$\sigma \propto \epsilon$

$$\Rightarrow \boxed{E = \frac{\sigma}{\epsilon}}$$

$$E = \frac{\sigma}{\epsilon} \rightarrow \frac{\frac{F}{A}}{\frac{\Delta}{L}} \Rightarrow \boxed{\Delta = \frac{F \cdot L}{A \cdot E}}$$

1)

$E = 207\,GPa$

$d = 10.2\,mm$

$F = 8900\,N$

$l_0 = ?$

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

$\Delta = \frac{F \cdot L}{A \cdot E}$

$$0.25 = \frac{8900 \times L_0}{\frac{\pi}{4}(10.2)^2 \times 207 \times 10^3}$$

$L_0 = 475\,mm$

$$0.25 \times 10^{-3} = \frac{8900N \times L_0}{\frac{\pi}{4}(10.2 \times 10^{-3})^2 \times 207 \times 10^9}$$

$\Rightarrow L_0 = 0.475\,m$

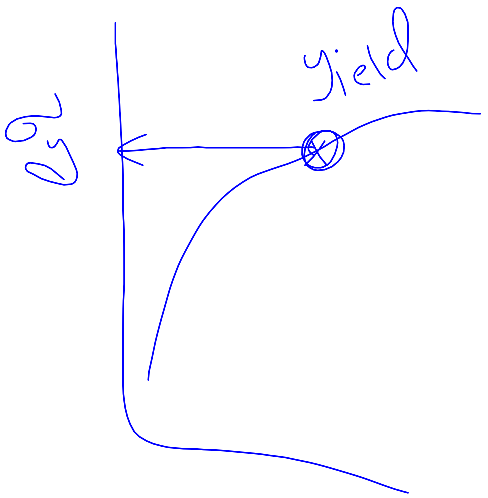
2)

$\sigma_y = 345 \, MPa$

$E = 103 \, GPa$

$A = 130 \, mm^2$

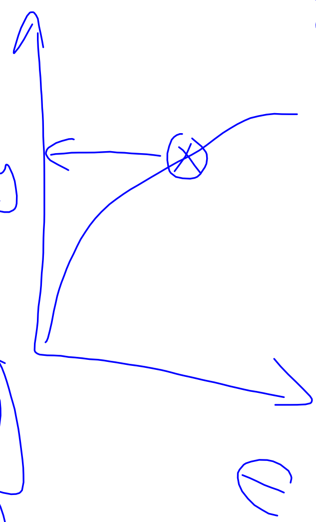
$L_o = 76 \, mm$

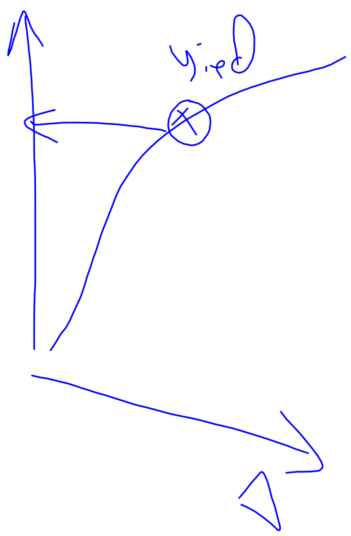


a)

