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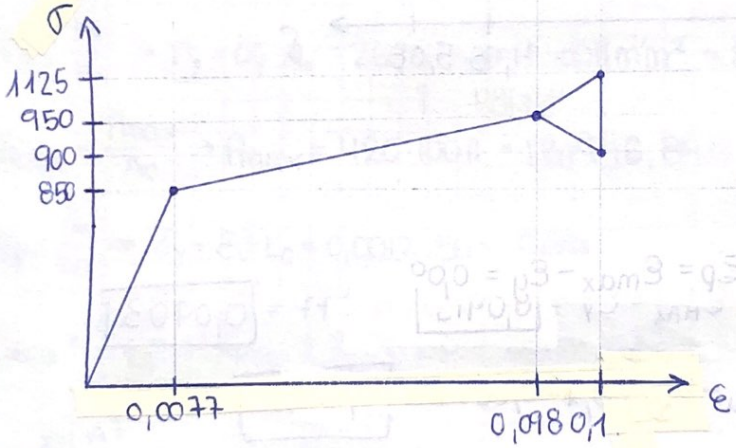
(1) $d = 20mm$; $L_0 = 50,8mm$; $\sigma_y = 850MPa$; $\sigma_{max} = 950MPa$; $\varepsilon_{max} = 0,098$;
$A = 10\%$; $A_1 = 0,8A_0$; $\sigma_u = 900MPa$; $E = 110GPa$; $G = 40GPa$; $\nu = 0,33$

a) $\varepsilon_y = \frac{\sigma_y}{E} = \frac{850MPa}{110 \cdot 10^3 MPa} = 0,0077$

$\sigma_u' = \frac{\sigma_{u_1} \cdot A_0}{A_1} = \frac{900MPa \cdot A_0}{0,8 \cdot A_0} = 1125MPa$



$A_0 = \pi r^2 = \pi \cdot 10^2 = 314,16mm^2$

$\sigma_y = \frac{P_y}{A_0} \rightarrow P_y = \sigma_y \cdot A_0 = 850MPa \cdot 314,16mm^2 = 267,04\,KN$

$\sigma_{MAX} = \frac{P_{MAX}}{A_0} \rightarrow P_{MAX} = \sigma_{MAX} \cdot A_0 = 950MPa \cdot 314,16mm^2 = 298,45\,KN$

$\sigma_u = \frac{P_u}{A_0} \rightarrow P_u = \sigma_u \cdot A_0 = 900MPa \cdot 314,16mm^2 = 282,74\,KN$

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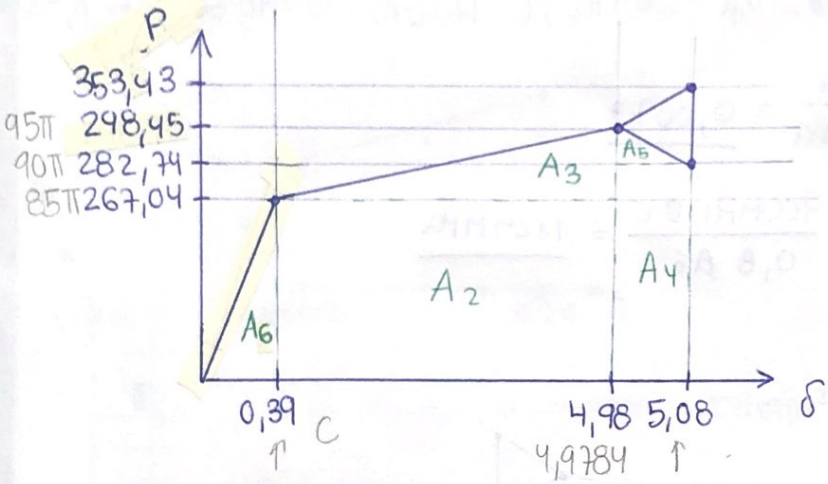
$Pa = \frac{N}{m^2} \rightarrow N = Pa \cdot m^2$

$$\sigma_{u'} = \frac{P_{u'}}{A} \rightarrow P_{u'} = \sigma_{u'} \cdot A = 1125 MPa \cdot 314,16 mm^2 = \underline{353,43 \ KN}$$

$$\varepsilon_Y = \frac{\delta_Y}{L_0} \rightarrow \delta_Y = \varepsilon_Y \cdot L_0 = 0,0077 \cdot 50,8 = \underline{0,3925 \ mm}$$

$$\varepsilon_{MAX} = \frac{\delta_{MAX}}{L_0} \Rightarrow \delta_{MAX} = \varepsilon_{MAX} \cdot L_0 = 0,098 \cdot 50,8 = \underline{4,9784 \ mm}$$

$$\varepsilon_u = \frac{\delta_u}{L_0} \rightarrow \delta_u = \varepsilon_u \cdot L_0 = 0,1 \cdot 50,8 = \underline{5,08 \ mm}$$



b) $\sigma_Y \rightarrow \boxed{\varepsilon_p = 0}$

$\sigma_{MAX} \rightarrow \varepsilon_p = \varepsilon_{MAX} - \varepsilon_Y = 0,098 - 0,0077 = \boxed{0,0903}$

