



# 土壤力學導論 - 土壤之剪力強度

0011

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- ◆ 土壤剪力強度之重要性
- ◆ 土壤之破壞理論
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- ◆ 土壤剪力強度參數之測定方式
- ◆ 第四次練習

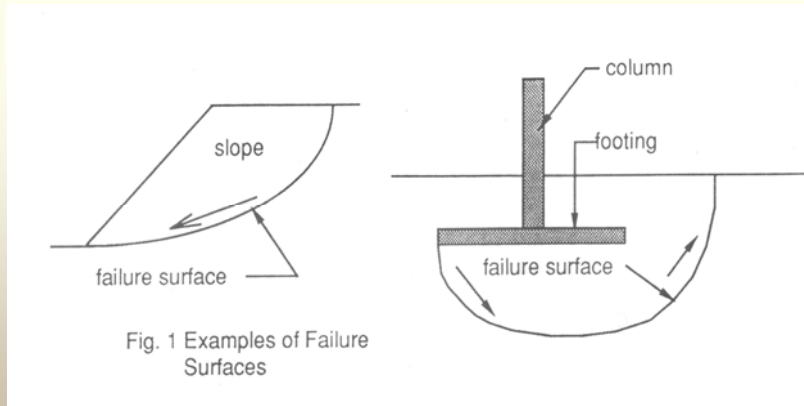
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## 土體之破壞模式

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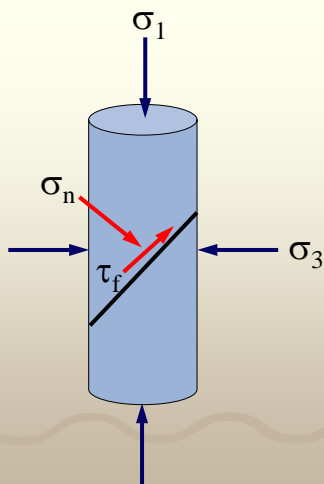
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## 摩爾庫倫破壞準則

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總應力

$$\tau_f = c + \sigma_n \tan \phi$$

有效應力

$$\tau_f = c' + \sigma_n' \tan \phi'$$

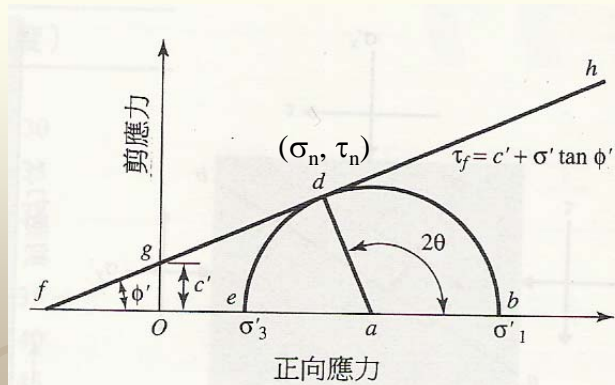
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## 摩爾圓

$$\sigma_n = \frac{1}{2}(\sigma_1 + \sigma_3) + \frac{1}{2}(\sigma_1 - \sigma_3)\cos 2\theta \quad \tau_n = \frac{1}{2}(\sigma_1 - \sigma_3)\sin 2\theta$$



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## 土壤剪力強度參數之測定方式

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- ◆ 直接剪力試驗 (Direct Shear Test)
- ◆ 三軸試驗 (Triaxial Test)
- ◆ 簡單直剪試驗 (Simple Shear Test)
- ◆ 扭剪試驗 (Torsional Shear Test)
- ◆ 中空圓柱試驗 (Hollow Cylinder Test)
- ◆ 真三軸試驗 (True Triaxial Test)