Find F_{max} at yield

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





$$\boxed{F_y = \sigma_y \cdot A}$$

345×10^6 130×10^{-6}

$$L_y = \Delta_y + L_o \quad ?$$

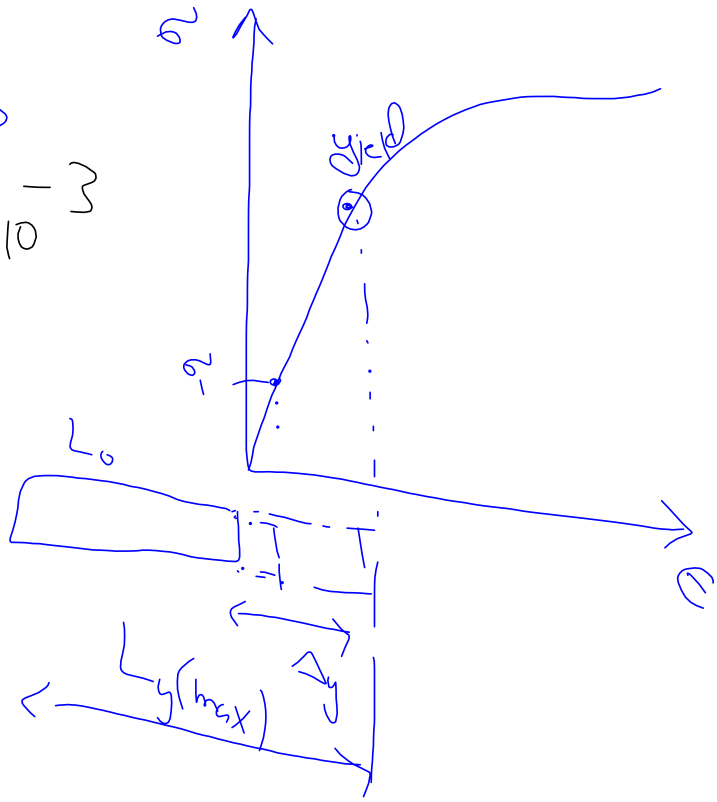
$a \leftarrow$

$$\Delta_y = \frac{f_y \cdot L_o}{A \cdot E} \qquad L_o \sim 76\times10^{-3}$$

A: 130×10^{-6} E: 103×10^{9}

$\Delta_y \leftarrow$

$$L_y = L_o + \Delta_y$$



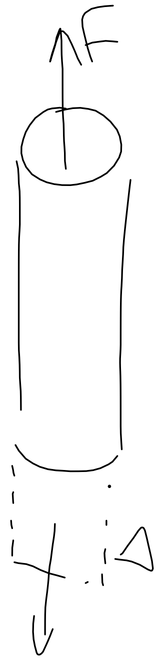
3)

$d = 15.2\,mm$

$l_0 = 250\,mm$

$F = 48{,}900\,N$

$\Delta = ?$



$E = \dfrac{\sigma}{\epsilon}$

$\Delta = \dfrac{F \cdot L_0}{A \cdot E}$

48,900N

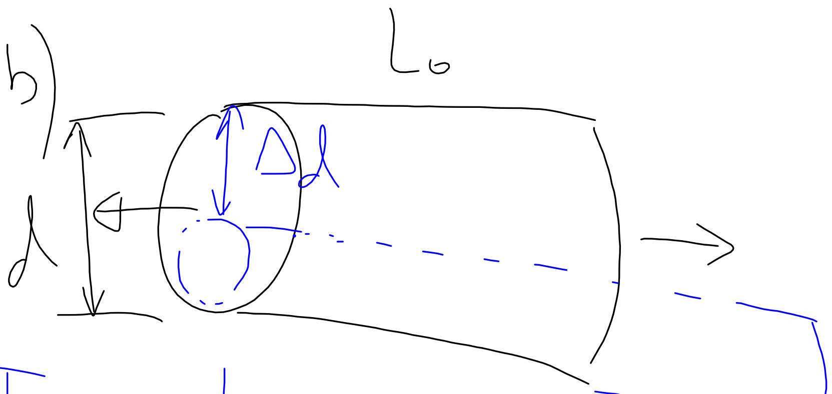
$$\Delta = \frac{F \cdot L_0}{A \cdot E} = 0.25\,m$$

a)

$\frac{\pi}{4}(15.2 \times 10^{-3})^2$

Table 6.1

b)



axial
Long.

