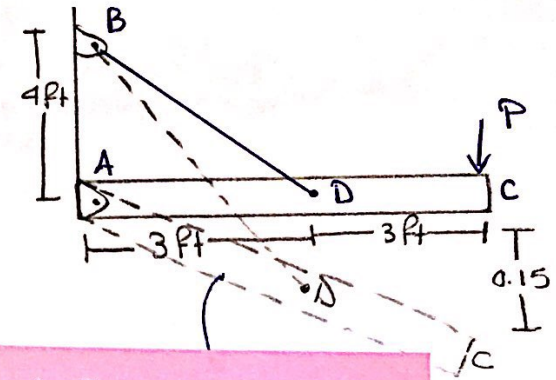
Examples of Chapter 3



$d_{BD} = 0.25$ in

C ↓ 0.15in

P = ??

BD is A-36

E = 200 GPa ← (نذهب إلى الجدول في آخر الكتاب)

We need to find F_{BD} :-

$E = \frac{\sigma}{\varepsilon}$ for BD

$\sigma = \varepsilon E$

↳ we need this

~~$\sigma = 199906.3$ Pa~~

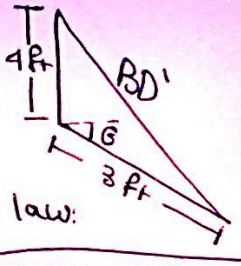
$= 29.01$ KSi

$\sigma = \frac{F_{BD}}{A_{BD}}$

To find ε:

$\tan\theta = \frac{0.15}{6 \times 12}$

$\theta = 0.11937$



using cosine law:

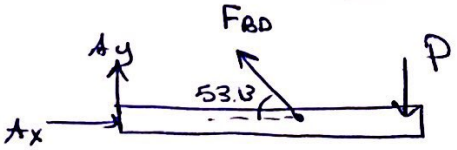
$BD' = \sqrt{(4^2) + (9) + -(2)(4)(3)\cos(90+\theta}$

$BD' = 5.00499$ ft $= 60.05988$ in

$\varepsilon = \frac{BD' - BD}{BD} = 1 \times 10^{-3}$

$F_{BD} = \sigma A_{BD} = (29.01)(0.25)^2 \frac{\pi}{4} = 1.4233$ Kip

To find P:



$\Sigma M_A = 0$

$(-P)(6) + (F_{BD})(\sin 53.13)(3) = 0$

$P = 570$ lb

Note:

Kip: Kilo pound

Ksi: Kilo pound per square inch

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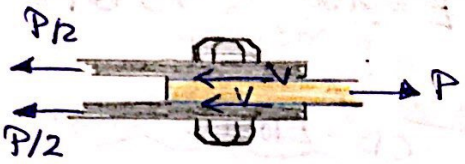
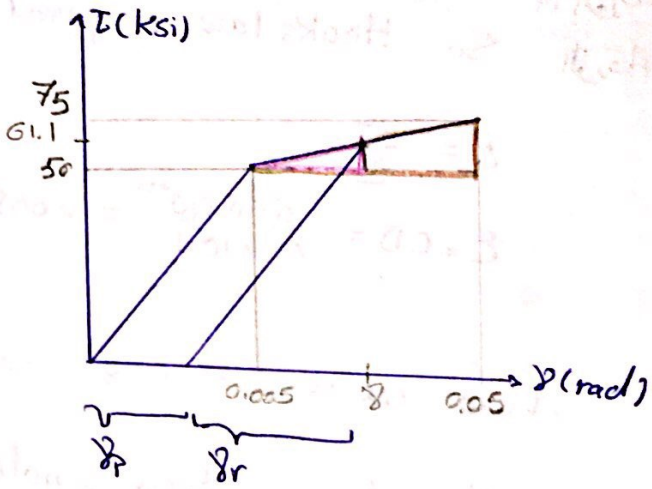
$P = 150$ kip
$d = 1.25$ in



$$V = \frac{150}{2} = 75 \text{ kip}$$

$$\tau = \frac{75}{(1.25)^2 \frac{\pi}{4}} = 61.1 \text{ ksi}$$



من تشابه المثلثات :

$$\frac{61.1-50}{\gamma-0.05} = \frac{75-50}{0.05-0.005}$$

$\gamma = 0.02501$ rad (Total Strain)

$$G = \frac{50}{0.005} = 10{,}000$$

$\tau = G\gamma_r$ ← recovery

$61.12 = 10{,}000\ \gamma$

$\gamma_r = 6.112 \times 10^{-3}$

$\gamma = \gamma_r + \gamma_p$

$0.02501 = 6.112 \times 10^{-3} + \gamma_p$

$\gamma_p = 0.0189$ rad

Example 3.2

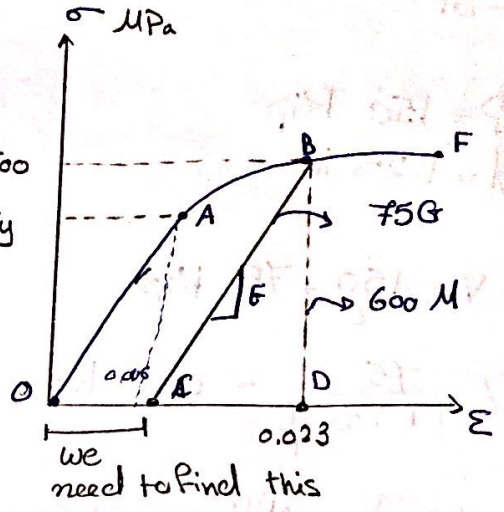
$$E = \frac{450}{0.006} = 75\ GPa$$

CD = Elastic strain

So Hooks law is applied

$$E = \frac{\sigma}{\varepsilon}$$

$$\varepsilon = CD = \frac{600 \times 10^{-6}}{75 \times 10^{9}} = 0.008\ mm/mm$$



Now $OC = 0.023 - 0.008 = 0.015\ mm/mm$

→ U_r before = Area under yield stress

$$U_r = \left(\frac{1}{2}\right)(450)(0.006) = 1.35\ MJ/m^3$$

→ U_r after = Area under the Triangle of the applied stress (الي قابل للعودة)

$$U_r = \left(\frac{1}{2}\right)(600)\ (0.008)$$

(600 ← after application)

$$= 2.4\ MJ/m^3$$

هنا نتطرق أقل من stress الـ yield للمادة فجير فيها strain من نوعين

قابل للعودة : Elastic ←

دائم : permenant ←

الـ Elastic نقدر نوجده من قانون هوك

و Permenant هو الـ strain بكل ناقص الـ Elastic

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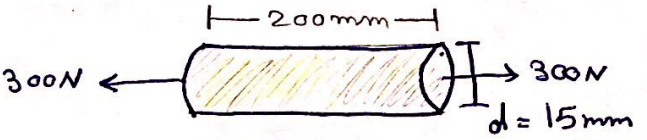
$E_p = 2.7\,GPa$

$\nu_p = 0.4$



ε_{long} :-

$\sigma = \frac{P}{A} \Rightarrow 1.678\,MPa = \sigma$

$\varepsilon_{long} = \frac{\sigma}{E} = 0.0006288$ → We used $\frac{\sigma}{E}$ because the stress is applied in the long direction

$\delta_L = 0.12576\,mm \quad (\varepsilon \times 200)$

$\varepsilon_{lat} = -\upsilon \varepsilon_{long} = -0.0002515$ → υ law

$\Delta d = \varepsilon_{lat}\, d = -0.00377\,mm$