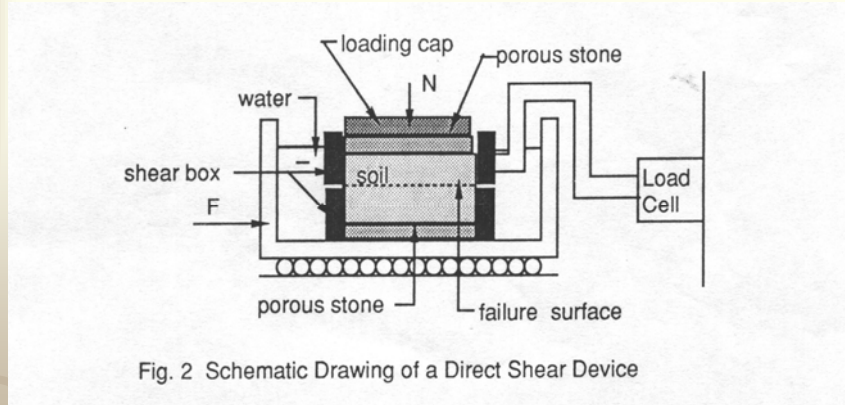
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## 直剪試驗—試驗儀器

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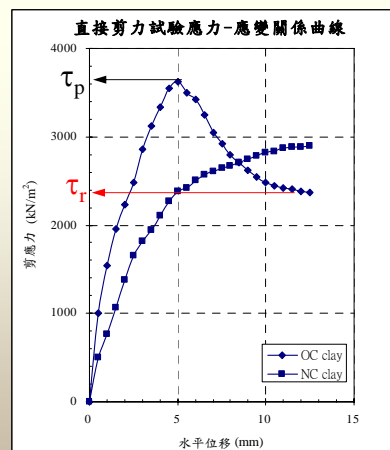
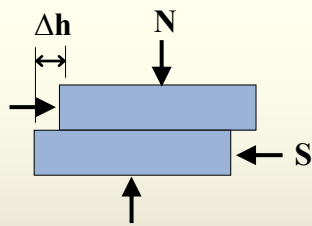
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## 直剪試驗—應力-應變曲線

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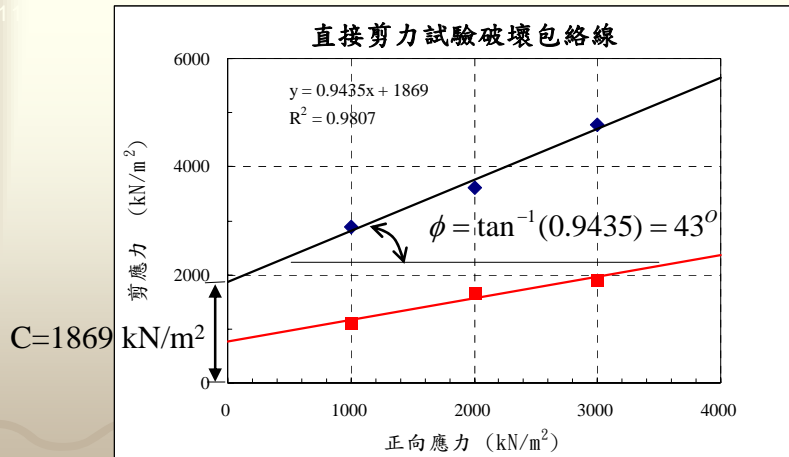
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## 直剪試驗—破壞包絡線

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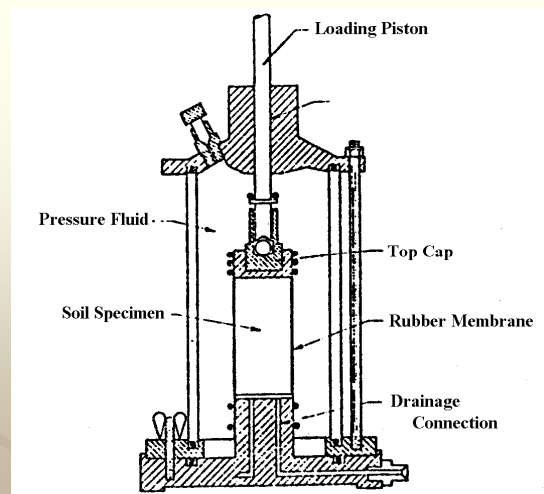
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## 三軸試驗—試驗儀器