Transverse
Lateral

$\epsilon_d = \frac{\Delta d}{d}$

$\epsilon_L = \frac{\Delta L}{L_0}$

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

Elastic constant

$$r = -\frac{\epsilon_d}{\epsilon_L}$$

$$\epsilon_d \rightarrow \frac{\Delta d}{d}$$

$$\epsilon_L \rightarrow \frac{\Delta L}{L_0}$$

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

$$\cancel{E = \frac{\sigma}{\epsilon_d}}$$

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

Elastic constants

E, ν, G

G → Shear Modulus or Modulus of Rigidity

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

b) $\Delta d = ?$

dia will decrease, because the load is Tension

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

$\nu = 0.3$

$\epsilon_d \rightarrow \frac{\Delta d = ?}{d = 15.2}$

$\epsilon_L \rightarrow \frac{\Delta L \Rightarrow 9}{L_0 = 250}$

$\Rightarrow \Delta d = (-)$

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

$207\,GPa = 2G(1+0.3)$

$G = \sim\ GPa$

4)

$\sigma_y = 249\ MPa$

$T.S = 310\ MPa$

$E = 110\ GPa$

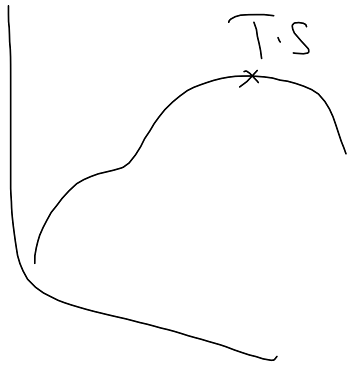
$d = 15.2\ mm$

$L_0 = 380\ mm$

Tensile load

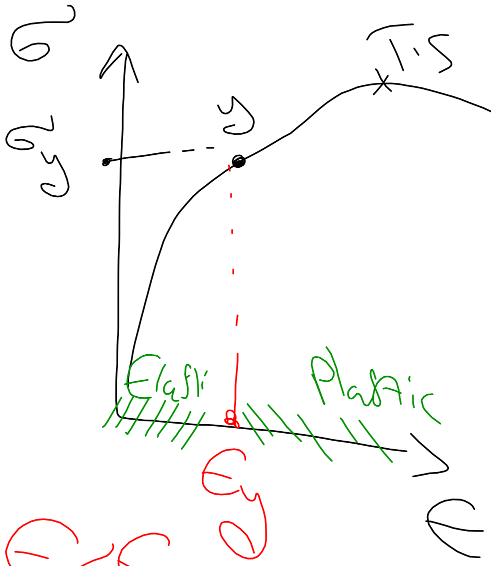
$\Delta = 1.9\ mm$

load?



$\sigma < \sigma_y \Rightarrow$ Elastic

$\sigma > \sigma_y \rightarrow$ Plastic



$\epsilon < \epsilon_y \rightarrow$ Elastic

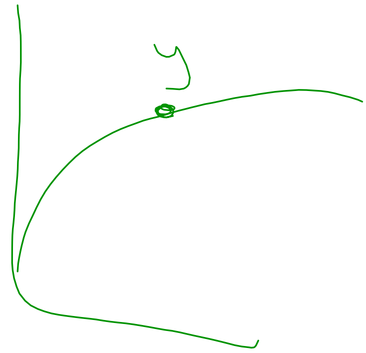
$\epsilon > \epsilon_y \rightarrow$ Plastic

$\epsilon_y = ?$

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

$\sigma_y = 249 \times 10^6$

$E = 110 \times 10^9$



$\epsilon = \frac{\Delta}{L_o} = \frac{1.9}{300}$

Since $\epsilon > \epsilon_y \rightarrow$ plastic $\rightarrow$ CANNOT FIND F

Fatigue

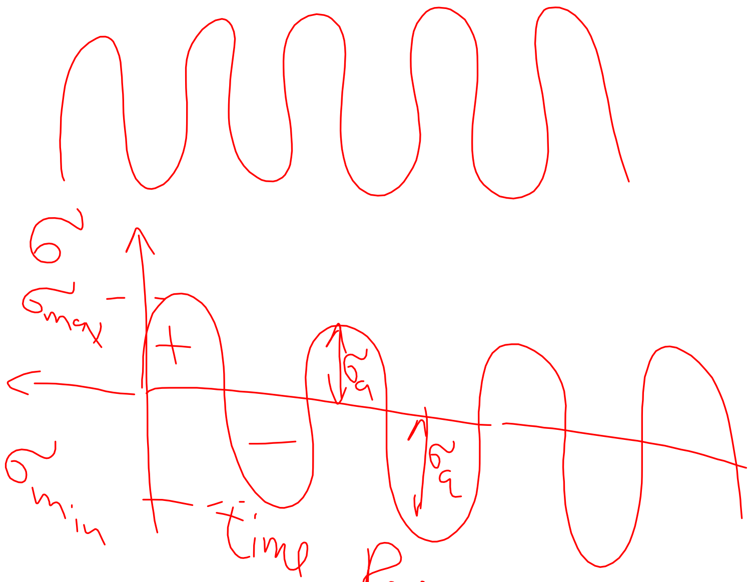
$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$$