$\sigma_u \rightarrow \varepsilon_p = \varepsilon_u - \varepsilon_Y = 0,1 - 0,0077 = \boxed{0,0923}$

c) Eremu plastiko handia → harikorra

d) $R = A_6 = \frac{267,04 \cdot 10^3 N \cdot 0,3925 \cdot 10^{-3} m}{2} = \boxed{52,41 J}$

$T = R + A_2 + A_3 + A_4 + A_5 =$

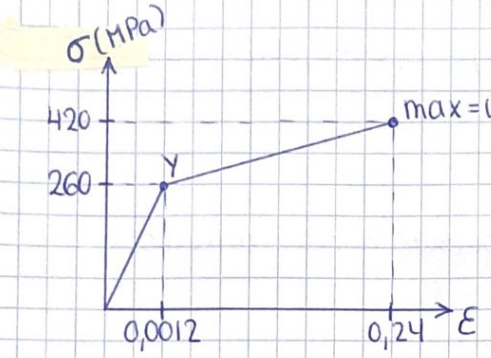
$= 52,41 + 267,04 \cdot (4,98 - 0,39) + \frac{(4,98 - 0,39)(298,45 - 267,04)}{2} + (5,08 - 4,98) \cdot 282,74 +$

$+ \frac{(5,08 - 4,98)(298,45 - 282,74)}{2} = \boxed{1378,56 J}$

$\sigma_y = 260MPa$; $\sigma_{max} = 420MPa$; $A = 24\%$; zilindro → $D = 20mm$; $L_0 = 50mm$; $E = 210GPa$.

a) $\varepsilon_y = \frac{\sigma_y}{E} = \frac{260\cancel{MPa}}{210 \cdot 10^3 \cancel{MPa}} = 0,0012$

$\varepsilon_{max} = \varepsilon_u = 0,24$



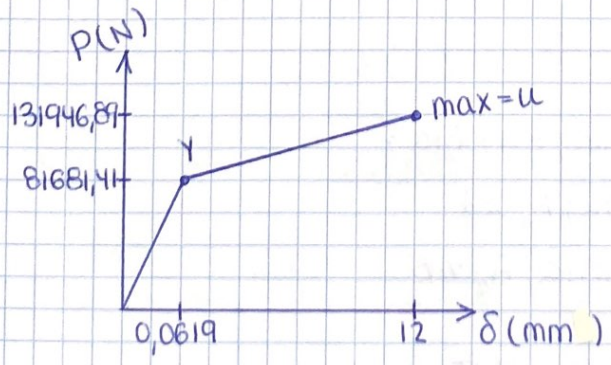
$A_0 = \frac{\pi D^2}{4} = 100\pi\, mm^2$

$\sigma_y = \frac{P_y}{A_0} \rightarrow P_y = \sigma_y \cdot A_0 = 260M(N/\cancel{m^2}) \cdot 100\pi \cancel{m^2} = 81681,41N$

$\sigma_{max} = \frac{P_{max}}{A_0} \rightarrow P_{max} = 420 \cdot 100\pi = 131946,89N = P_u$

$\varepsilon_y = \frac{\delta_y}{L_0} \rightarrow \delta_y = \varepsilon_y \cdot L_0 = 0,0012 \cdot 50 = 0,0619mm$

$\varepsilon_{max} = \frac{\delta_{max}}{L_0} \rightarrow \delta_{max} = 0,24 \cdot 50 = 12mm = \delta_u$



b) $\varepsilon = 0,0005$; $\varepsilon = 0,1$

$\varepsilon_y = 0,0012$

$\varepsilon = 0,0005 \rightarrow \varepsilon < \varepsilon_y \rightarrow \boxed{\varepsilon_p = 0}$ (eremu elastikoan dago, beraz, ez du deformazio plastikorik)

$\varepsilon = 0,1 \rightarrow \varepsilon_p = \varepsilon - \varepsilon_y = 0,1 - 0,0012 = \boxed{0,0988}$

$\varepsilon_u = \varepsilon_{max} = 0,24 \rightarrow \varepsilon_p = \varepsilon_u - \varepsilon_y = 0,24 - 0,0012 = \boxed{0,2388}$

c) $L_u = L_0 + \delta_u = 50 + 12 = \boxed{62mm}$

Material hauskorra da, eremu plastiko handia duelako.

d) $A_1 = 0,8 A_0$

$\sigma_{u1} = \frac{P_u}{A_1} = \frac{420MPa \cdot 100\pi mm^2}{0,8 \cdot 100\pi mm^2} = \boxed{525MPa}$

f) $R = \frac{81,6814KN \cdot 0,0619mm}{2} = \boxed{2,53J}$

$T = 2,53 + (12 - 0,0619) \cdot 81,6814 + \frac{(12 - 0,0619)(131,9469 - 81,6814)}{2} =$