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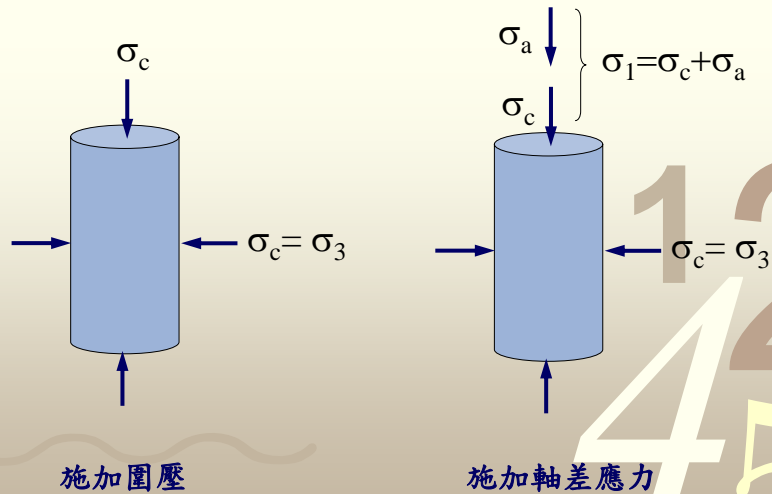
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## 三軸試驗之進行步驟

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## 三軸試驗之進行方式

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- ◆ 無圍壓縮試驗 (UC test)
- ◆ 不壓密不排水試驗 (UU test)
- ◆ 壓密不排水試驗 (CU test)
- ◆ 壓密排水試驗 (CD test)

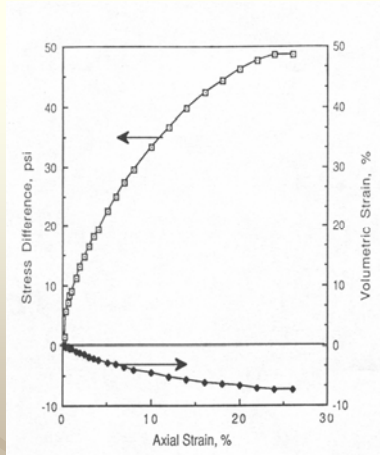
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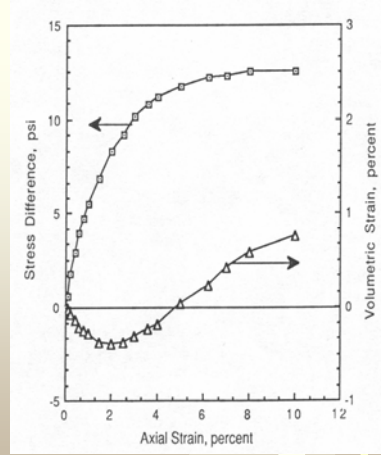


## CD試驗—應力-應變關係圖

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NC clay



OC clay

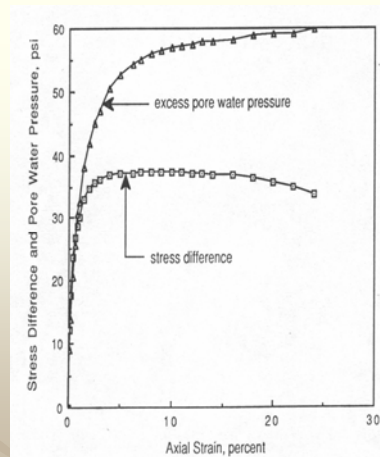
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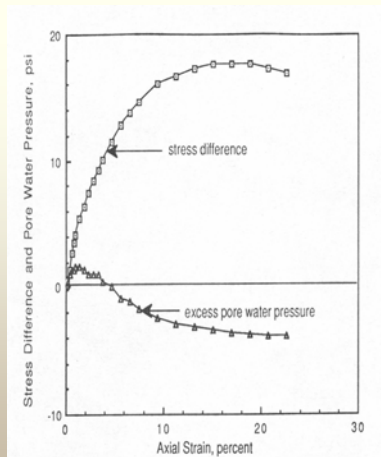


