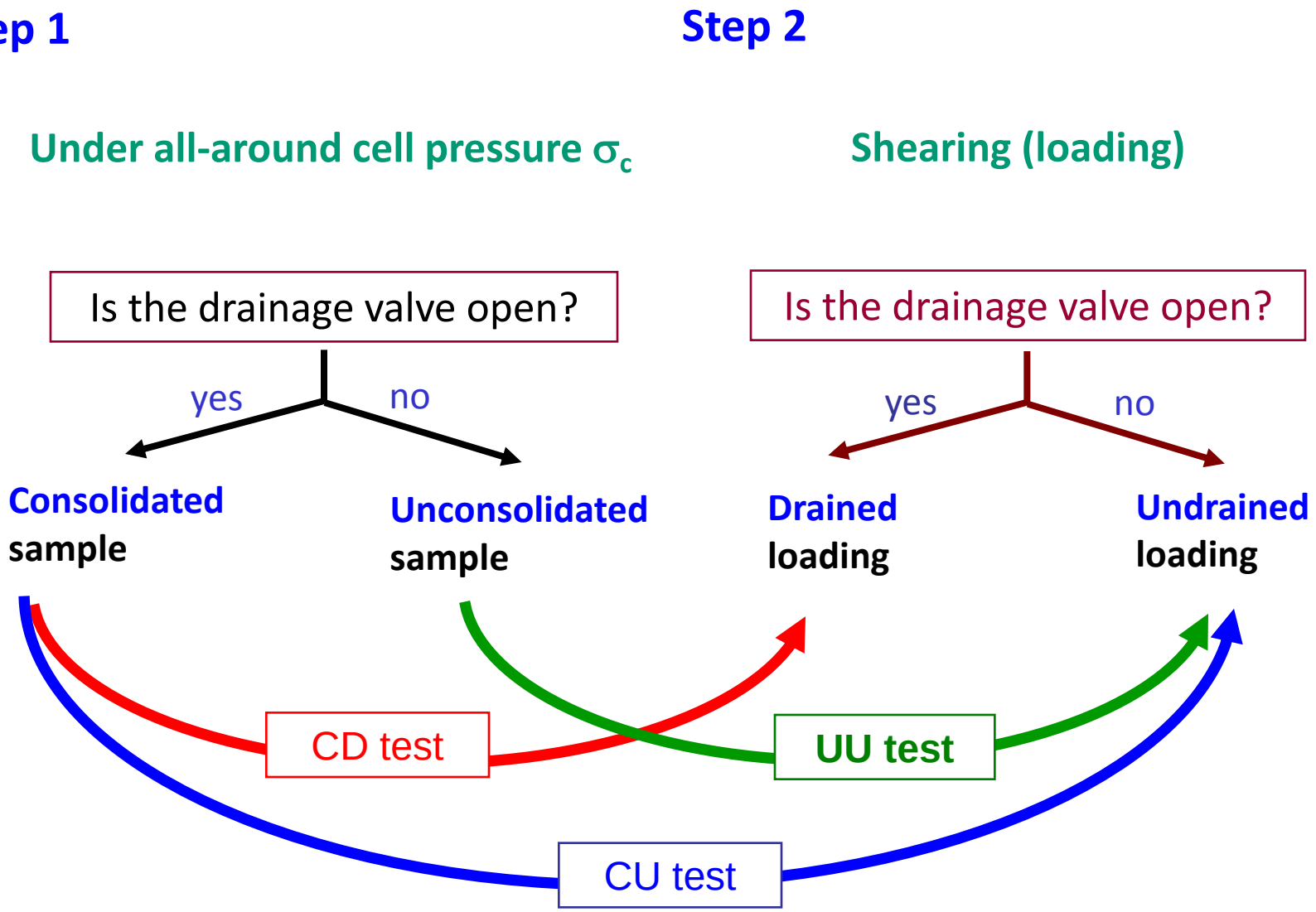
If $\tau_f = \tau_p$ then $\phi = \phi'_p$

If $\tau_f = \tau_{cs}$ then $\phi = \phi'_{cs}$

