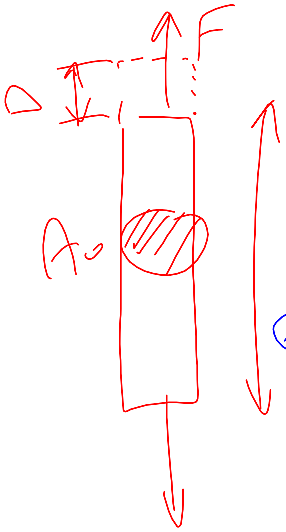
Ductile

Brittle

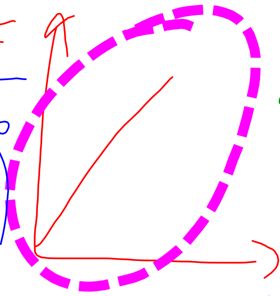


Δ: extension

$F \propto \Delta$

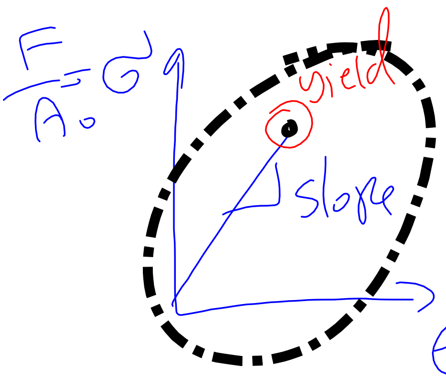
$\sigma = \frac{F}{A_0}$

$\frac{N}{m^2}$ (Pa)



Elastic Zone

$\frac{\Delta}{L_0} = \varepsilon$



$\sigma \propto \epsilon$

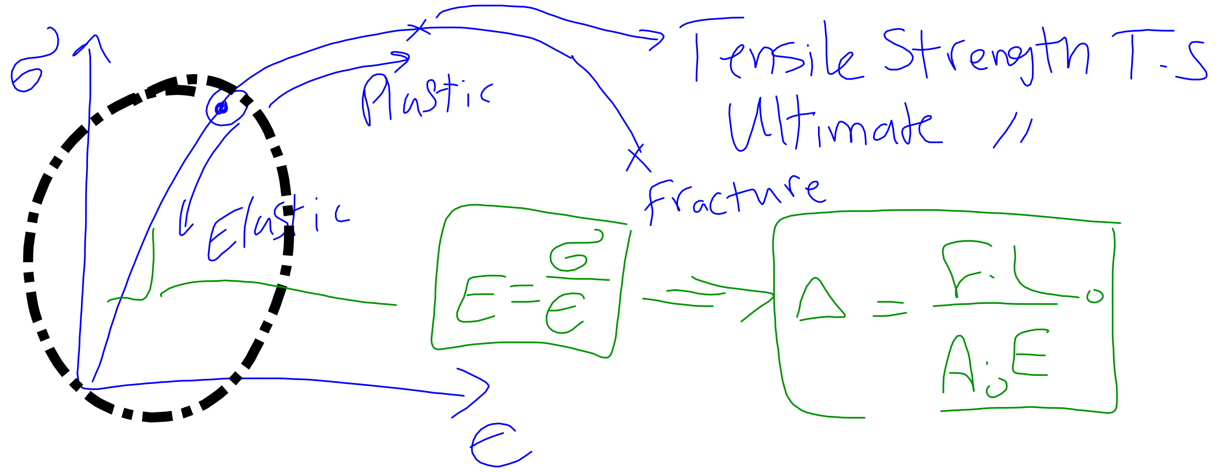
$$\boxed{E = \frac{\overset{F/A_0}{\sigma}}{\epsilon}}$$

E: Modulus of Elasticity
or Elastic Modulus

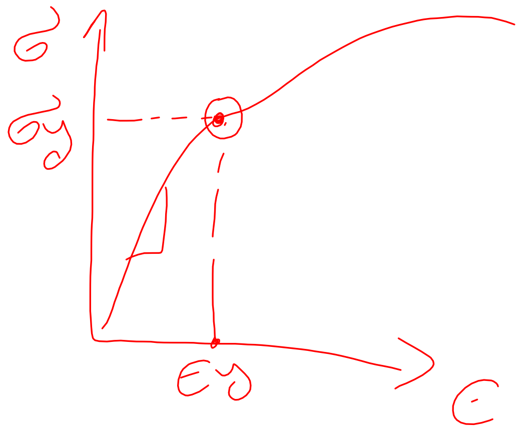
$\epsilon = \frac{\Delta}{L_0}$ $\frac{\Delta}{L_0}$