## CU試驗—應力-應變關係圖

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NC clay



OC clay

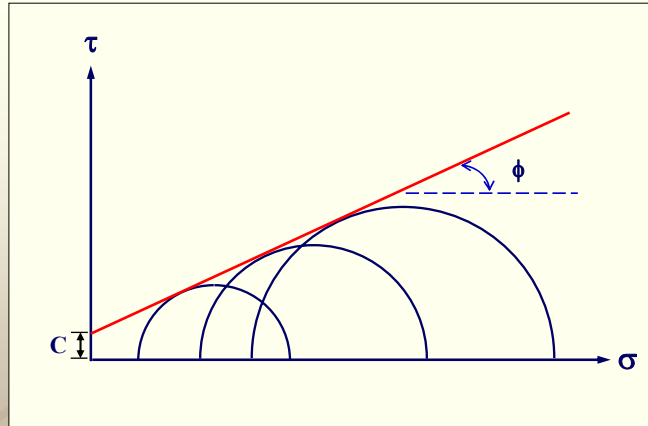
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## 莫爾庫倫破壞包絡線

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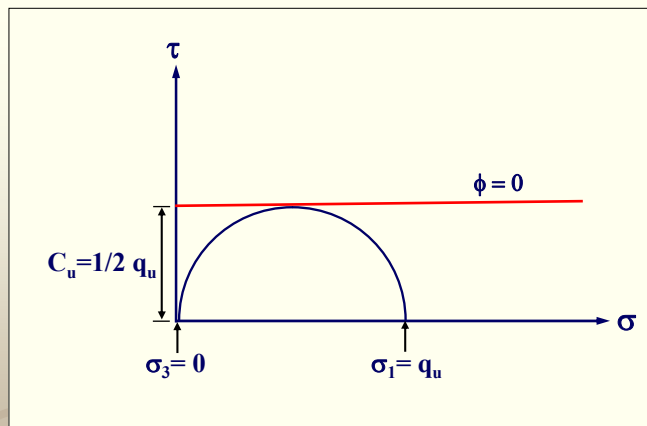
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## UC試驗破壞包絡線

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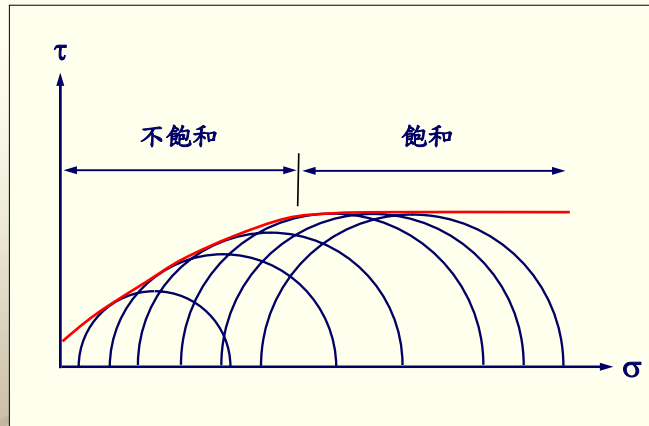
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## UU試驗破壞包絡線

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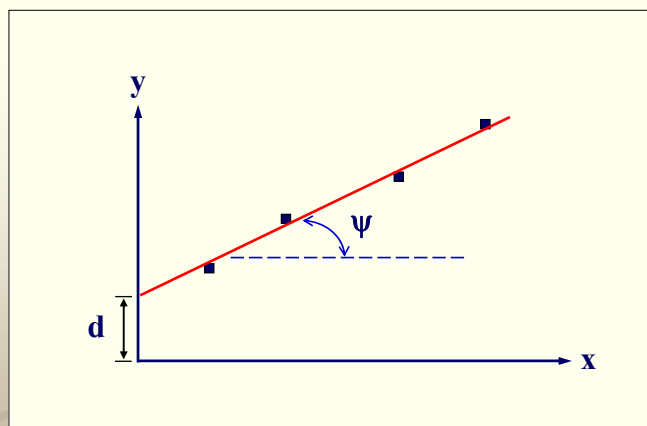
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## 修正莫爾庫倫破壞包絡線

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## C, $\phi$ 與 $d, \psi$ 間之關係

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x軸	y軸	C	$\phi$
$\frac{1}{2}(\sigma_1 + \sigma_3)$	$\frac{1}{2}(\sigma_1 - \sigma_3)$	$\frac{d}{\cos \phi}$	$\sin^{-1}[\tan(\psi)]$
$\sigma_3$	$\sigma_1 - \sigma_3$	$d \left( \frac{1 - \sin \phi}{2 \cos \phi} \right)$	$\sin^{-1} \left( \frac{\tan(\psi)}{2 + \tan(\psi)} \right)$
$\sigma_3$	$\sigma_1$	$d \left( \frac{1 - \sin \phi}{2 \cos \phi} \right)$	$\sin^{-1} \left( \frac{\tan(\psi) - 1}{\tan(\psi) + 1} \right)$