mean

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

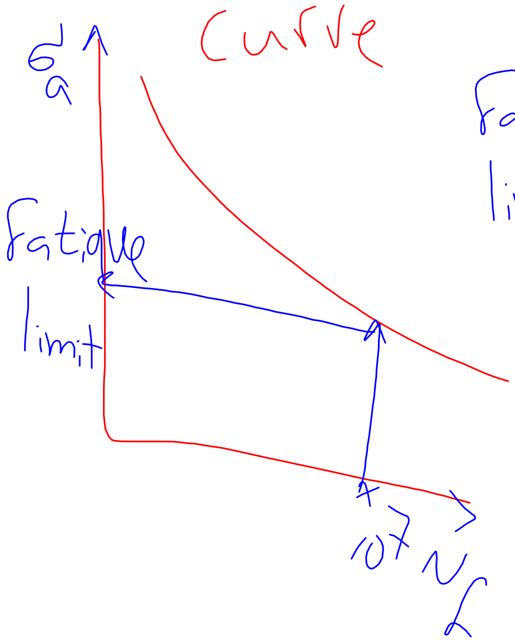
amplitude

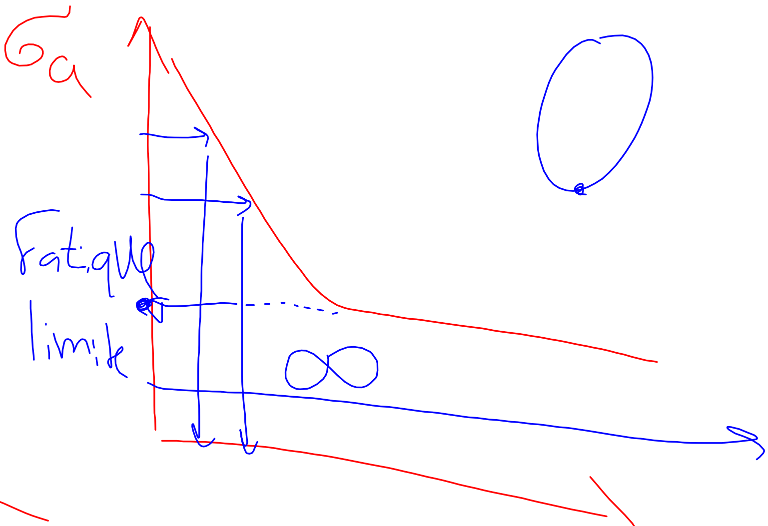
$\sigma_{mean} = 0$



Reversed load

S-N Curve





σ = N_f - No. of cycles to failure

1)

