

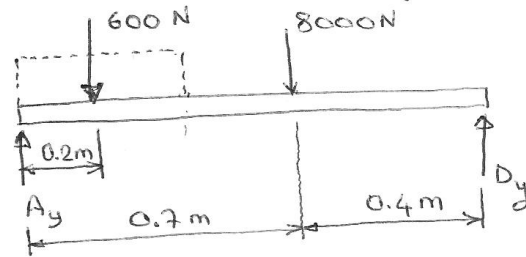
MUKAVEMET I
STRENGTH OF MATERIALS I

Final Sınavı / Final Exam

18.01.2011

ÇÖZÜM 1
SOLUTION 1

S.C.D. ve statik denge / F.B.D and static equilb.



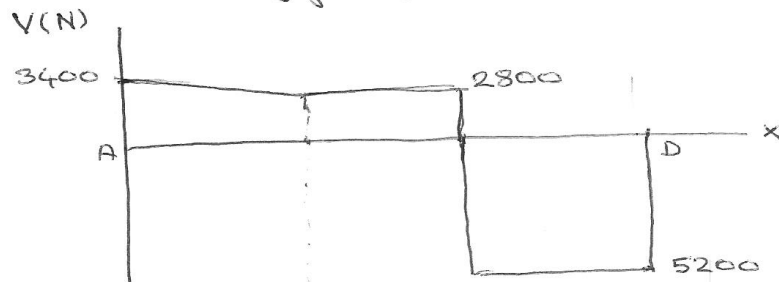
$$\sum M_A = 0 \quad -600 \times 0.2 - 8000 \times 0.7 + 1.1 D_y = 0$$

$$D_y = 5200 \text{ N}$$

$$\sum F_y = 0 \quad A_y - 600 - 8000 + 5200 = 0$$

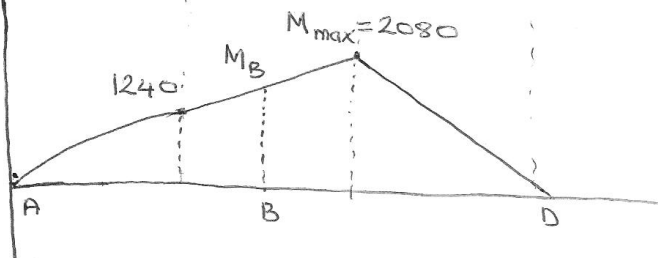
$$A_y = 3400 \text{ N}$$

Kesme diyagramı / Shear diagram



M(N.m)

Moment diagram
Moment diagram

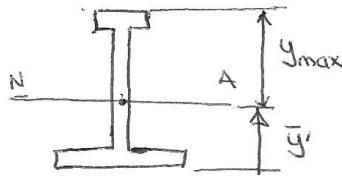


a-a kesitindeki eğilme momenti / bending moment at cross-section a-a

$$M_B = \frac{1240 + 2080}{2} = 1660 \text{ N}\cdot\text{m}$$

Maksimum moment / Maximum moment : $M_{\max} = 2080 \text{ N}\cdot\text{m}$

(b) Kesit özellikleri / section properties :



$$\bar{y}' = \frac{40 \times 8 \times 4 + 60 \times 6 \times 38 + 20 \times 8 \times 72}{40 \times 8 + 60 \times 6 + 20 \times 8}$$

$$\bar{y}' = 31,52 \text{ mm}$$

$$I = \frac{40 \times 8^3}{12} + 40 \times 8 \times (31,52 - 4)^2 + \frac{6 \times 60^3}{12} + 6 \times 60 \times (38 - 31,52)^2 + \frac{20 \times 8^3}{12} + 20 \times 8 \times (72 - 31,52)^2$$

$$I = 630\,210 \text{ mm}^4$$

Maksimum eğilme gerilmesi (a-a kesitinde) / max. bending stress at a-a cross-section

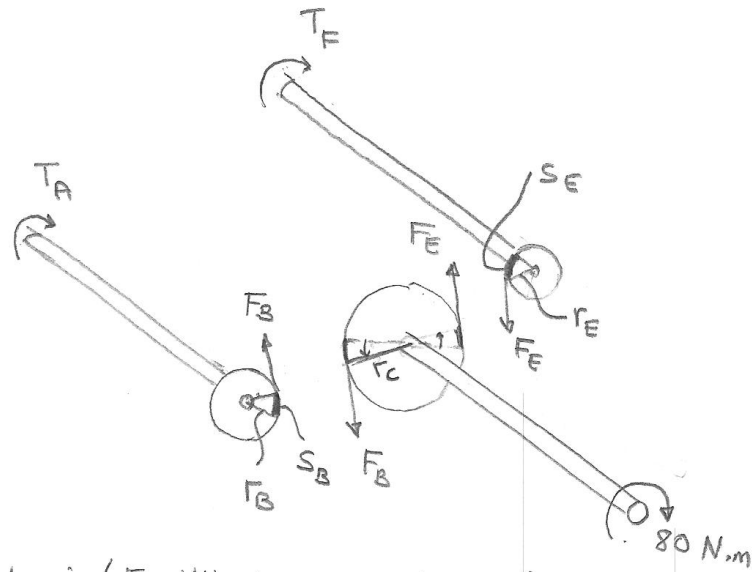
$$(C_{\max})_{a-a} = \frac{M_B}{I} y_{\max} \quad y_{\max} = 76 - 31,52 = 44,48 \text{ mm}$$

$$= \frac{1660 \times 10^3}{630\,210} 44,48 \Rightarrow (C_{\max})_{a-a} = 117,2 \text{ MPa}$$

$$(c) \quad C_{\max} = \frac{M_{\max}}{I} y_{\max}$$

$$= \frac{2080 \times 10^3}{630\,210} 44,48 \Rightarrow C_{\max} = 146,8 \text{ MPa}$$

