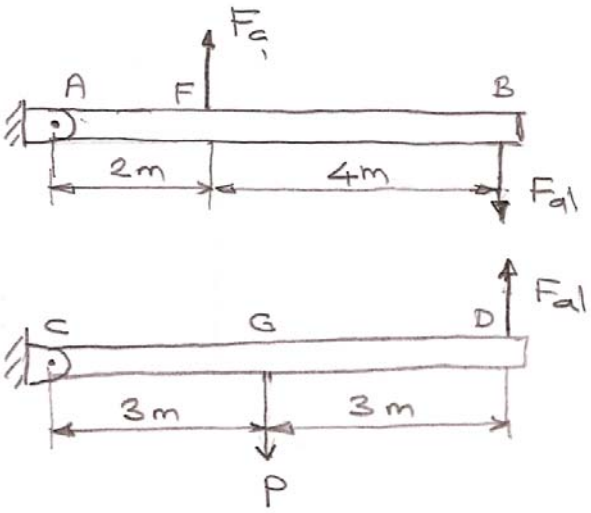
2009

MUKAVEMET I

2. Arasınav Çözümleri

çözüm 1

(a)



CGD kirişinde

$\sum M_C = 0 \quad 3P = 6F_{ç}$

$$\boxed{F_{al} = \frac{1}{2}P}$$

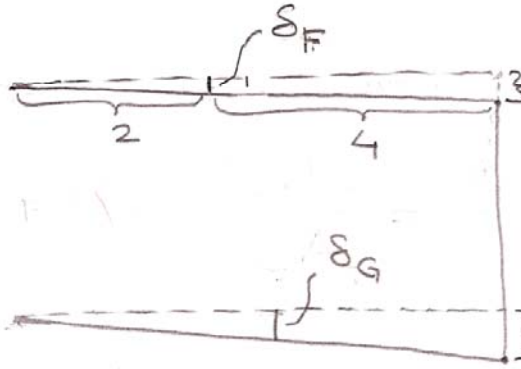
AFB kirişinde

$\sum M_A = 0$

$6F_{al} = 2F_{ç}$

$$\boxed{F_{ç} = 3F_{al} = \frac{3}{2}P}$$

(b)



$$\frac{2}{6} = \frac{\delta_F}{\delta_B} \Rightarrow \quad \delta_B = 3\delta_F = 3\delta_{ç}$$

$$\delta_D = \delta_B + \delta_{al}$$

$$= 3\delta_{ç} + \delta_{al}$$

$$\frac{\delta_G}{\delta_D} = \frac{3}{6} \qquad \delta_G = \frac{1}{2}\delta_D = \frac{1}{2}\left(3\delta_{ç} + \delta_{al}\right)$$

$$= 1.5\delta_{ç} + 0.5\delta_{al}$$

$\delta_G = 5$ mm

$$5 = 1.5\,\frac{F_{ç} \cdot L_{ç}}{E_{ç} A_{ç}} + 0.5\,\frac{F_{al} \cdot L_{al}}{E_{al} A_{al}}$$

$$1{,}5\,\frac{1{,}5P\cdot 2000}{200\times10^{3}\times 500}+0{,}5\,\frac{0{,}5P\cdot 2000}{70\times10^{3}\times 300}=5$$

$$4{,}5\times10^{-5}P+2{,}38\times10^{-3}P=5 \qquad \boxed{P=72664\ N}$$

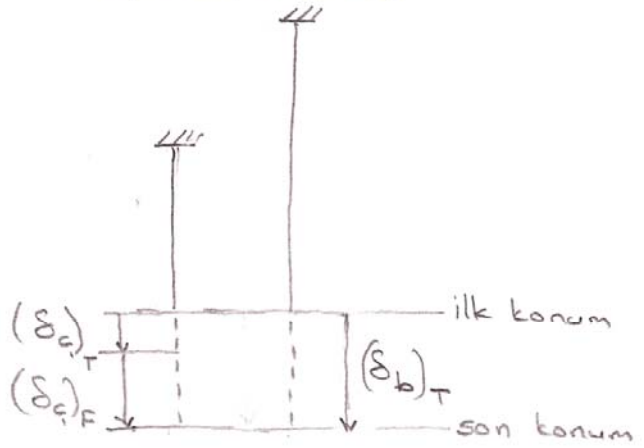
(c) $\sigma_ç=\dfrac{F_ç}{A_ç}$ $\qquad F_ç=1{,}5P=108997\ N$

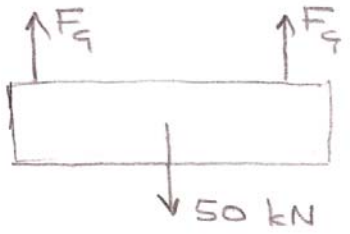
$$\sigma_c=\frac{108997}{500}=218\ MPa<\underbrace{250\ MPa}_{(\sigma_e)_ç}\ \checkmark$$

$$\sigma_{al}=\frac{F_{al}}{A_{al}} \qquad F_a=0{,}5P=36332\ N$$

$$\sigma_{al}=\frac{36332}{300}=121\ MPa>\underbrace{100\ MPa}_{(\sigma_{al})_e}\ X \text{ Emniyetsiz.}$$

ÇÖZÜM 2.(a)





Denge denklemi:

$2F_ç=50\ kN$

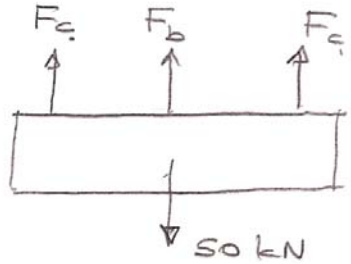
$F_ç=25\ kN$

Uygunluk denklemi: $(\delta_ç)_T+(\delta_ç)_F=(\delta_b)_T$

$$(\alpha\Delta TL)_ç+\left(\frac{FL}{AE}\right)_ç=(\alpha\Delta TL)_b \Rightarrow 12\times10^{-6}\times\Delta T\times0{,}5+\frac{25\times10^{3}\times0{,}5}{500\times10^{-6}\times200\times10^{9}}=19\times10^{-6}\Delta T\times1$$

$\Delta T=9{,}62^{\circ}C$

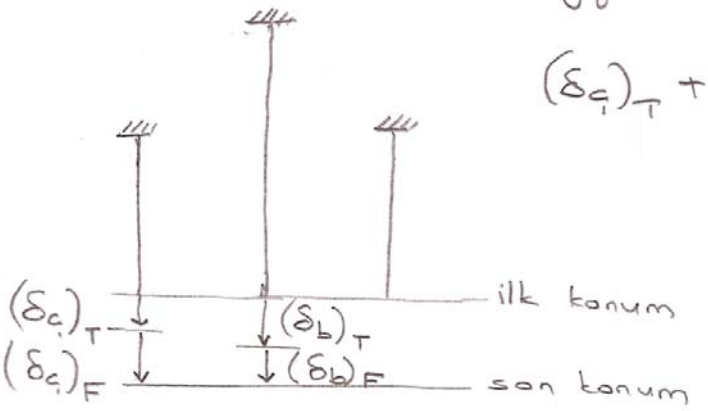
ÇÖZÜM 2 (b) Statik denge:



$$2F_ç + F_b = 50\ kN \quad (1)$$

Uygunluk denklemi:

$$(\delta_ç)_T + (\delta_ç)_F = (\delta_b)_T + (\delta_b)_F$$



$$(\alpha \Delta T.L)_ç + \left(\frac{FL}{AE}\right)_ç = (\alpha \Delta T L)_b + \left(\frac{FL}{AE}\right)_b$$

$$12\times10^{-6} \times 40 \times 0{,}5 + \frac{F_ç \cdot 0{,}5}{500\times10^{-6} \times 200\times10^{9}}$$

$$= 19\times10^{-6} \times 40 \times 1 + \frac{F_b \cdot 2}{900\times10^{-6} \times 83\times10^{9}}$$

$$-0{,}5F_ç + 2{,}677F_b = 52000 \quad (2)$$

(1) ve (2) denklemlerinden

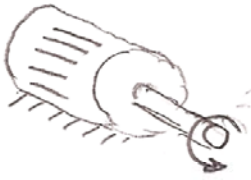
$$2F_ç + F_b = 50000$$
$$+0{,}18745F_ç - F_b = +19495$$

$$2{,}18745F_ç = 30505 \Rightarrow F_ç = 13945\ N$$
$$F_b = 22110\ N$$

$$\sigma_ç = \frac{F_ç}{A_ç} = \frac{13945}{500} = 27{,}9\ MPa, \quad \sigma_b = \frac{22110}{900} = 24{,}6\ MPa$$

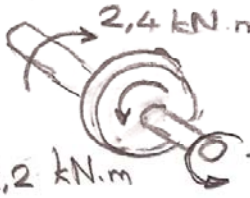
ÇÖZÜM 3.

AB arası



$T_{AB} = 2,4$ kN.m

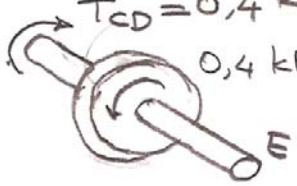
BC arası



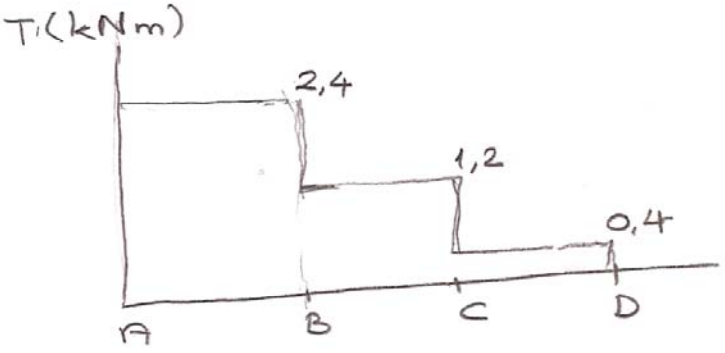
$T_{BC} = 2,4 - 1,2$

$= 1,2$ kNm

CD arası



Burulma momenti diyagramı



(b) $(\tau_{AB})_{maks} = \dfrac{T_{AB}}{J_{AB}} c_{AB} = \dfrac{2400 \times 10^3}{\frac{\pi}{2} 27^4} \cdot 27$

$= 77,6$ MPa

$(\tau_{BC})_{maks} = \dfrac{T_{BC}}{J_{BC}} c_{BC} = \dfrac{1200 \times 10^3}{\frac{\pi}{2} 23^4} 23$

$= 62,8$ MPa

$$(\tau_{CD})_{maks} = \frac{T_{CD}}{J_{CD}} c_{CD} = \frac{400 \times 10^3}{\frac{\pi}{2} 20^4} 20$$

$$= 31,8 \text{ mPa}$$

(c) Şaft sisteminde oluşan maksimum gerilme

$$\tau_{maks} = 77,6 \text{ MPa}$$

$$77,6 = \frac{1200 \times 10^3}{\frac{\pi}{2} c^4} c$$

$c = 21,43$ mm $\quad d = 42,86$ mm

$\boxed{d = 43 \text{ mm}}$