$d = 6.4mm$

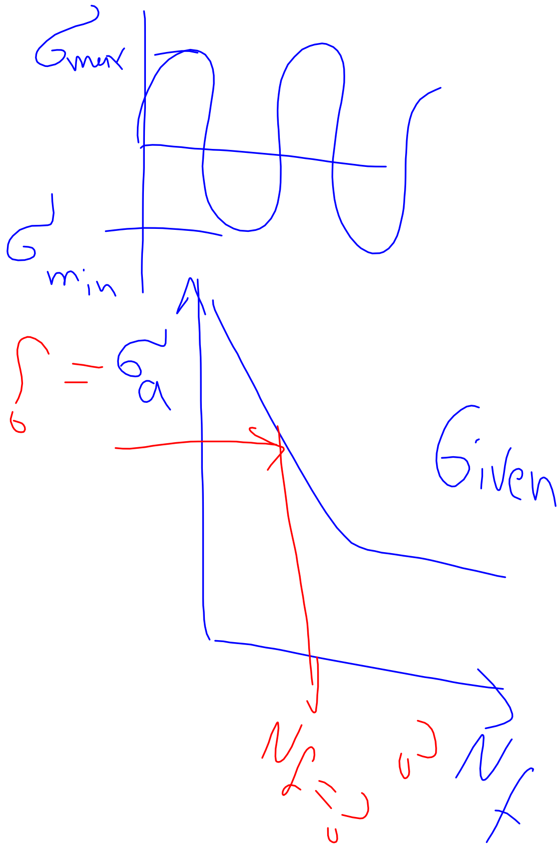
Reverse

$F_{max} = +5340\ N$

$\therefore F_{min} = -5340N$

$N_f = ?$

$S = \sigma_a$



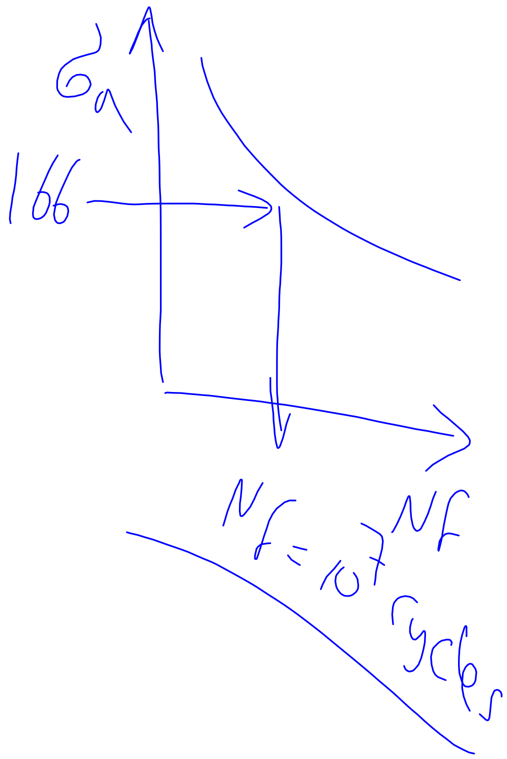
$$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2} = 166 MPa$$

$$\sigma_{max} = \frac{F_{max}}{A}, \quad \sigma_{min} = \frac{F_{min}}{A} = -5430$$