Hook's law

$$\boxed{\Delta = \frac{F \cdot L}{A_0 \cdot E}}$$



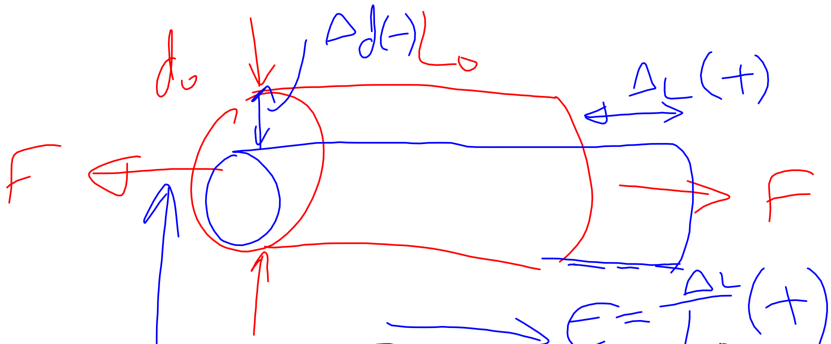
$$\boxed{E = \frac{\sigma}{\epsilon}} \Longrightarrow \boxed{\Delta = \frac{F \cdot L_o}{A_o E}}$$



$\sigma > \sigma_y \longrightarrow$ plastic

$\epsilon > \epsilon_y \longrightarrow$ plastic

Feb 16-8:30 AM



$$\boxed{\Delta_L = \frac{F \cdot L_0}{A_0 \cdot E}}$$

$$\epsilon = \frac{\Delta L}{L_0}(+)$$

$$\boxed{\epsilon_d = \frac{\Delta d}{d_0}}(-)$$

$$\cancel{\Delta d = \frac{F \cdot d_0}{A_0 \cdot E}}$$

Poisson's Ratio : Elastic constant

$$\boxed{\nu = -\frac{\epsilon_d}{\epsilon_L}}$$

$$\frac{\Delta d}{d_0}$$

$$\frac{\Delta L}{L_0} \rightarrow \frac{F \cdot L_0}{A_0 \cdot E}$$

$\nu < 1$

0.3

Elastic Constants

E, ν, G: Shear Modulus
or Modulus of Rigidity
Torsion Test

$$E = 2G(1+\nu)$$

$$G = \frac{E}{2(1+\nu)}$$

Q1 $E = 207\,GPa = 207 \times 10^9\ N/m^2$

$d_0 = 10.2\,mm$

Elastic Behaviour $\Rightarrow E = \dfrac{\sigma}{e} \Rightarrow \Delta_L = \dfrac{F \cdot L_0}{A_0 E}$

$F = 8900\,N$

$\nu = -\dfrac{e_d}{e_L}$

$L_0 = ?$

$\Delta_L = 0.25\,mm$

Feb 16-8:45 AM

$$\Delta L = \frac{F \cdot L_o}{A_o \cdot E}$$

$$L_o = ?$$

$$0.25\,mm = \frac{8900\,N \times L_o}{\frac{\pi}{4}(10.2)^2\,mm^2 \times 207 \times 10^3\,\frac{N}{mm^2}}$$

