OPPGAVE 1

Kraftresultant: $R = \Sigma F$

$= 80+35+30+40+85$ $\quad R = 270\,kN$

Resultantens moment om origo skal vær lik summen av enkeltkreftenes momenter

$$R \cdot x_R = \Sigma F_i \cdot a_i$$

$$270 \cdot x_R = 35\cdot 3 + 30\cdot 6 + 40\cdot 9 + 85\cdot 12 \quad \Rightarrow \quad x_R = 6{,}17\ m$$

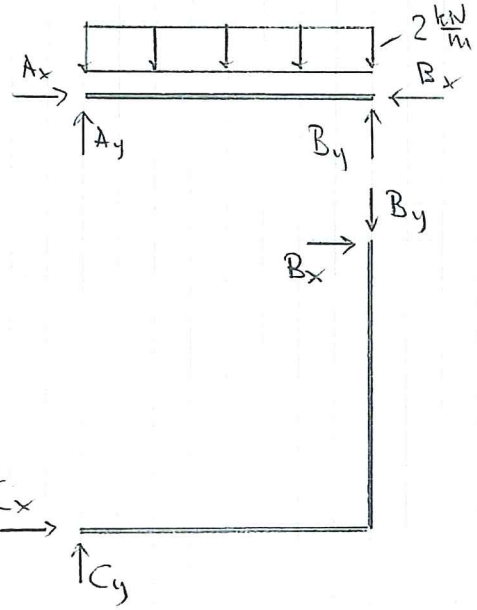
OPPGAVE 3

UKJ = {$A_x, A_y, B_x, B_y, C_x, C_y$} = 6

LVL = 2 komponenter à 3 lign. = 6

} STATISK BESTEMT

FLD:



DEL AB

$\Sigma M_A = 0 \Rightarrow \underbrace{2\frac{kN}{m}\cdot 3m}_{R} \cdot \underbrace{\frac{3}{2}m}_{arm} - B_y \cdot 3m = 0$

$\Rightarrow B_y = 3\,kN$

$\Sigma F_y = 0 \Rightarrow A_y + B_y + 2\frac{kN}{m}\cdot 3m = 0$

$\Rightarrow A_y = 3kN$

HELE RAMMEN

$\Sigma F_x = 0 \Rightarrow A_x + C_x = 0 \Rightarrow A_x = -3kN$

DEL BC

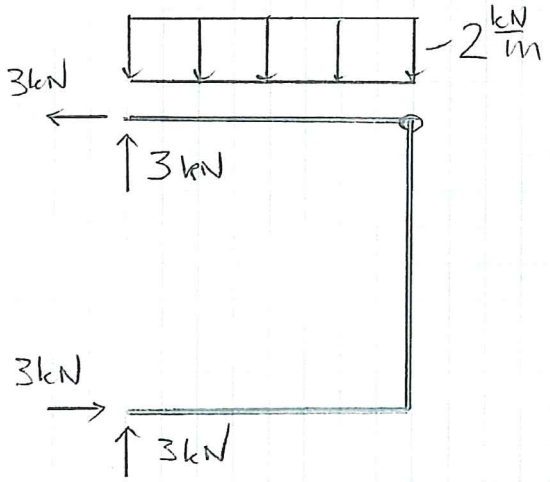
$\Sigma M_c = 0 \Rightarrow B_y \cdot 3m + B_x \cdot 3m = 0$

$\Rightarrow B_x = -3kN$

$\Sigma F_x = 0 \Rightarrow C_x + B_x = 0 \Rightarrow C_x = 3kN$

$\Sigma F_y = 0 \Rightarrow C_y - B_y = 0 \Rightarrow C_y = 3kN$

Belastningsdiagram for hele rammen — med krefter i korrekt retning:



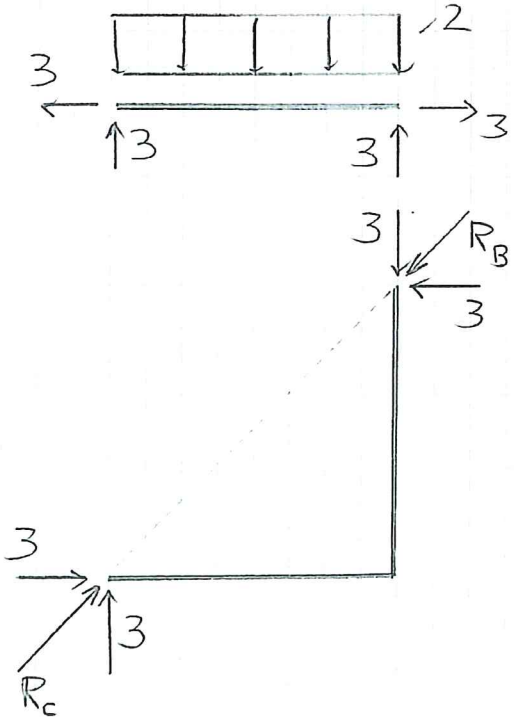
Momentlikevekt om B:

$$\Sigma M_B = 0$$

$$\Rightarrow \underbrace{3}_{A_y} \cdot 3 - \underbrace{2}_{q} \cdot 3 \cdot \frac{3}{2} + \underbrace{3}_{C_y} \cdot 3 - \underbrace{3}_{C_x} \cdot 3$$

$$= 9 - 9 + 9 - 9 = 0 \quad \underline{\text{ok}}$$

Separate belastningsdiagram:



Resultanten av kreftene i B og C, hhv. R_B og R_C, har samme angrepslinje. Hvis så ikke var tilfelle, ville ikke del BC vært i momentlikevekt.

