

$$10^{12} \text{ mm}^4 \rightarrow 1 \text{ m}^4$$

$$44,22 \text{ mm}^4 \rightarrow x = 4,42 \cdot 10^{-11} \text{ m}^4$$

$$1000 \text{ mm} \rightarrow 1 \text{ m}$$

$$10,2 \text{ mm} \rightarrow x = 0,0102 \text{ m}$$

Δίνονται:

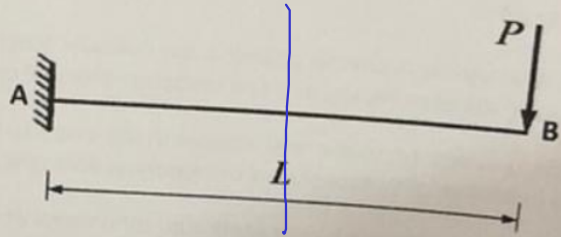
$$P = 200 + 10 \cdot i \text{ (N)},$$

$$L = 100 + 10 \cdot j \text{ (mm)},$$

$$h = 10 + 0,2 \cdot k \text{ (mm)},$$

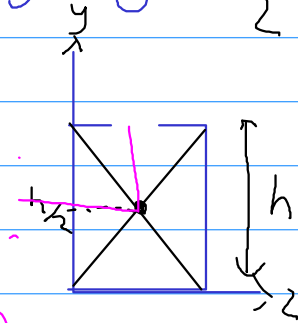
$$b = 0,5 \cdot h \text{ (mm)},$$

όπου i, j, k τα τρία τελευταία ψηφία του Α.Μ.



$$I_{z_1} = \frac{b \cdot h^3}{12} = 44,22 \text{ mm}^4, \quad C_y \text{ ή } \bar{y} = \frac{h}{2} = 10,2 \text{ mm}$$

$$A_1 = 5,1 \text{ mm}^2$$



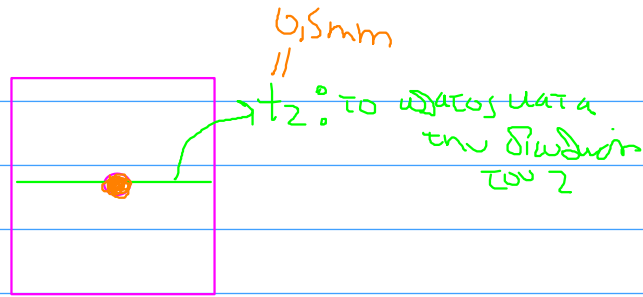
$$\sigma_{\text{Total}} = \frac{P}{A} + \frac{m \cdot \bar{y}}{I_z} = \frac{m \cdot \bar{z}}{I_y}$$

$$= \frac{231000 \cdot 0,0102 \text{ m}}{4,42 \cdot 10^{-11} \text{ m}^4}$$

$$= 5,33 \cdot 10^{12} \frac{\text{N}}{\text{m}^2} \text{ ή Pa} \rightarrow \div 10^6$$

$$= 5,3 \cdot 10^6 \text{ MPa}$$

Βήμα 1^ο Σχεδιάζω την διατάξη και βρίσκω το t_2



Διατήρηση ταν

station path $Q_y = y_1' \cdot A_1'$

τμήν

$$\tau = \frac{T \cdot \rho}{J \rho} + \underbrace{V_y}_{\substack{\text{οριζόντια ανώταση} \\ \text{σταθμ. ραχί}}} \underbrace{\frac{Q_{zy}}{I_z t_2}}_{\substack{\text{οριζόντια ανώταση} \\ \text{σταθμ. ραχί}}} + \frac{V_z \cdot Q_z}{I_y t_y}$$

Βήμα 2^ο Σχεδιάζω το νέο σχήμα και βρίσκω C_1', A_1'

$C_1' = \frac{(h/2)}{2} = \frac{(10/2)}{2} = 2,5\text{mm}$

$A_1' = \frac{h}{2} \cdot b = 5 \cdot 0,5 = 2,5\text{mm}^2$

Βήμα 3^ο Υπολογίζω την ανώταση του κέντρου Κ.Β με του κέντρου Κ.Β και την station path Q_y

$$Q_y = y_1' \cdot A_1'$$

$$= (ΚΒ_{\text{παιτίο}} - ΚΒ_{\text{κεν}}) \cdot A_1'$$

$$= \left(\frac{h}{2}/2\right) \cdot 2,5\text{mm}^2$$

$$= 2,5 \cdot 2,5\text{mm}^2 = 6,25\text{mm}^3 \rightarrow$$

$10^9 \text{mm}^3 \rightarrow 1\text{m}^3$
 $6,25 \rightarrow x = 6,25 \cdot 10^{-9}$