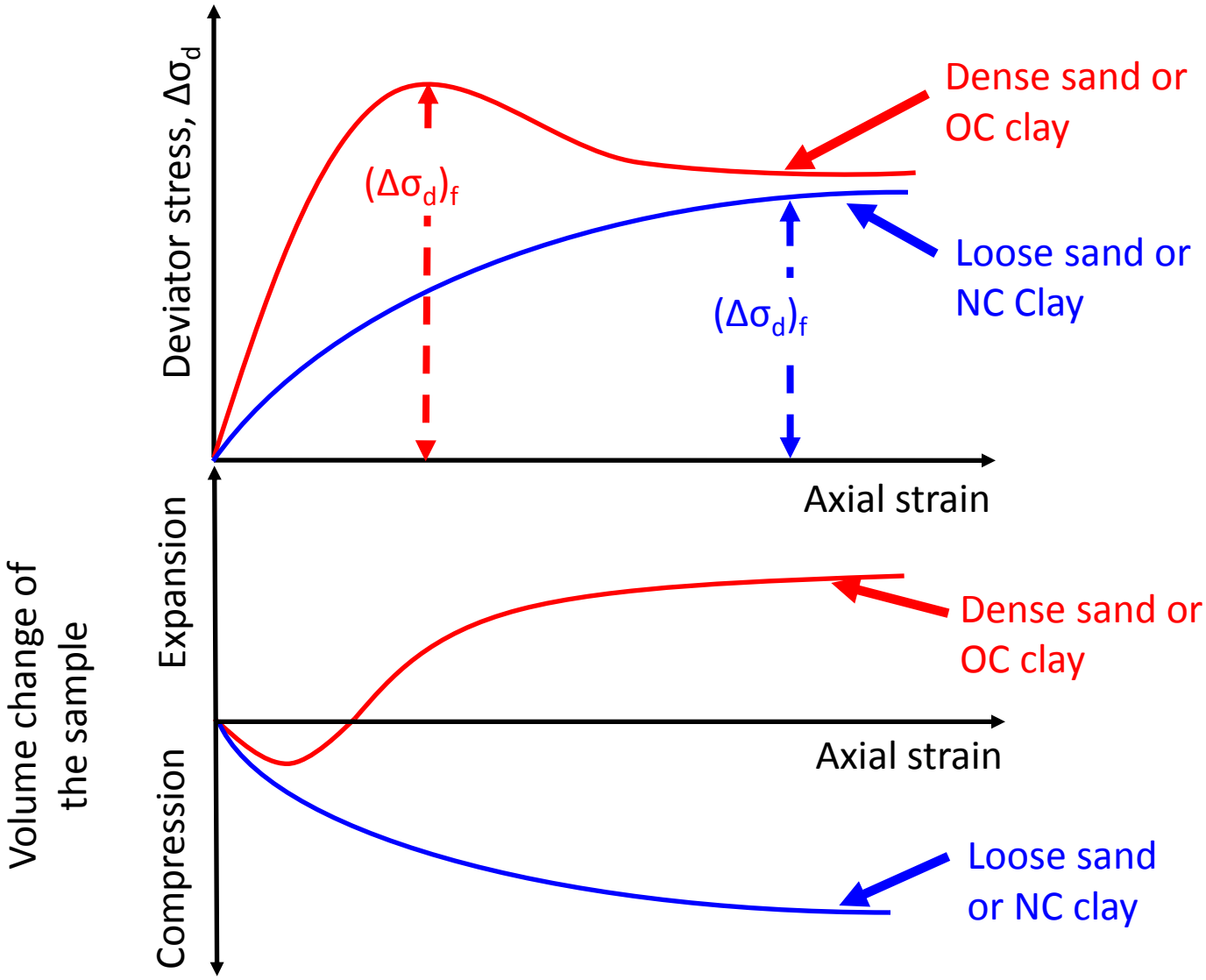
Triaxial Testing of Soils



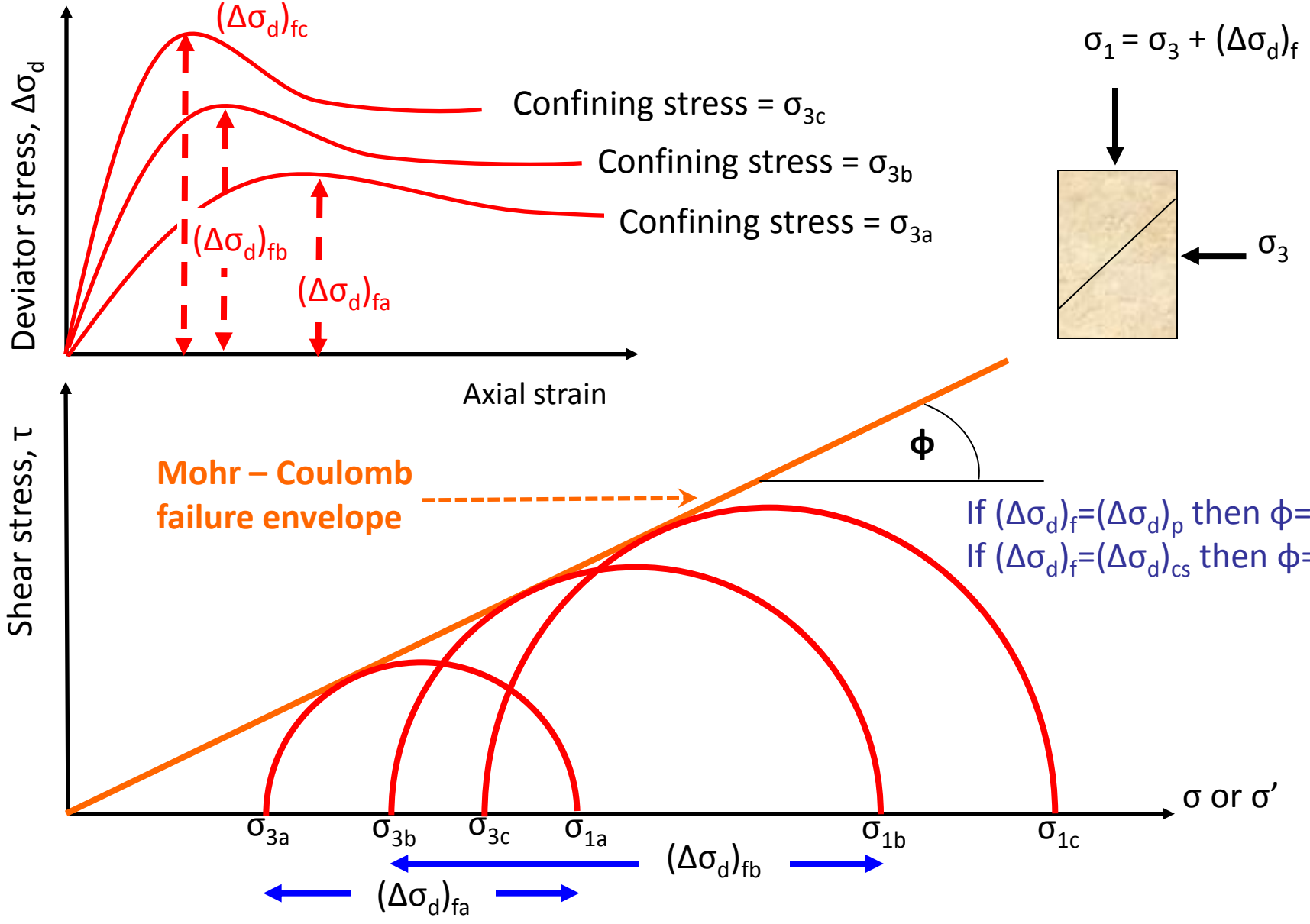
Types of Typical Triaxial Tests



