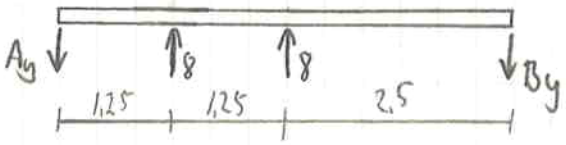
Mekanikk 2010 B, 23/2 '11 - Løsning

Oppgave 1

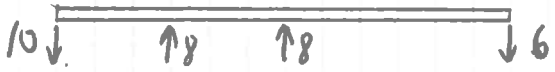
a) FLD



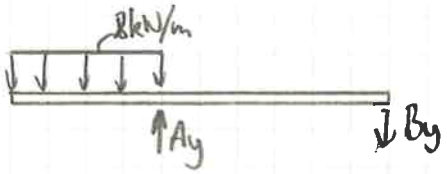
$\curvearrowright \Sigma M_A = 0 \Rightarrow B_y \cdot 5 - 8 \cdot 2{,}5 - 8 \cdot 1{,}25 = 0 \Rightarrow B_y = 6\,kN$

$\uparrow \Sigma F_y = 0 \Rightarrow 8 + 8 - 6 - A_y = 0 \Rightarrow A_y = 10\,kN$

BD



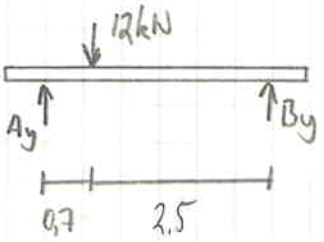
b) FLD:



$\curvearrowright \Sigma M_A = 0 \Rightarrow B_y \cdot 3 - 8 \cdot 2 \cdot 1 = 0 \Rightarrow \underline{B_y = 5{,}33\,kN}$

$\uparrow \Sigma F_y = 0 \Rightarrow A_y - 5{,}33 - 8 \cdot 2 = 0 \Rightarrow \underline{A_y = 21{,}33\,kN}$

c) FLD:

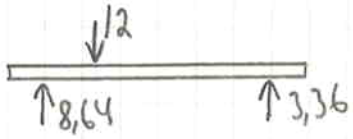


$\curvearrowright \Sigma M_A = 0 \Rightarrow 12 \cdot 0{,}7 - B_y \cdot 2{,}5 = 0$

$\Rightarrow \underline{B_y = 3{,}36\,kN}$

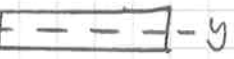
$\uparrow \Sigma F_y = 0 \Rightarrow A_y + 3{,}36 - 12 = 0$

$\Rightarrow \underline{A_y = 8{,}64\,kN}$



Oppgave 2

a) Minste arealmoment: $I_o = \frac{1}{12} 80 \cdot 8^3 = 3413\,mm^4$



$$i = \sqrt{\frac{I_o}{A}} = \sqrt{\frac{3413}{80 \cdot 8}} = 2,3 \qquad \lambda = \frac{L_k}{i} = \frac{3000}{2,3} = 1304$$

dvs elastisk knekning.

$$\underline{\underline{F_k}} = \frac{\pi^2 E I_o}{L_k^2} = \frac{\pi^2 \cdot 70000 \cdot 3413}{3000^2} = \underline{\underline{262\,N}}$$

b)

$$\Delta L = \frac{FL}{EA} = \frac{5000 \cdot 3000}{70000 \cdot 80 \cdot 8} = 0,33\,mm$$

$$\sigma = \frac{F}{A} = \frac{5000}{640} = 7,8\,MPa$$

c) $\Delta L = \alpha \Delta T \cdot L = 23,8 \cdot 10^{-6} \cdot 40 \cdot 3000 = 2,9\,mm$

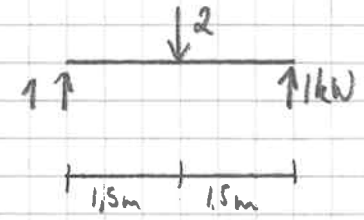
d) $\rho_{AL} = 2,7\,t/m^3$

$$q = 2700 \cdot 9,81\,N/m^3 \cdot 0,08 \cdot 0,008 = 16,95\,N/m = 0,017\,N/mm$$

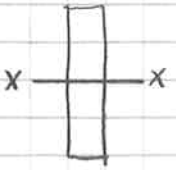
Bruker utbøyningsformel nr. 7

$$\underline{\underline{\delta}} = \frac{5}{384} \cdot \frac{qL^4}{EI} = \frac{5}{384} \cdot \frac{0,017 \cdot 3000^4}{70000 \cdot 3413} = \underline{\underline{75\,mm}}$$

e) BD:



$M_{dim} = 1,5\,kNm$ (unter Punktlasten)