$$L_o = \boxed{475}\,mm = 0.475\,m$$

Feb 16-8:54 AM

Q2

$\sigma_y = 345\,MPa$

$E = 103\,GPa$

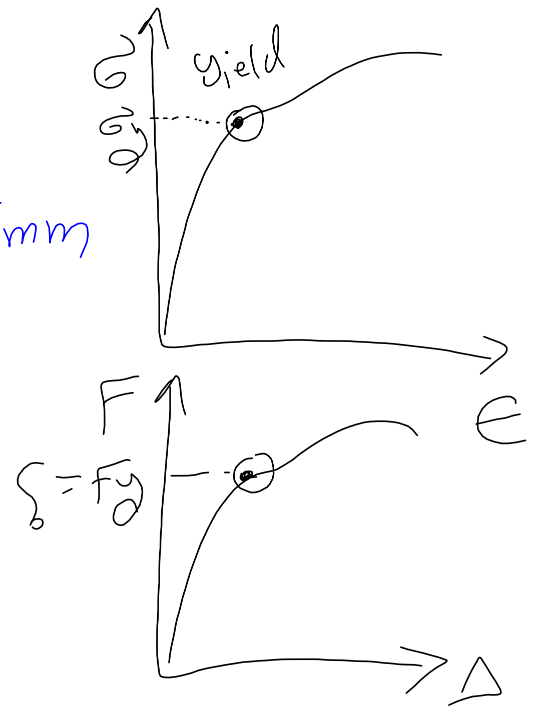
$A_0 = 130\,mm^2$, $L_0 = 76\,mm$

$F_{max}\,? \Rightarrow F_y = ?$

a) Sol

$$\sigma_y = \frac{F_y}{A_0}$$

$$F_y = \sigma_y \cdot A_0$$

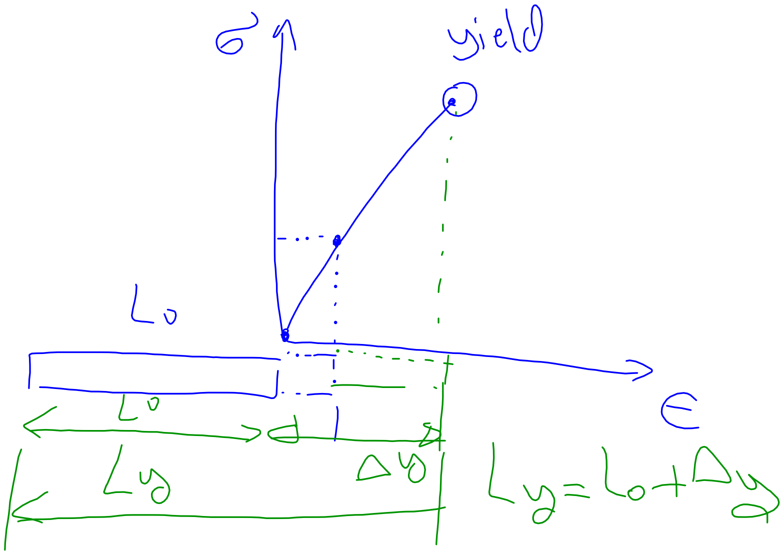


Feb 16-8:58 AM

b) $\Delta_y = \dfrac{F_y \cdot L_0}{A_0 \cdot E}$

Δ_y

$L_y = L_0 + \Delta_y$



Q3 $L_o = 250mm$

$d_o = 15.2 mm$

Elastic $\Rightarrow E = \frac{\sigma}{\epsilon}$, $\Delta_L = \frac{F \cdot L_o}{A_o \cdot E}$

$F = 48,900N$ $\nu = -\frac{\epsilon_d}{\epsilon_L}$

Table: Mech. Prop $\Rightarrow E, \nu, \sigma_y$

a) $\Delta_L = ?$ $\Delta_L = \frac{F \cdot L_o}{A_o \cdot E}$ $\rightarrow$ table $\Rightarrow \Delta_L$