$$A = \frac{\pi}{4} d^2$$

or

$$\boxed{\sigma_a = \frac{F_a}{A}}, \quad F_a = \frac{F_{max} - F_{min}}{2}$$



σ_a
166
N_f
$N_f = 10^7$ cycles

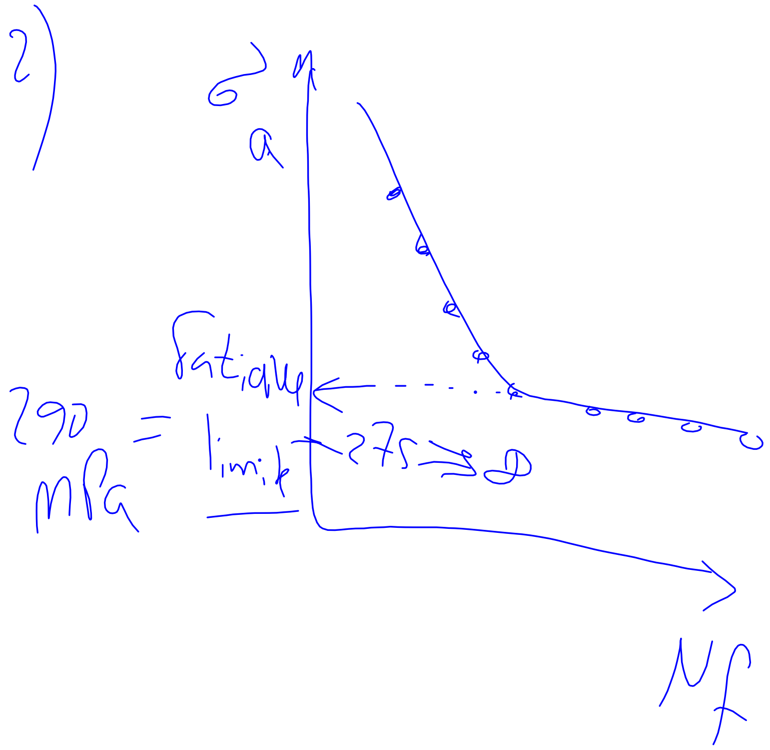
b) $S.f = 1.5$

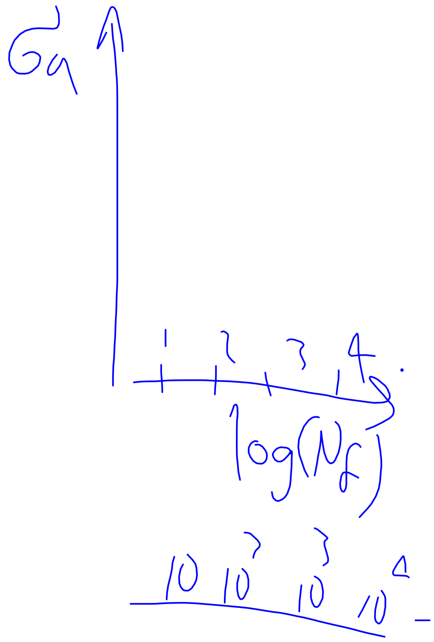
$$\sigma_a = \frac{\sigma_a}{S.f} = \frac{166}{1.5} = \underline{111 \text{ MPa}}$$

New design allowable

$\rightarrow \underline{N_f = 10^9 \text{ cycles}}$

2)





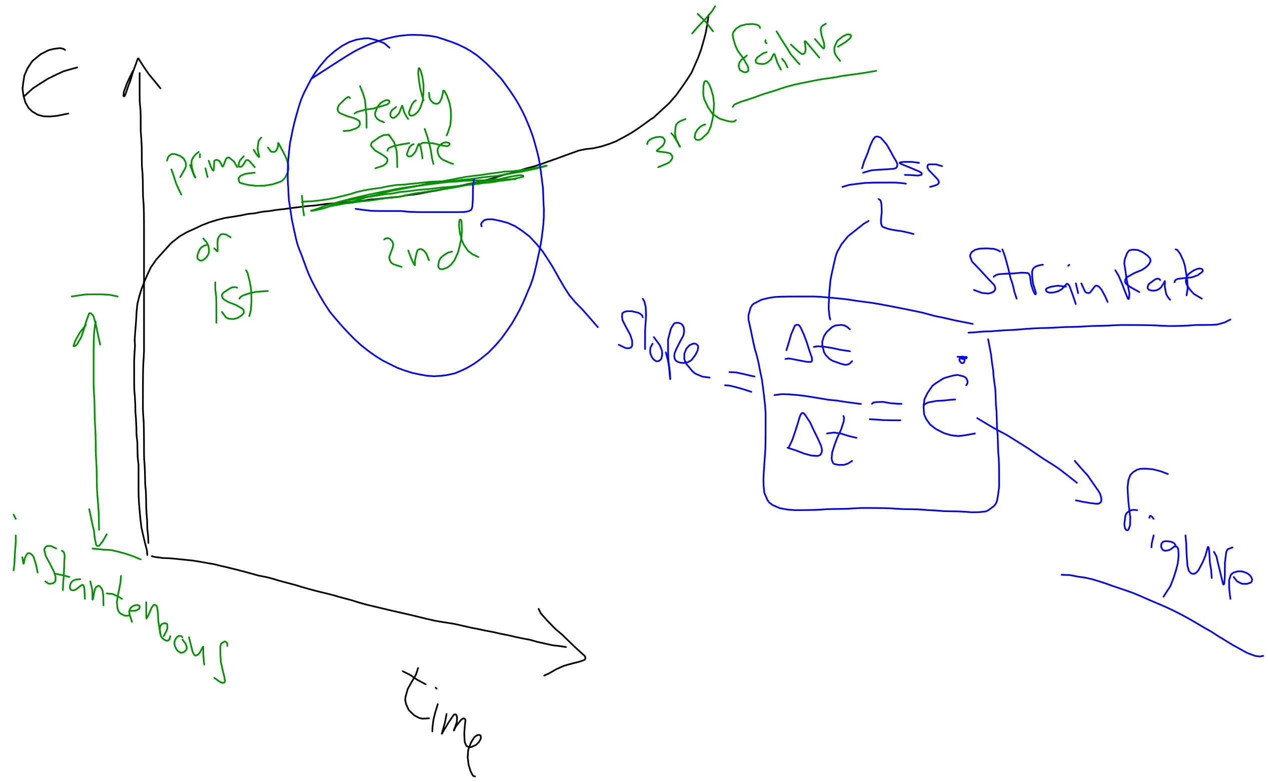
Creep ?