$$\tau = \frac{V \cdot Q_y}{I_z t_2} = \frac{210 \cdot 6,25 \cdot 10^{-9}}{4,42 \cdot 10^{-11} \cdot 5 \cdot 10^{-3}} = 5,9 \cdot 10^6 \text{ Pa}$$

$$\Rightarrow \tau = 5,9 \text{ MPa}$$

B2) $\sigma = 100 \text{ MPa}$

$$\sigma = \frac{m_2 \cdot c}{I_z}$$

$$\frac{100 \cdot 10^6 \text{ N}}{\text{m}^2} = \frac{m_2 \cdot 10,2 \cdot 10^{-3} \text{ m}}{4,42 \cdot 10^{-11} \text{ m}^4}$$

$$\Rightarrow m_2 = 0,43 \text{ Nm}$$

Topic 1-1

$$M(x) = -P \cdot x$$

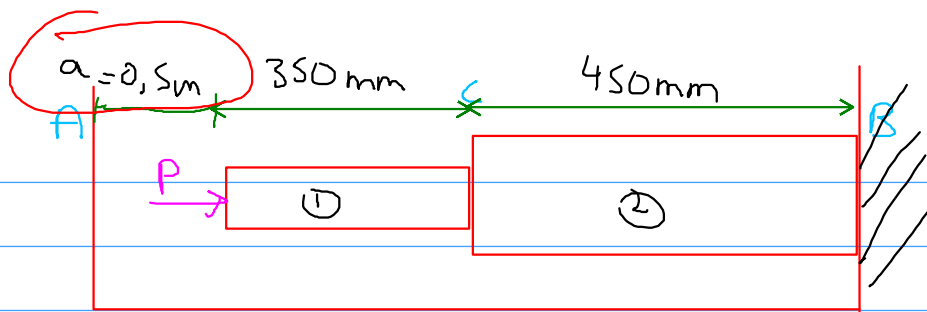
$$0,43 = -P \cdot 110$$

$$P = -3,90 \cdot 10^{-3} \Rightarrow \boxed{P = 3,9 \cdot 10^{-3} \text{ N}}$$

$$\tau = 1 \text{ MPa}$$

$$\tau = \frac{V_y Q_y}{I_z t_2} \rightarrow \frac{3,9 \cdot 10^{-3} \cdot 6,25 \cdot 10^{-9}}{4,42 \cdot 10^{-11} \cdot 5 \cdot 10^{-3}} = 110 \text{ Pa}$$