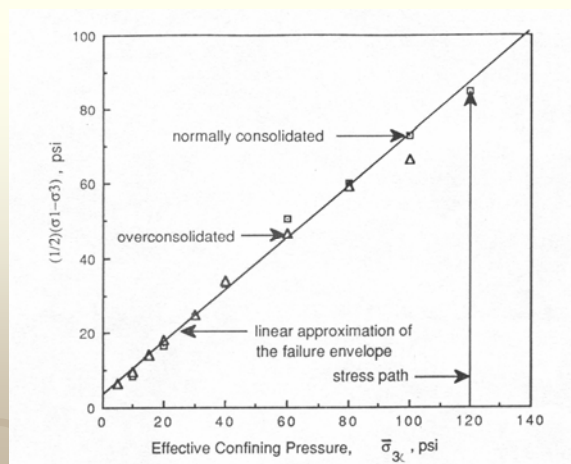
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## CD試驗修正破壞包絡線

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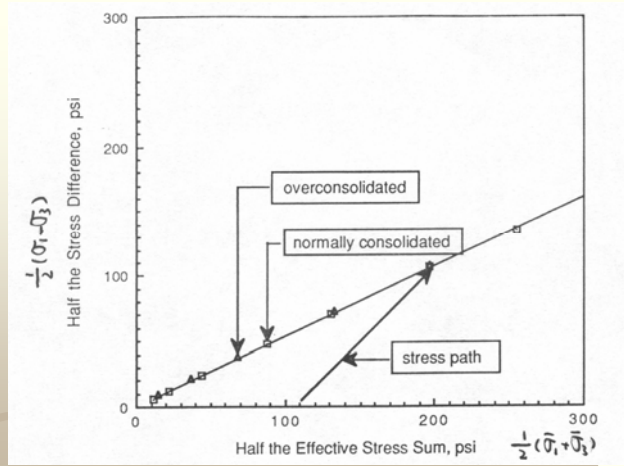
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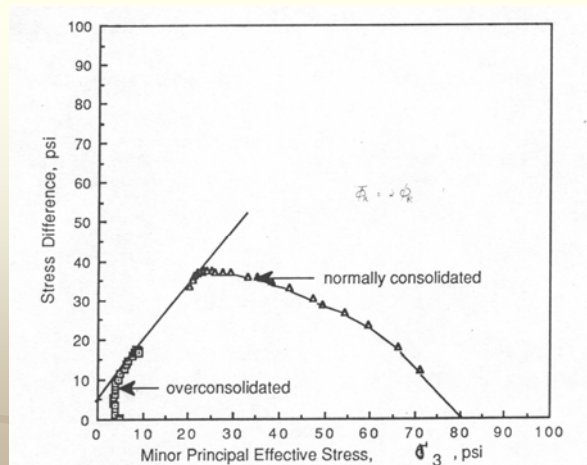
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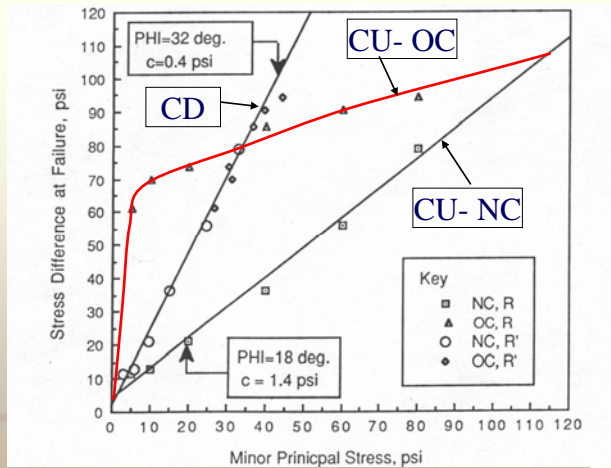
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## CU試驗修正破壞包絡線