Time dependent

load is constant

Temp > 40% T_m

melting



ε
Primary
or
1st
steady
state
2nd
3rd
failure
instantaneous
time
slope
ΔE/Δt = Ė
Δss
Strain Rate
figure

1) $L = 1015 mm$

$\sigma = 70 MPa$

$T = 427 C^{o}$

$\Delta_{total} = ?$ $time = 10,000 hr$

$\Delta_{inst} + \Delta_{1st} = 1.3$

Primary

$$\Delta_{total} = \Delta_{ss} + \underbrace{(\Delta_{inst} + \Delta_{1st})}_{1.3}$$

??

?

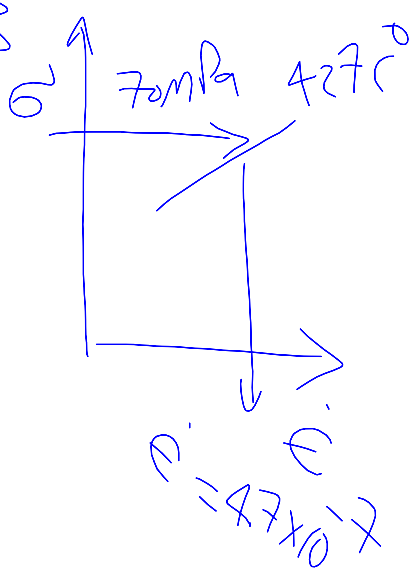
$$\dot{\epsilon} = \frac{\epsilon}{time}$$

$\epsilon \rightarrow \Delta_{ss}$

$\Delta_{ss} = 1.015$

$time = 10,000$

$\dot{\epsilon} \rightarrow$ figure



Strain $\epsilon = \frac{\Delta}{L_o}$

2)

$\dot{\epsilon} = ?$

$$\boxed{\begin{array}{l} \text{Temp} = 1300\text{K} \\ \sigma = 83\text{Pa} \end{array}}$$

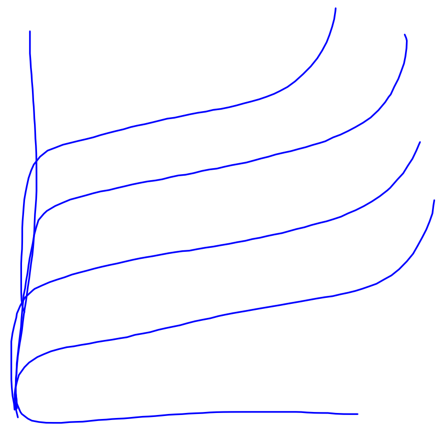
8.5

$= n$

$\dot{\epsilon}_s = K_? \sigma^? \exp\left(-\frac{Q_c = ?}{RT}\right)$

8.31

$T \to 1300$



$$6.6 \times 10^{-4} = K_2 (140) \exp\left(-\frac{Q_c}{8.31 \times 1090}\right) \quad — (1)$$

$$8.8 \times 10^{-2} = K_2 (140) \exp\left(-\frac{Q_c}{8.31 \times 1200}\right) \quad — (2)$$

Solve to get Q_c & K_2 $\rightarrow$ sub. in