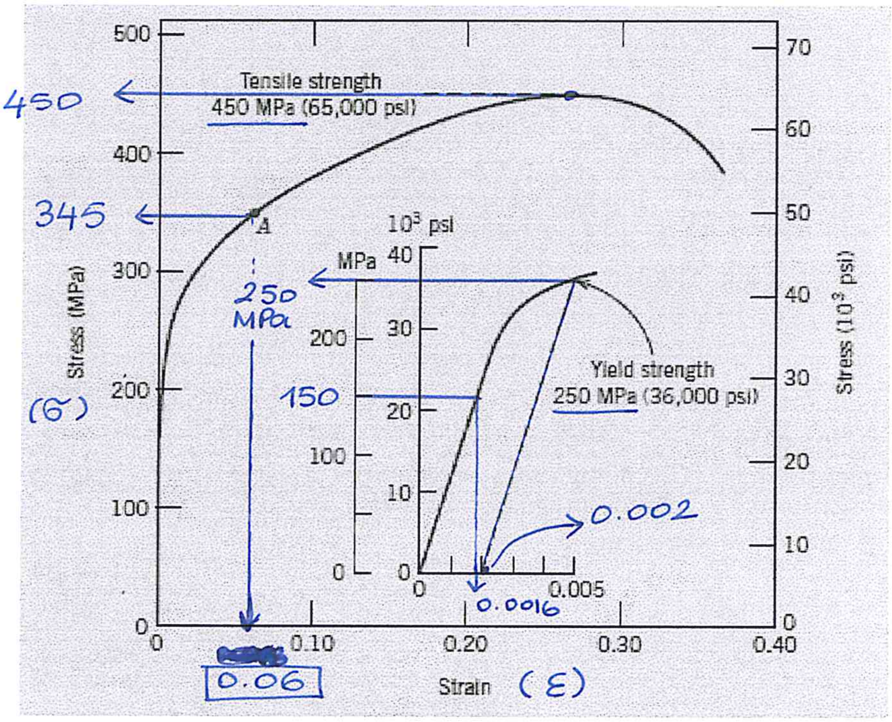
IN CLASS # 3

1. From the tensile stress-strain behavior for the brass specimen shown in the figure, determine the following:
   a) The modulus of elasticity
   b) The yield strength at a strain offset of 0.002
   c) The maximum load (at tensile strength) that can be sustained by a cylindrical specimen having an original diameter of 12.8 mm.
   d) The change in length of a specimen originally 250 mm long that is subjected to a tensile stress of 345 MPa **(point A).**



a) The modulus of elasticity is the slope of the elastic region or initial linear portion of the stress-strain curve.

$$E = \text{slope} = \frac{\Delta\sigma}{\Delta\varepsilon} = \frac{\sigma_2 - \sigma_1}{\varepsilon_2 - \varepsilon_1}$$

$$E = \frac{(150 - 0)\text{MPa}}{0.0016 - 0} \cong 93.8 \text{ GPa}$$

$$(1 \text{ GPa} = 10^3 \text{ MPa})$$

b) 0.002 strain offset line drawn in the figure corresponds to the yield strength value of 250 MPa.

c) The maximum load applied to the specimen means " the load at tensile strength".

$$\sigma = \frac{F}{A_o}$$

$A_o = \pi r^2$ (for cylindrical specimen)

A_o → cross-sectional area

$D_o = 12.8\ mm$

D_o → original diameter

r → radius

$$r = \frac{D_o}{2}$$

$$F = \sigma . A_o = \sigma . \left(\frac{D_o}{2}\right)^2 . \pi$$

F → load (N)

$$1\ Pa = 1\ \frac{N}{m^2} = 1\ \frac{kg}{m.s^2}$$

$$1\ MPa = 10^6\ Pa$$

From the figure, tensile strength = 450 MPa

$$F = \left(450 . 10^6 \frac{N}{m^2}\right)\left(\frac{12.8 . 10^{-3} m}{2}\right)^2 . \pi$$

$$F \cong 57900\ N$$

d) From the figure, 345 MPa stress corresponds to the strain value of 0.06 (point A).

$l_o = 250\ mm$

$\Delta l = ?$

$$\varepsilon = \frac{\Delta l}{l_o}$$

$$\Delta l = \varepsilon . l_o = (0.06)(250mm)$$

$$\Delta l = 15\ mm$$

2. A cylindrical specimen of steel having an original diameter of 12.8 mm is tensile-tested to fracture and found to have an engineering fracture strength σ_f of 460 MPa. If its cross-sectional diameter at fracture is 10.7 mm, determine:

a) The ductility in terms of percent reduction in area
b) The true stress at fracture.

cross-sectional area at fracture point

a) % Reduction in Area (% RA) $= \left(\dfrac{A_o - A_f}{A_o}\right) \times 100$

$$A_o = \pi r_o^2 = \left(\frac{D_o}{2}\right)^2 \cdot \pi$$

$$A_f = \pi r_f^2 = \left(\frac{D_f}{2}\right)^2 \cdot \pi$$

$$\% RA = \frac{\left[\pi\left(\frac{12.8\,mm}{2}\right)^2 - \pi\left(\frac{10.7\,mm}{2}\right)^2\right] \times 100}{\left(\frac{12.8\,mm}{2}\right)^2 \cdot \pi} = \frac{128.7 - 89.9}{128.7} \times 100$$

$$\% RA \cong 30\ \%$$

b) True stress at fracture: $\sigma_T = \dfrac{F}{A_f}$

First, the load at fracture should be calculated;

$$\sigma_F = \frac{F}{A_o} \Rightarrow \quad F = \sigma_F \cdot A_o$$

$$F = \left(460 \cdot 10^6 \frac{N}{m^2}\right) \cdot \left(128.7\,mm^2\right)\left(\frac{1\,m^2}{10^6\,mm^2}\right)$$

$$F \cong 59200\,N$$

$$\sigma_T = \frac{59200\,N}{(89.9\,mm^2)\left(\frac{1\,m^2}{10^6\,mm^2}\right)} \cong 6.6 \times 10^8 \frac{N}{m^2}$$

$$= 660\ MPa$$