$A_o = \frac{\pi}{4} d_o^2$

Feb 16-9:07 AM

b) $\Delta d = ?$ $\quad \nu = -\frac{\epsilon_d}{\epsilon_L}$

$\epsilon_d \rightarrow \frac{\Delta d}{d_0} = ?$ ✓

$\epsilon_L \rightarrow \frac{\Delta L}{L_0} \Rightarrow$ a ✓

$\nu \rightarrow$ Table

Δd ✓

c) $E = 2G(1+\nu)$

$G = \frac{E}{2(1+\nu)} \Rightarrow G$ ✓

Feb 16-9:12 AM

Q4

$\sigma_y = 249\,MPa$

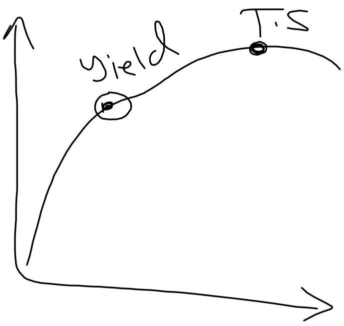
$T.S = 310\,MPa$

$E = 110\,GPa$

$d_0 = 15.2\,mm$

$L_0 = 380\,MPa$

$\Delta L = 1.9\,mm$

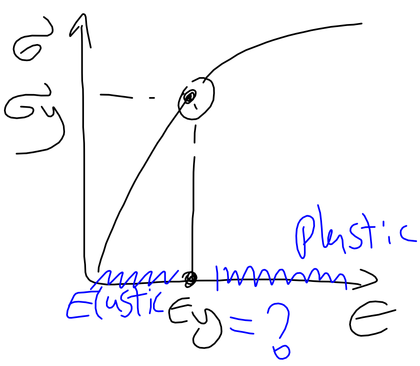


Feb 16-9:19 AM

$\sigma > \sigma_y \rightarrow$ Plastic

$\downarrow$

$\frac{F}{A_0} = ??$



$\epsilon > \epsilon_y \rightarrow$ Plastic

$\epsilon < \epsilon_y \rightarrow$ Elastic $\rightarrow \Delta_L = \frac{\overset{?}{F} \cdot L_0}{A_0 \cdot E}$

Sol.

$$E = \frac{\sigma_y}{\epsilon_y} \Rightarrow \epsilon_y = \frac{\sigma_y}{E}$$

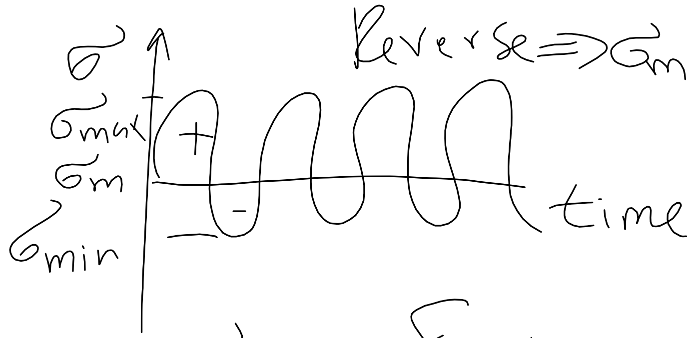
Theek check $\epsilon = \frac{\Delta L}{L_o}$

compare ϵ & ϵ_y

Feb 16-9:25 AM

Fatigue

Reverse $\Rightarrow \sigma_m = 0$



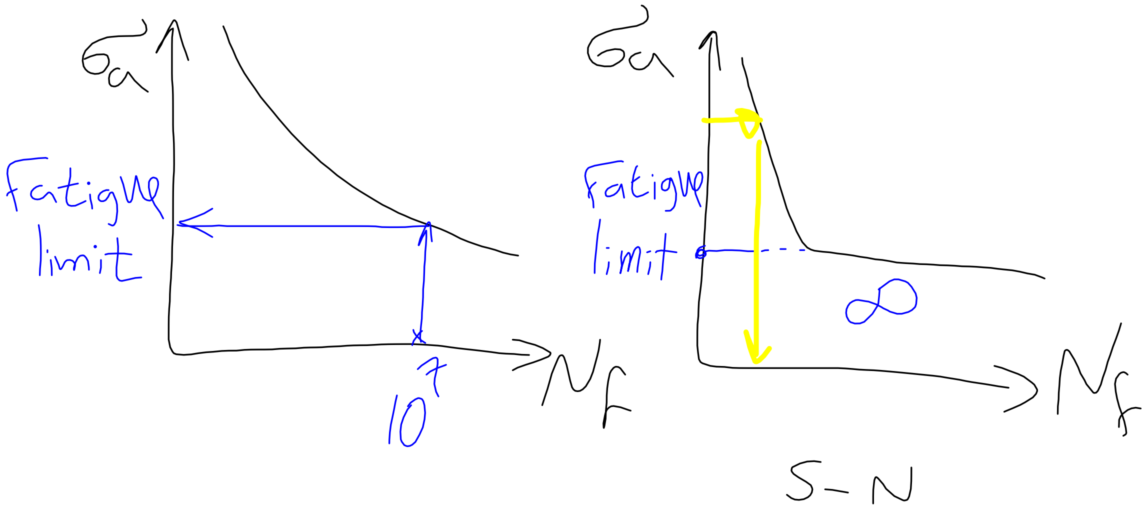
$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$$