ÇÖZÜM 2
SOLUTION 2



Denge denklemi / Equilibrium equation

$$\sum T = 0 \quad 0.125 F_E + 0.125 F_B - 80 = 0 \quad (1)$$

Uygunluk denklemi / Compatibility equation:

$$S_B = S_E \quad (2)$$

$$\phi_B r_B = \phi_E r_E$$

$$\left. \begin{aligned} \phi_B &= \frac{T_A \cdot 2}{GJ} \\ \phi_E &= \frac{T_F \cdot 2}{GJ} \end{aligned} \right\} \Rightarrow T_A r_B = T_F r_E \quad (3)$$

T_A ve T_F torkları F_B ve F_E kuvvetleri cinsinden yazılabilir.

T_A and T_F torques can be written in terms of F_B and F_E forces.

$$T_A = F_B r_B$$

$$T_F = F_E r_E$$

(4)

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(3) ve (4)'ten

$$F_B r_B^2 = F_E r_E^2 \Rightarrow F_E = \left(\frac{r_B}{r_E}\right)^2 F_B \\ = \left(\frac{75}{50}\right)^2 F_B \Rightarrow F_E = 2.25 F_B \quad (5)$$

(5)'i (4)'e koyarak / (5) into (1)

$$0.125 \times (2.25 F_B) + 0.125 F_B = 80$$

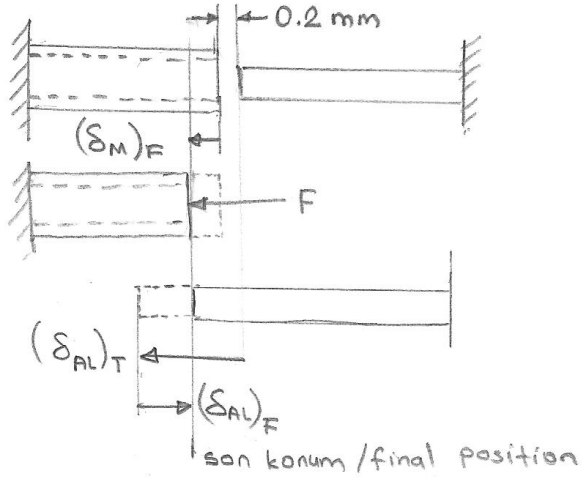
$$F_B = 197 \text{ N.m} \quad \text{ve/and} \quad F_E = 443 \text{ N.m} \quad (6)$$

(6)'yı (4)'e koyarak / (6) into (4)

$$T_B = 197 \times 0.075 = 14.775 \text{ N.m} \quad (7)$$

$$T_E = 443 \times 0.050 = 22.15 \text{ N.m} \quad (8)$$

ÇÖZÜM 3
SOLUTION 3



Uygunluk denklemi / Compatibility equation

$$(\delta_{AL})_T - (\delta_{AL})_F - 0.2 = (\delta_M)_F \quad (1)$$

$$\alpha_{AL} \Delta T \cdot L_{CD} - \frac{F \cdot L_{CD}}{A_{CD} E_{AL}} - 0.2 = \frac{F \cdot L_{AB}}{A_{AB} E_M}$$

$$A_{CD} = \pi \times (12.5)^2 = 490.9 \text{ mm}^2 \quad A_{AB} = \pi (25^2 - 20^2) = 706.9 \text{ mm}^2$$

$$12 \times 10^{-6} \times 70 \times 450 - \frac{F \cdot 450}{490.9 \times 70 \times 10^3} - 0.2 = \frac{F \cdot 300}{706.9 \times 44 \times 10^3}$$

$$2.273 \times 10^{-5} F = 0.178 \Rightarrow F = 7831 \text{ N (basma)}$$

$$\sigma_{AB} = \frac{F}{A_{AB}} = \frac{7831}{490.9} = 16.0 \text{ MPa (Basma)}$$

$$\sigma_{CD} = \frac{F}{A_{CD}} = \frac{7831}{706.9} = 11.1 \text{ MPa (Basma)}$$

$$(b) (\epsilon_{AB})_{uzun.} = \frac{\sigma_{AB}}{E_M} = \frac{-16.0}{44 \times 10^3} = -3.64 \times 10^{-4}$$

$$(\epsilon_{AB})_{yanal} = -\nu_M (\epsilon_{AB})_{uzun.} = -0.30 (-3.64 \times 10^{-4}) = 1.0909 \times 10^{-4}$$

Kalınlık değişimi / The change in the thickness is

$$\Delta t = (\epsilon_{AB})_{yanal} t = 1.0909 \times 10^{-4} \times 5 = 5.45 \times 10^{-4} \text{ mm}$$

kalınlık artar.