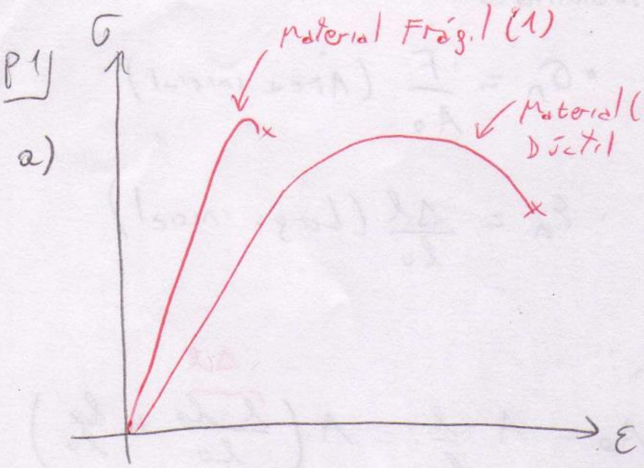
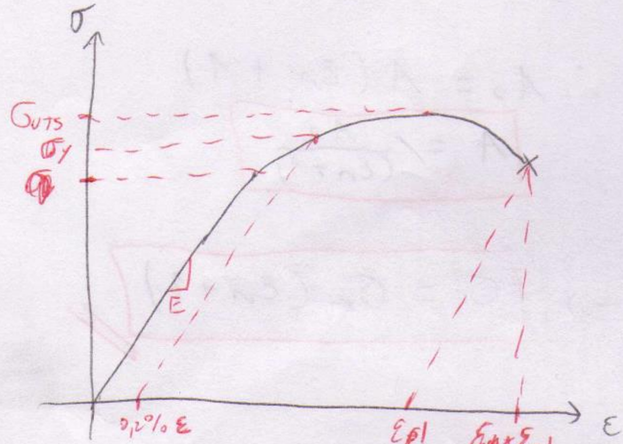
Pauta Aux. N°2 ME3601 — 2018-1

P1)

a)



- Material Frágil: $\uparrow E$, $\downarrow$ Plasticidad
- Material dúctil: $\downarrow E$ (o $\approx$), $\uparrow$ Plasticidad

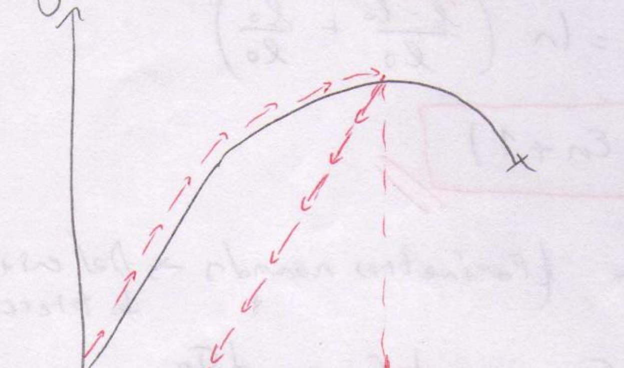


σ_{UTS}: Resistencia Máxima a la Tracción

σ_y: Límite de fluencia

E: Módulo de Elasticidad

$\int_0^{\varepsilon_f} \sigma \, d\varepsilon$: Tenacidad (Área bajo la curva, energía por unidad de volumen)



ε_{pl}: Deformación plástica

$$\varepsilon_T = \varepsilon_{pl} + \varepsilon_{el}$$

b) Definiciones

i) Reales (~~Área en cada pto.~~)

- $\sigma = \frac{F}{A}$ (Área en cada pto.)

- $\varepsilon = \int_{l_0}^{l} \frac{dl}{l} = \ln\left(\frac{l}{l_0}\right)$

ii) Nominales:

- $\sigma_n = \frac{F}{A_0}$ (Área inicial)

- $\varepsilon_n = \frac{\Delta l}{l_0}$ (Largo inicial)

* Asumimos conservación de volumen:

$$\underbrace{A_0 \cdot l_0}_{\text{Área y largo inicial}} = \underbrace{A \cdot l}_{\text{Área y largo en cualquier instante}} \rightsquigarrow A_0 = A \cdot \frac{l}{l_0} = A\left(\frac{\overbrace{l - l_0}^{\Delta l}}{l_0} + \frac{l_0}{l_0}\right)$$

$$\therefore A_0 = A \cdot (\varepsilon_n + 1)$$

$$\boxed{A = \frac{A_0}{(\varepsilon_n + 1)}}$$

* Reemplazando en σ real:

$$\sigma = \frac{F}{A} = \underbrace{\frac{F}{A_0}}_{\sigma_n} \cdot (\varepsilon_n + 1) \Rightarrow \boxed{\sigma = \sigma_n (\varepsilon_n + 1)}$$