$$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2}$$

amplitude

$$\sigma_{max} = \frac{F_{max}}{A}$$

$$\sigma_{min} = \frac{F_{min}}{A}$$



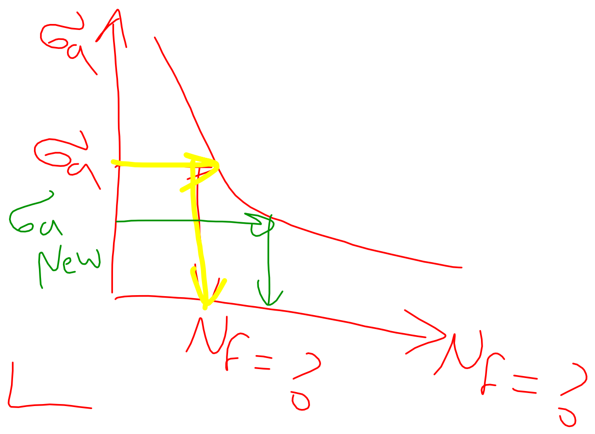
Feb 16-9:42 AM

Q1

a) $\sigma_{max} = \frac{F_{max}}{A}$

$\sigma_{min} = \frac{F_{min}}{A}$

$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2} = \_\_\_$



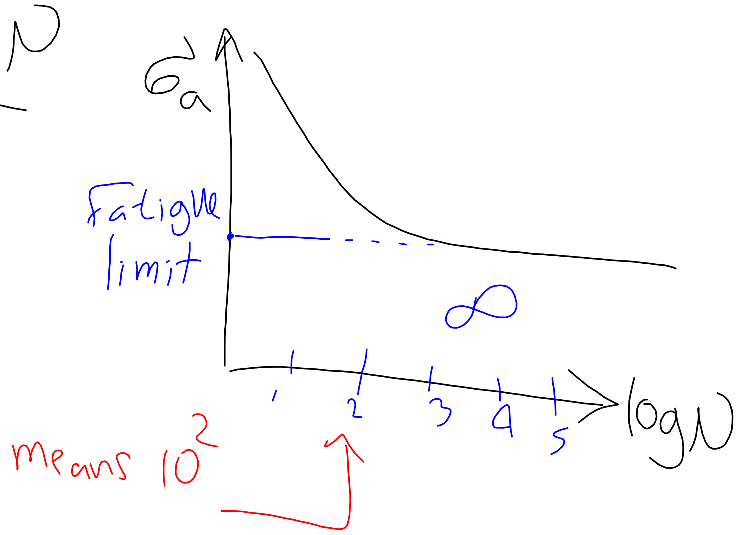
b) $\sigma_{a\,New} = \frac{\sigma_a}{S.F} = \frac{\sigma_a}{1.5}$

$\Downarrow$

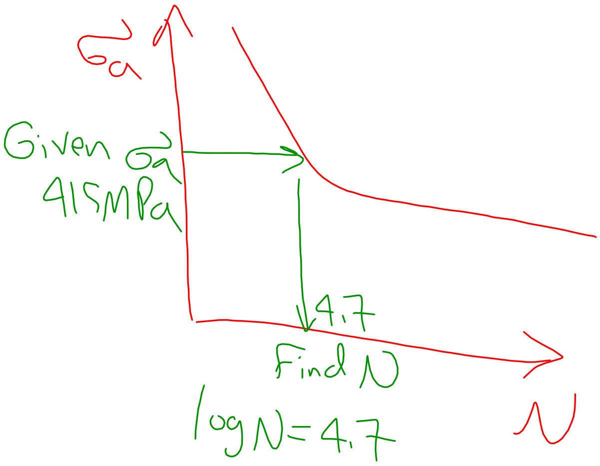
allowable

Q2

σ_a	$\log N$



c)



$\log N = 4.7$

$N = 50,000$

d)