$= \boxed{1277,69J}$

d = 20mm; zilindro; $L_0 = 50,8mm$; $E = 170GPa$:

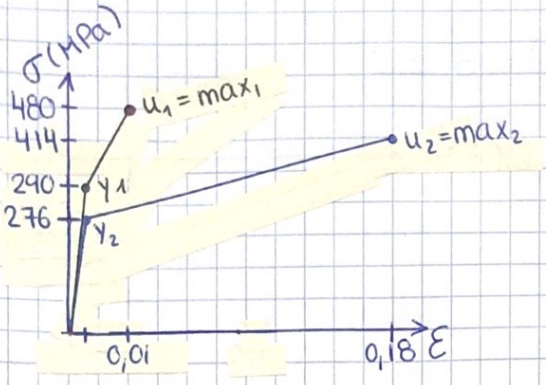
1. $\sigma_{y_1} = 290MPa$; $\sigma_{max_1} = 480MPa$; $A_1 = \%1$
2. $\sigma_{y_2} = 276MPa$; $\sigma_{max_2} = 414MPa$; $A_2 = \%18$

a) 1) $\varepsilon_{y_1} = \frac{\sigma_{y_1}}{E} = \frac{290MPa}{170 \cdot 10^3 MPa} = 0,0017$

$\varepsilon_{max_1} = \varepsilon_{u_1} = 0,01$

2) $\varepsilon_{y_2} = \frac{\sigma_{y_2}}{E} = \frac{276MPa}{170 \cdot 10^3 MPa} = 0,0016$ B

$\varepsilon_{max_2} = \varepsilon_{u_2} = 0,18$



$A_0 = \pi \cdot 10^2 = 100\pi mm^2$

1) $\sigma_{y_1} = \frac{P_{y_1}}{A_0} \rightarrow P_{y_1} = \sigma_{y_1} \cdot A_0 = 290MPa \cdot 100\pi mm^2 = 29000\pi N = 29\pi KN$

$\sigma_{max_1} = \frac{P_{max_1}}{A_0} \rightarrow P_{max_1} = 480 \cdot 100\pi = 48\pi KN$

$\varepsilon_{y_1} = \frac{\delta_{y_1}}{L_0} \rightarrow \delta_{y_1} = \varepsilon_{y_1} \cdot L_0 = 0,0017 \cdot 50,8mm = 0,0867mm$ C

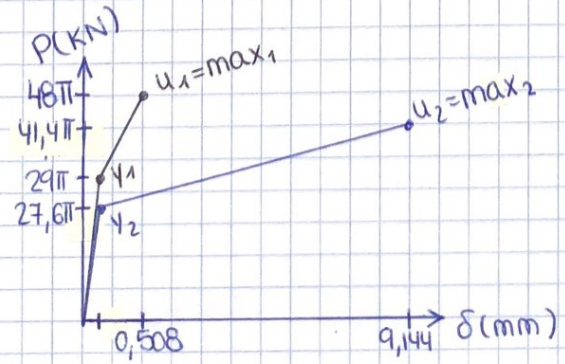
$\varepsilon_{max_1} = \frac{\delta_{max_1}}{L_0} \rightarrow \delta_{max_1} = 0,01 \cdot 50,8mm = 0,508mm$

2) $\sigma_{y_2} = \frac{P_{y_2}}{A_0} \rightarrow P_{y_2} = 276 \cdot 100\pi = 27,6\pi KN$

$\sigma_{max_2} = \frac{P_{max_2}}{A_0} \rightarrow P_{max_2} = 414 \cdot 100\pi = 41,4\pi KN$

$\varepsilon_{y_2} = \frac{\delta_{y_2}}{L_0} \rightarrow \delta_{y_2} = 0,0016 \cdot 50,8 = 0,0825mm$ D

$\varepsilon_{max_2} = \frac{\delta_{max_2}}{L_0} \rightarrow \delta_{max_2} = 0,18 \cdot 50,8 = 9,144mm$



b) 1) $R_1 = \frac{P_{V_1} \cdot \delta_{V_1}}{2} = \frac{29\pi \cdot 0,0867}{2} = \boxed{3,95\,J}$

$T_1 = R_1 + \frac{(0,508 - 0,0867)(48\pi - 29\pi)}{2} + 29\pi\,(0,508 - 0,0867) \rightarrow$

$\hookrightarrow \boxed{T_1 = 54,91\,J}$

2) $R_2 = \frac{P_{V_2} \cdot \delta_{V_2}}{2} = \frac{27,6\pi \cdot 0,0825}{2} = \boxed{3,58\,J}$

$T_2 = R_2 + (9,144 - 0,0825) \cdot 27,6\pi + \frac{(9,144 - 0,0825)(41,4\pi - 27,6\pi)}{2} \rightarrow$

$\hookrightarrow \boxed{T_2 = 985,71\,J}$