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## 直剪試驗之優缺點

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- ◆ 優點
  - 構造簡單
  - 試驗所需時間較短
  - 可測殘餘剪力強度
- ◆ 缺點
  - 無法控制排水
  - 無法控制主軸應力
  - 強制破壞方向
  - 試體所受應力不均勻

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## 三軸試驗之優缺點

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### ◆ 優點

- 可控制排水
- 可控制主軸應力
- 試體容易準備
- 不強制破壞方向

### ◆ 缺點

- 儀器設備費用較高
- 排水試驗所需時間較長
- 無法進行大應變試驗
- 只能控制兩個主軸應力

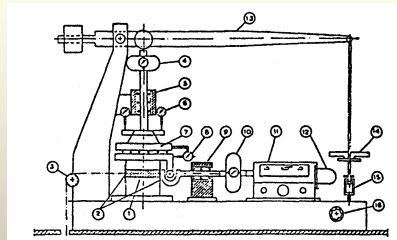
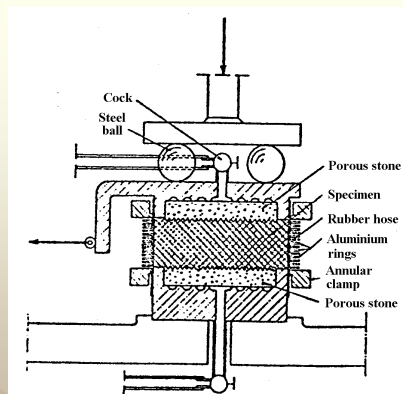
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## 簡單直剪試驗

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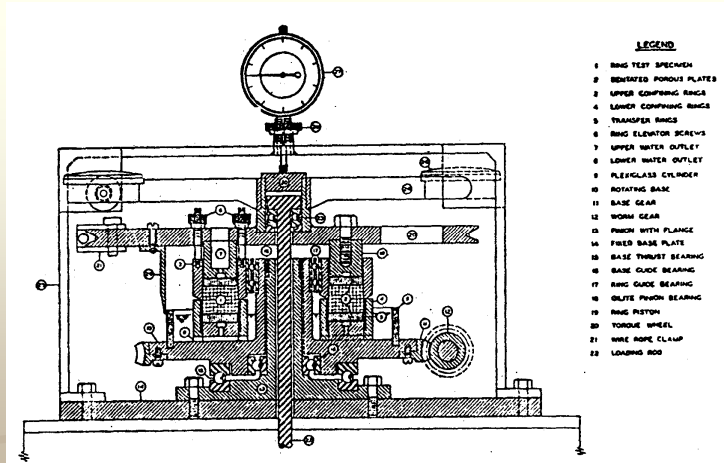
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# 扭剪試驗

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- LEGEND**
- 1 RING TEST SPECIMEN
  - 2 DEWATERED POROUS PLATES
  - 3 UPPER COMPRESSING RINGS
  - 4 LOWER COMPRESSING RINGS
  - 5 TRANSFER RINGS
  - 6 RING ELEVATOR SCREWS
  - 7 UPPER WATER OUTLET
  - 8 LOWER WATER OUTLET
  - 9 PLESGLASS CYLINDER
  - 10 ROTATING BASK
  - 11 BASE GEAR
  - 12 WORM GEAR
  - 13 PUNCH WITH FLANGE
  - 14 FIXED BASE PLATE
  - 15 BASE THRUST BEARING
  - 16 BASE GUIDE BEARING
  - 17 RING GUIDE BEARING
  - 18 GUIDE PUNCH BEARING
  - 19 RING PISTON
  - 20 TORQUE WHEEL
  - 21 WIRE ROPE CLAMP
  - 22 LOADING ROD