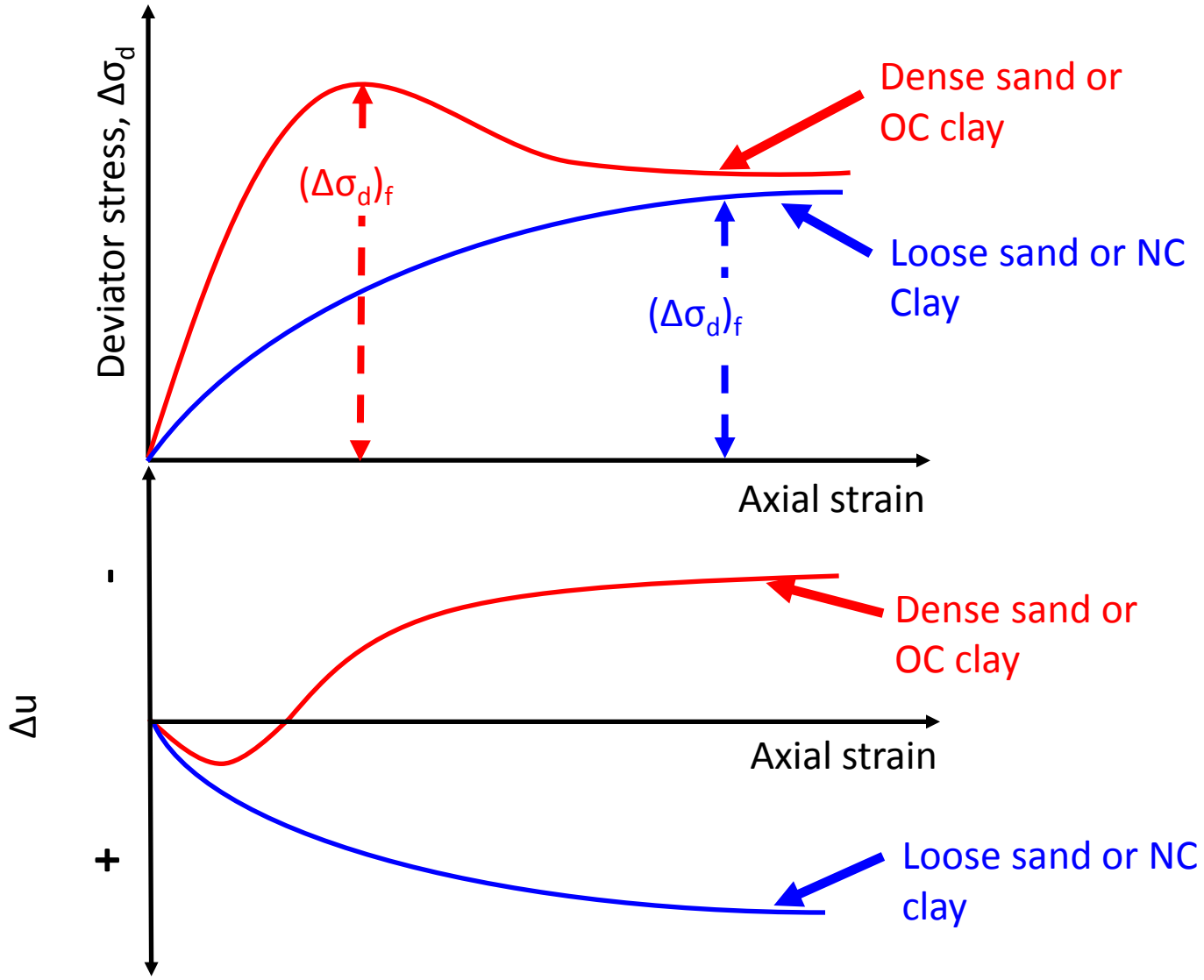
Stress-strain relationship during drained shearing



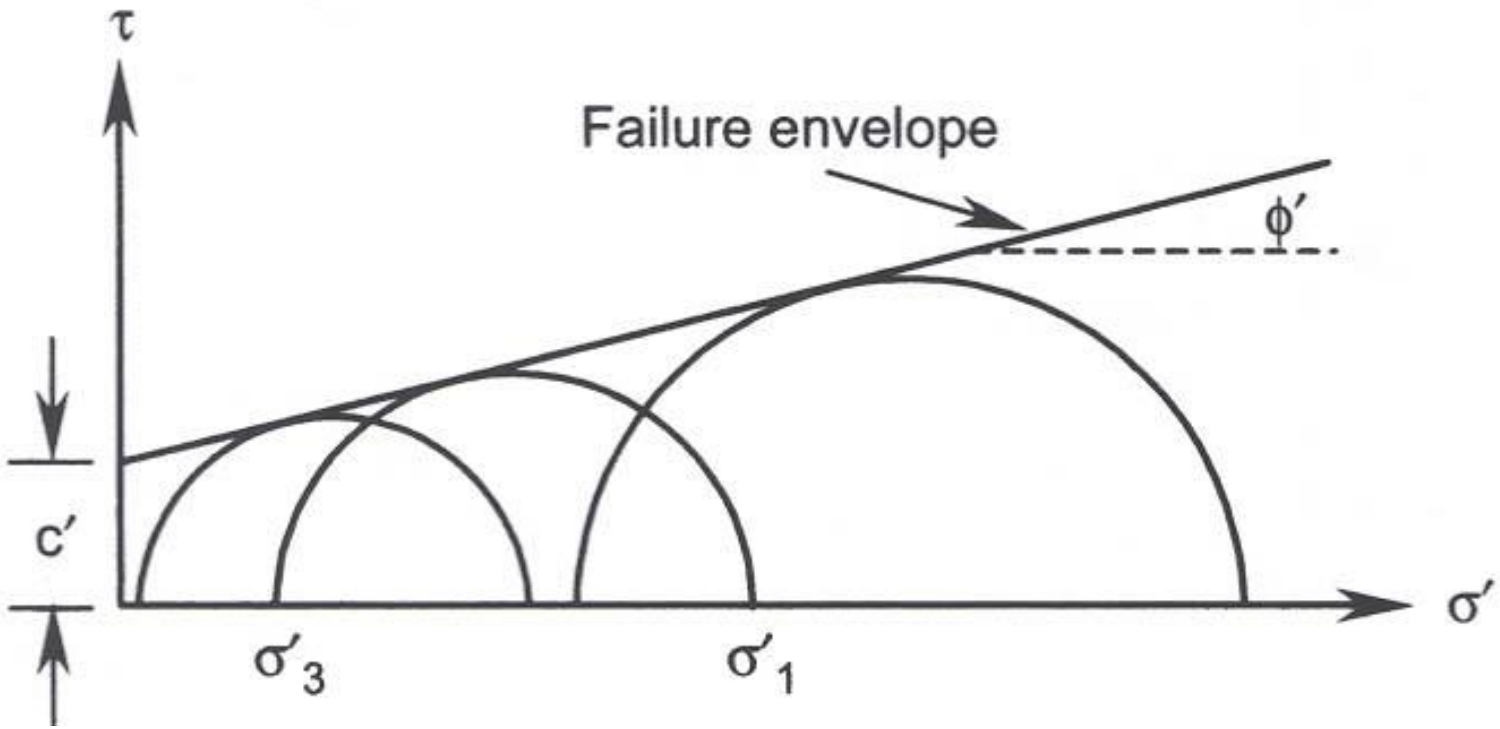
How to determine strength parameters c' and φ'



Consolidated- drained test (CD Test)
Stress-strain relationship during undrained shearing



How to determine effective stress strength parameters c' and φ'



Unconsolidated- drained test (CD Test)
Stress-strain relationship during undrained shearing