* Para la deformación:

$$\varepsilon = \int_{l_0}^{l} \frac{dl}{l} = \ln\left(\frac{l}{l_0}\right) = \ln\left(\frac{\overbrace{l - l_0}^{\Delta l}}{l_0} + \frac{l_0}{l_0}\right)$$

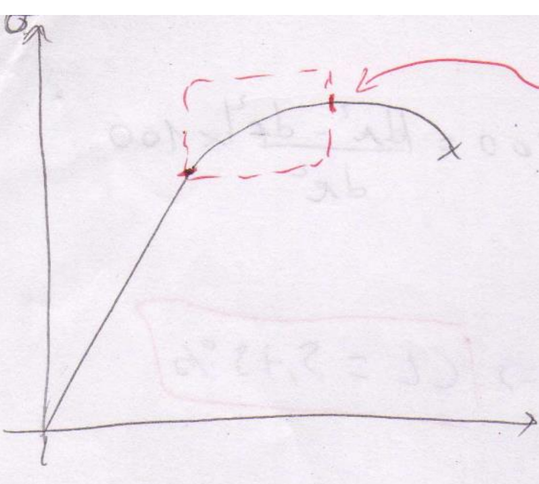
$$\boxed{\therefore \varepsilon = \ln(\varepsilon_n + 1)}$$

iii) Resiliencia $U_{el} = \int \sigma_n \, d\varepsilon_n$ (Parámetros nominales → Del ensayo de tracción)

- Pero $E = \frac{\sigma_n}{\varepsilon_n} \Rightarrow \varepsilon_n = \frac{\sigma_n}{E} \rightsquigarrow d\varepsilon_n = \frac{d\sigma_n}{E}$

$$\Rightarrow U_{el} = \int \sigma_n \, d\varepsilon_n = \int \frac{\sigma_n}{E} \, d\sigma_n \rightsquigarrow \boxed{\therefore U_{el} = \frac{\sigma_n^2}{2E}}$$

P2)



$\sigma = K\cdot\varepsilon^n$ → n: Coef. de endurecimiento.

→ σ, ε → Parámetros reales

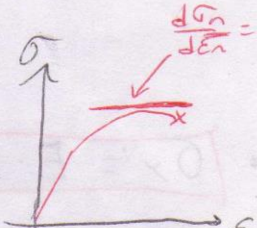
• Para encontrar un resultado útil, primero convertimos la ec. a parámetros nominales

• $\sigma = \sigma_n(\varepsilon_n+1) \wedge \varepsilon = \ln(\varepsilon_n+1)$

$$\Rightarrow \sigma_n(\varepsilon_n+1) = K\cdot(\ln(\varepsilon_n+1))^n$$

$$\boxed{\therefore \sigma_n = K\,\frac{(\ln(\varepsilon_n+1))^n}{(\varepsilon_n+1)}}$$

• Al comienzo de la formación de cuello, $\frac{d\sigma_n}{d\varepsilon_n} = 0$



$$\Rightarrow \frac{d\sigma_n}{d\varepsilon_n} = K\left[\frac{n(\ln(\varepsilon_n+1))^{n-1}\cdot\frac{1}{\cancel{\varepsilon_n+1}}\cdot\cancel{(\varepsilon_n+1)} - 1\cdot(\ln(\varepsilon_n+1))^n}{(\varepsilon_n+1)^2}\right] = 0$$

$$\Rightarrow n\,\frac{[\ln\cancel{(\varepsilon_n+1)}]^n}{\ln(\varepsilon_n+1)} = [\ln\cancel{(\varepsilon_n+1)}]^n$$

$$\Rightarrow n = \underbrace{\ln(\varepsilon_n+1)}_{\varepsilon} \Rightarrow \boxed{\therefore n = \varepsilon}$$

• Luego, en $\sigma_{UTS} \sim \varepsilon_{UTS} = n = 0{,}2$

$$\therefore \sigma_{UTS} = 100\cdot 0{,}2^{0{,}2} \Rightarrow \boxed{\sigma_{UTS} = 72{,}48\ [MPa]}$$

P3]

• Reducción de Área: $RA = \left|\frac{A_i - A_f}{A_f}\right| \times 100 = \left|\frac{d_i^2 - d_f^2}{d_i^2}\right| \times 100$

$$\boxed{\therefore RA = 51\%}$$

• Ductilidad: $CL = \frac{l_f - l_i}{l_i} \times 100 \Rightarrow \boxed{CL = 5{,}75\%}$

• Deformación elástica máxima: $\cancel{\varepsilon_{el} = \frac{92{,}4 - 80}{80} =}$

$$\varepsilon_{el} = \varepsilon_T - \varepsilon_{pl} = \frac{92{,}4 - 80}{80} - 0{,}0575$$

$$\boxed{\therefore \varepsilon_{el} = 0{,}0975}$$

• $\boxed{\sigma_y = E \cdot \varepsilon_{el} = 200 \cdot 0{,}0975 = 19{,}5 \text{ [GPa]}}$