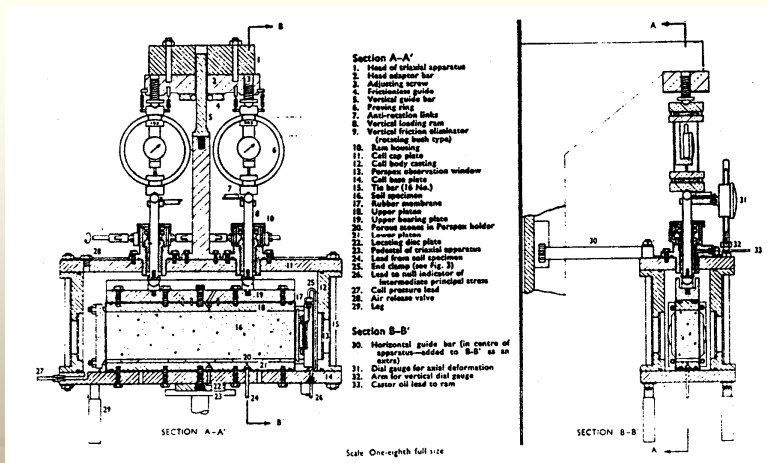
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# 平面應變試驗

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- Section A-A'**
- 1. Head of orbital apparatus
  - 2. Head support bar
  - 3. Adjusting screw
  - 4. Frictionless pulley
  - 5. Vertical guide bar
  - 6. Friction ring
  - 7. Anti-rotation links
  - 8. Vertical loading ram
  - 9. Vertical friction dialindicator (fracturing both type)
  - 10. Base housing
  - 11. Coll cap plate
  - 12. Coll inner casting
  - 13. Porous observation window
  - 14. Coll inner plate
  - 15. Yarn bar (16 Mils.)
  - 16. Coll specimen
  - 17. Rubber membrane
  - 18. Rubber piston
  - 19. Upper bearing plate
  - 20. Curved groove in Porcupine holder
  - 21. Lower piston
  - 22. Loading disc plate
  - 23. Piston of orbital apparatus
  - 24. Lead from soil specimen
  - 25. Soil clamp (see Fig. 7)
  - 26. Lead to soil indicator of instantaneous principal stress
  - 27. Coll pressure lead
  - 28. Air release valve
  - 29. Leg
- Section B-B'**
- 30. Horizontal guide bar (in centre of apparatus—added to B-B' as an note)
  - 31. Dial gauge for axial deformation
  - 32. Arm for vertical dial gauge
  - 33. Castor oil lead to ram

Scale One-eighth full size

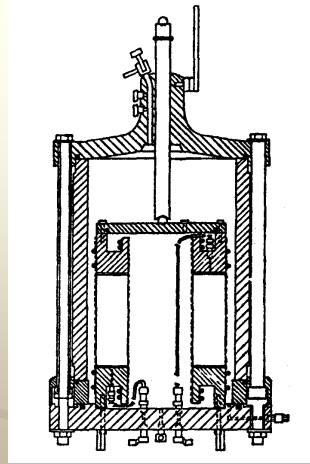
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# 中空圓柱三軸試驗

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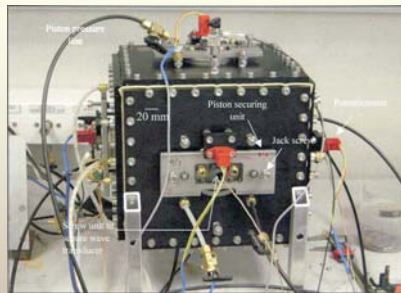
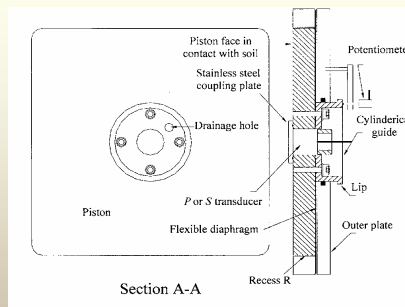
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# 真三軸試驗

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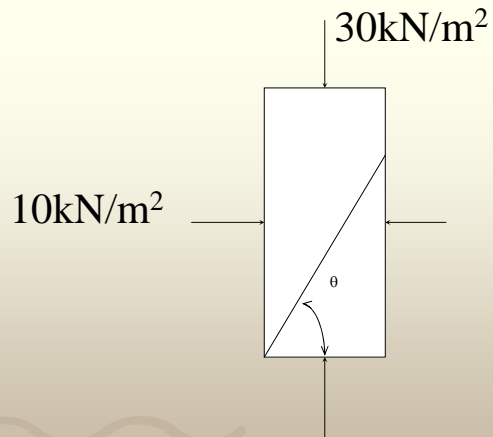
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# 第四次練習

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