$I_x = \frac{1}{12} 8 \cdot 80^3 = 341333\,mm^4$

$$\underline{\sigma} = \frac{M}{I} y = \frac{1,5 \cdot 10^6}{341333} \cdot 40 = \underline{176\,MPa}$$

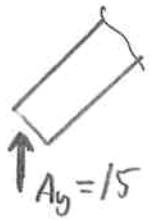
f) $V = 1kN$

$$\tau_{max} = 1,5 \cdot \frac{V}{A} = 1,5 \cdot \frac{1000}{80 \cdot 8} = 2,3\,MPa$$

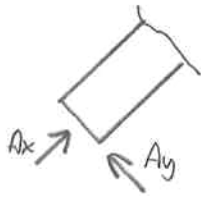
Oppgave 3.

a) Symmetri gir oss at $A_y = B_y = 15kN$

Globalt koordinat-system

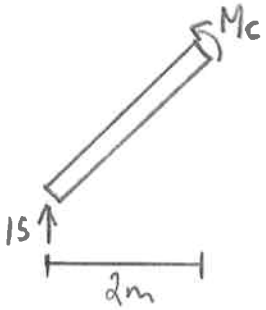


Lokalt koordinat-system:



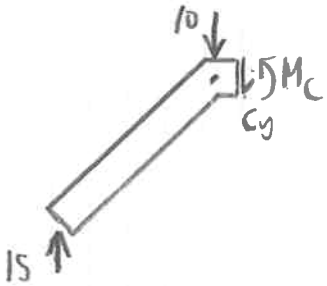
$A_x = A_y = 15 \cos 45^\circ = 10,6kN$

b) Element AC (konstr. snittet til venstre for C)



$M_C = 15 \cdot 2 = 30kNm$

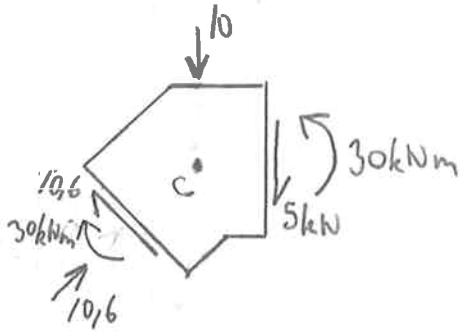
Element AC (inkludert selve hjørnet)



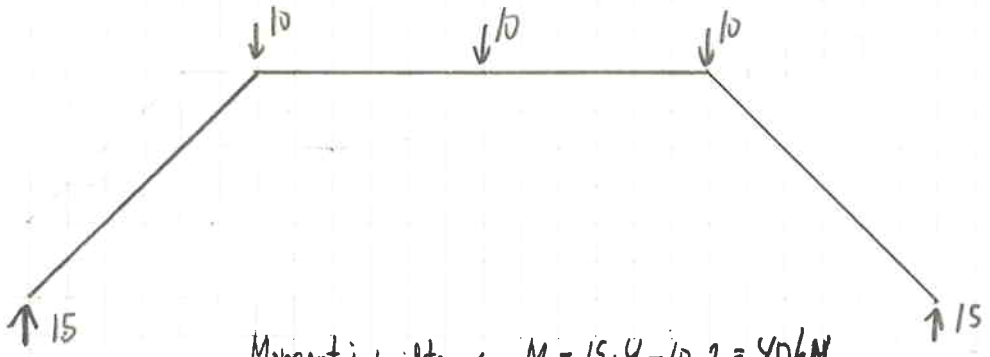
$M_C = 30kNm$ (Se over)

$\Sigma F_y = 0 \Rightarrow 15 - 10 - C_y = 0 \Rightarrow C_y = 5kN$

Bel. diagr. for hjørnet:

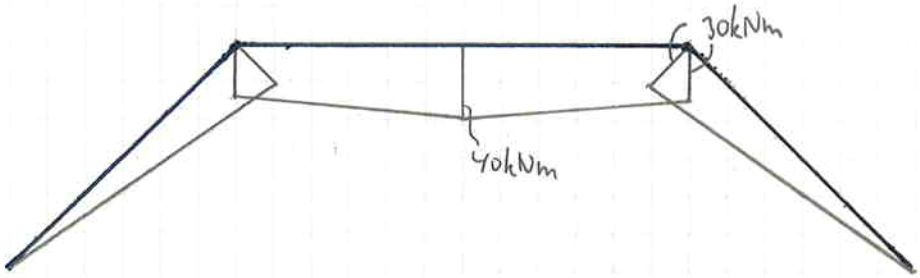


c) BD:

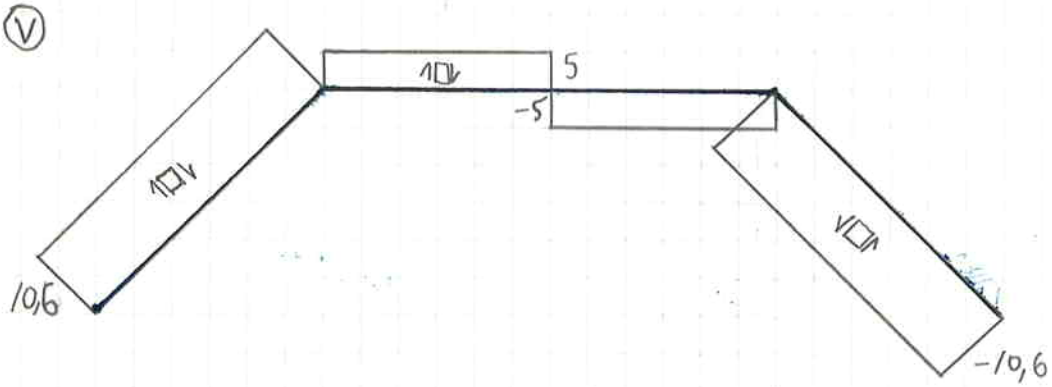


Moment i midten: $M = 15 \cdot 4 - 10 \cdot 2 = 40\,kNm$

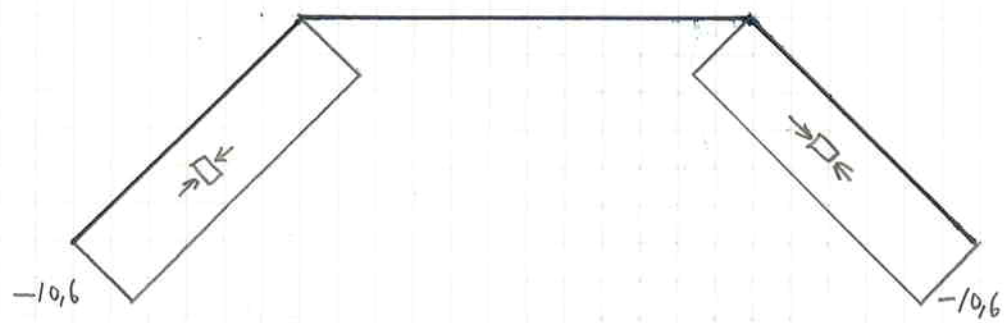
(M)



(V)



(N)



d) $M_{dim} = 40 kNm$, $R_e = 355 MPa$, $n = 1,2$

$$\sigma_{tillatt} = \frac{355}{1,2} = 296 MPa$$

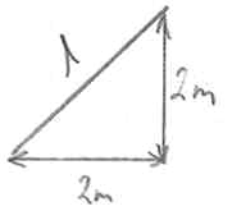
$$I_{krav} = \frac{M_{dim}}{\sigma_{tillatt}} \cdot y = \frac{40 \cdot 10^6}{296} \cdot 70 = 946 cm^4$$

Bruker HUP140x140x8 med $I = 1127 cm^4$ og $A = 40,0 cm^2$

e)

$\rho_{stål} = 7850 kg/m^3$

total lengde for bjelkene: $L = 2 \cdot 2,83 + 4,0 = 9,66 m$



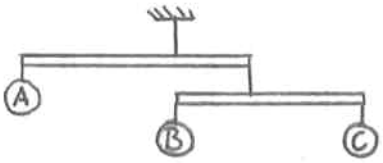
$l = \sqrt{2^2 + 2^2} = 2,83 m$

$$Vekt = \rho \cdot L \cdot A = 7850 \cdot 9,66 \cdot 40,0 \cdot 10^{-4} = \underline{303 kg}$$

Oppgave 4

a)

$A = 25\,g$



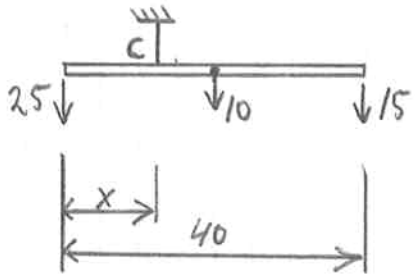
Øvre pinne: $A \cdot 20 = (B+C) \cdot 10 \Rightarrow \underline{B+C} = 25 \cdot \frac{20}{10} = \underline{50}$ (1)

Nedre pinne: $B \cdot 10 = C \cdot 15 \rightarrow \underline{B = 1{,}5C}$ (2)

(2) satt inn i (1): $1{,}5C + C = 50 \Rightarrow \underline{\underline{C = 20\,g}}$

$\underline{\underline{B = 1{,}5C = 30\,g}}$

b)



$\curvearrowright \sum M_C = 0 \Rightarrow 15 \cdot (40 - x) + 10\,(20 - x) - 25x = 0$

$\Rightarrow 600 - 15x + 200 - 10x - 25x = 0$

$\Rightarrow 800 = 50x$

$\Rightarrow \underline{x = 16\,cm}$