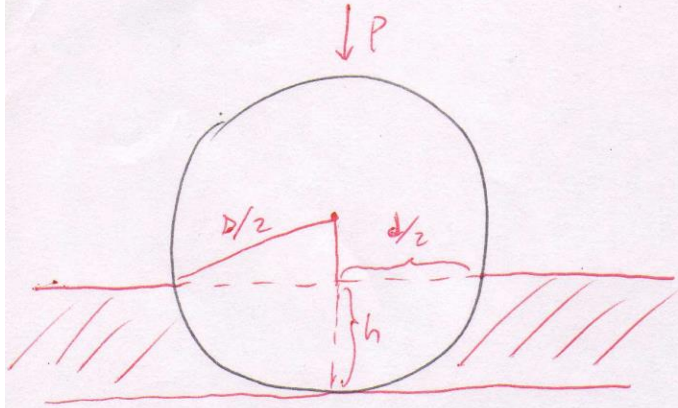
P4] a) $\sigma = \frac{F}{A} \wedge \varepsilon = \frac{\Delta l}{l_0} \Rightarrow \frac{F}{A} = E \cdot \frac{\Delta l}{l_0}$

$$\boxed{\therefore E = \frac{F \cdot l_0}{A(l_f - l_0)}}$$

$$\Rightarrow E = \frac{15 \cdot 10^3 \text{ [N]} \cdot 100 \cdot 10^{-3} \text{ [m]}}{150 \cdot 10^{-6} \text{ [m}^2\text{]} \cdot 0{,}08 \cdot 10^{-3} \text{ [m]}} = 1{,}25 \cdot 10^{11} \text{ [Pa]}$$

$$\boxed{E = 125 \text{ [GPa]}}$$

b) $$HB = \frac{2P}{\pi D\left(D - \sqrt{D^2 - d^2}\right)} \qquad \begin{pmatrix} KP: \text{Kilopondio} \\ 1[KP] = 9{,}8[N] \end{pmatrix}$$



· Calculemos d, por pitágoras

$$\left(\frac{D}{2}\right)^2 = \left(\frac{D}{2} - h\right)^2 + \left(\frac{d}{2}\right)^2$$

$$\boxed{\therefore d = 2\sqrt{\left(\frac{D}{2}\right)^2 - \left(\frac{D}{2} - h\right)^2}}$$

· En este caso, $D = 2{,}5\ mm$ y $h = 0{,}24\ [mm]$

$$\boxed{\therefore d = 1{,}49\ [mm]}$$

· Calculando HB:

$$\boxed{HB = 97{,}487\ [HB]}$$

P5

a) Calculemos el cambio de energía del péndulo:

$$\Delta E = m \cdot g \cdot \Delta h = 20\ [kgf] \cdot (90 - 70)\ [cm] \cdot 10^{-2}$$

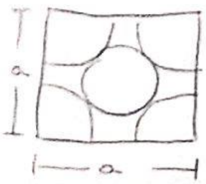
$$\boxed{\therefore \Delta E = 40 [J]}$$

b) La resiliencia del material es energía absorbida por unidad de ~~volumen~~ superficie de rotura:

$$U = \frac{\Delta E}{Sr} = \frac{4}{0{,}008 \cdot 0{,}01} \Rightarrow \boxed{U = 500 \frac{kJ}{m^2}}$$

P6|

· Estructura FCC

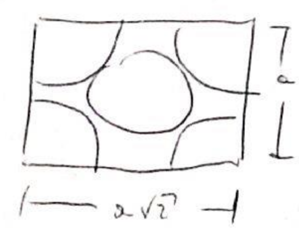


$$\rightsquigarrow a^2 + a^2 = 4^2 R_{Fe}^2$$

$$2a^2 = 16 R_{Fe}^2$$

$$a = 2\sqrt{2} R_{Fe} \Rightarrow \boxed{V_{c.u}^{(Fcc)} = 16\sqrt{2} R_{Fe}^3}$$

· Estructura BCC



$$a^2 + (a\sqrt{2})^2 = 4^2 R_{Fe}^2$$

$$3a^2 = 16 R_{Fe}^2$$

$$a = \frac{4}{\sqrt{3}} R_{Fe} \Rightarrow \boxed{V_{c.u.}^{(BCC)} = \frac{64}{3\sqrt{3}} R_{Fe}^3}$$

$$\Rightarrow \frac{V_{Fcc}}{V_{Bcc}} = \frac{\cancel{16}\sqrt{2}\,\cancel{R_{Fe}^3}}{\frac{64}{3\sqrt{3}}\cancel{R_{Fe}^3}} = \frac{3\sqrt{6}}{4} \rightsquigarrow$$ Disminuye el volumen en un 54,4%