$$\tau = 1,10 \cdot 10^{-4} \text{ MPa} \quad \text{OK}$$



AC: $A_1 = 200 \text{ mm}^2$

$E_1 = 72 \text{ GPa}$

$\alpha_1 = 2.3 \cdot 10^{-6} / ^\circ\text{C}$

CB: $A_2 = 900 \text{ mm}^2$

$E_2 = 190$

$\alpha_2 = 17 \cdot 10^{-6} / ^\circ\text{C}$

$T_1 = 20^\circ\text{C}$ $\sigma_{\text{EL}} = 80 \text{ MPa}$

$\alpha = 0.5 \text{ mm}$

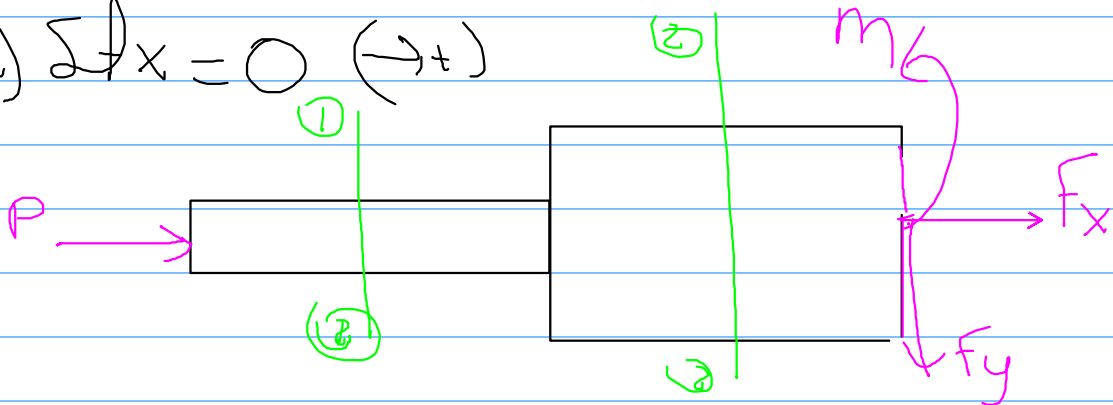
$T_2 = 120$

a) Υπολογίστε αέθνηση συνάρτησης

b) Υπολογίστε τάση

γ) ΔT_{max}

a) $\sum F_x = 0 \quad (\rightarrow +)$

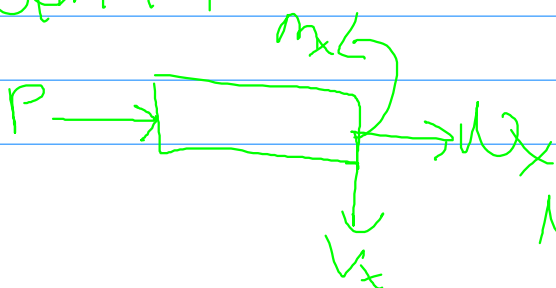


$(\rightarrow) \sum F_x = 0$
 $F_x = -P$

$\sum F_y = 0$
 $F_y = 0$

$\sum M = 0$
 $m = 0$

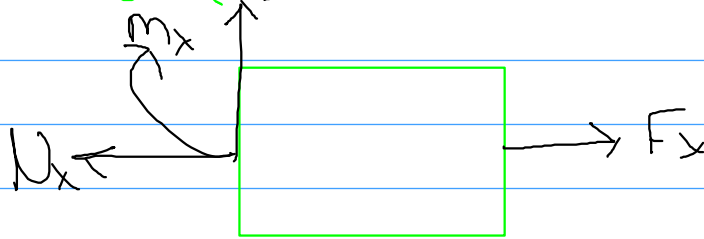
Top 1-1



$\sum M = 0$ $\sum F_y = 0$
 $M_x = 0$ $V_x = 0$

$\sum F_x = 0$
 $N_x = -P$

Topn 2-2



$$\sum F_x = 0$$

$$V_y = 0$$

$$M_x = 0$$

$$N_x = F_x$$

$$\delta = \frac{P \cdot L}{A \cdot E}$$

$$\delta_{oj} = \delta_P + \delta_{F_x}(1)$$

$$\begin{aligned} \sum \eta_{iPa} \\ \delta_{oxn} &= \delta_{oj} + a \\ \Rightarrow \delta_{oj} &= \delta_{oxn} - a \end{aligned}$$

$$\Rightarrow \delta_{oxn} = a_1(\Delta T) \cdot L_1 + a_2(\Delta T) \cdot L_2$$

$$\delta_{oxn} = 2,3 \cdot 10^{-6} (120 - 20) \cdot 0,350 + 17 \cdot 10^{-6} (120 - 20)$$

$$\delta_{oxn} = 8,47 \cdot 10^{-4} \text{ m}$$

$$\begin{aligned} (2) \Rightarrow \delta_{oj} &= \delta_{oxn} - \delta_{oxn0} \\ &= 8,47 \cdot 10^{-4} - 0,5 \cdot 10^{-3} \\ &= 3,47 \cdot 10^{-4} \text{ m} \end{aligned}$$

$$\begin{aligned} (1) \Rightarrow \delta_{oj} &= \delta_P + \delta_{F_x} \\ &= \frac{P \cdot L_1}{A_1 E_1} + \frac{F_x \cdot L_2}{A_2 E_2} \end{aligned}$$

$$3,47 \cdot 10^{-4} = \frac{P_1 \cdot 0,350}{200 \cdot 10^{-6} \cdot 77 \cdot 10^9} + \frac{P_1 \cdot 0,45}{900 \cdot 10^{-6} \cdot 190 \cdot 10^9}$$

$$\Rightarrow P_1 = 13,80 \text{ kW}$$

$$b) \sigma = \frac{N}{A} \pm \frac{M \cdot y}{I_y} \pm \frac{M \cdot y}{I_z}$$

$$\sigma_{AL} = \frac{13,80}{200 \cdot 10^{-6}} = 69 \text{ MPa}$$

$$\sigma_{UB} = \frac{13,80}{900 \cdot 10^{-6}} = 15,33 \text{ MPa}$$

80 MPa $\rightarrow$ New P $\rightarrow$ dT_{max}

$$80 \cdot 10^6 \text{ Pa} = \frac{P_1}{A_1 = 200 \cdot 10^{-6}}$$

$$P_1 = 16000 \text{ W}$$

$$P_1 = 16 \text{ kW} = P_2$$

$$\delta_k = \frac{P_1 L_1}{A_1 E_1} + \frac{P_2 L_2}{A_2 E_2} = S$$

$$\delta_k = \delta_{ox} - u$$

$$S = \delta_{ox} - 0,5$$

$$\delta_{ox} = 4,5 \text{ m}$$

$$\delta_{ox} = \alpha \Delta T \cdot L_1 + \alpha_2 \Delta T L_2$$