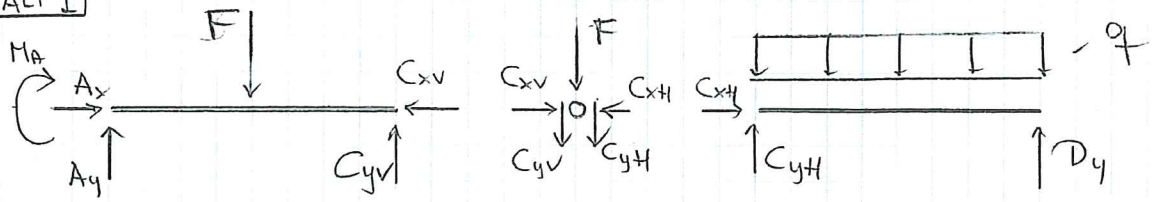
Dessuten: R_B og R_C er like store og motsatt rettet $\Rightarrow$ Kraftlikevekt OK

OPPGAVE 4

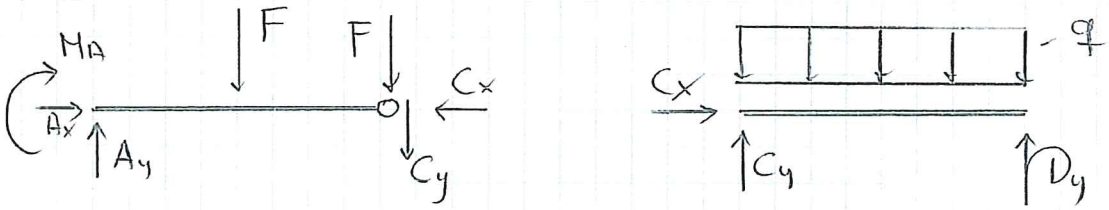
Statisk bestemt?

$UKF = \{M_A, A_x, A_y, C_x, C_y, D_y\} = 6$
$LVL = 2 \text{ komp. à } 3 \text{ lign} = 6$
} OK

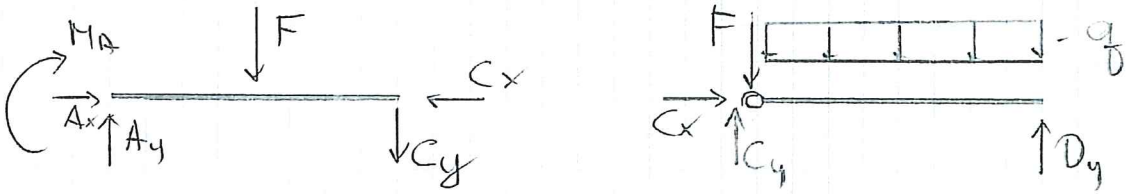
ALT 1



ALT 2



ALT 3



Belastningsdiagram blir (for ALT 2)

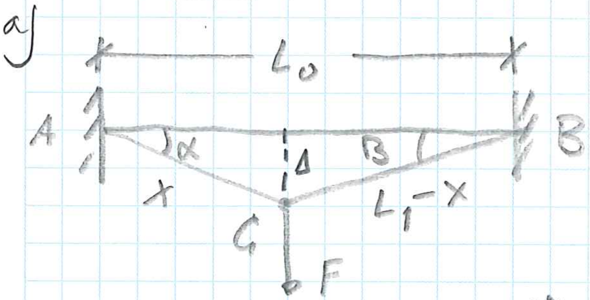
TKT4118 Mekanikk 1

Øving 3

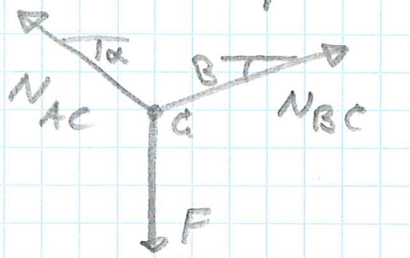
Oppgave 2a (justert oppgavetekst, MATLAB tatt ut)

Løsning

a)



Likevekt i pkt. C



$\Delta = x \sin\alpha$

$\Delta = (L_1 - x)\sin\beta$

$\overset{\rightarrow}{\Sigma} K_x = 0 \Rightarrow N_{AC}\cos\alpha = N_{BC}\cos\beta$

$\uparrow \Sigma K_y = 0 \Rightarrow N_{AC}\sin\alpha + N_{BC}\sin\beta = F$

$$N_{AC}\sin\alpha + \Big(\underbrace{N_{AC}\frac{\cos\alpha}{\cos\beta}}_{N_{BC}}\Big)\sin\beta = F \Rightarrow \boxed{N_{AC} = \frac{F}{\sin\alpha + \cos\alpha\dfrac{\sin\beta}{\cos\beta}}}$$

$$\Big(\underbrace{N_{BC}\frac{\cos\beta}{\cos\alpha}}_{N_{AC}}\Big)\sin\alpha + N_{BC}\sin\beta = F \Rightarrow \boxed{N_{BC} = \frac{F}{\sin\beta + \cos\beta\dfrac{\sin\alpha}{\cos\alpha}}}$$

cos-setning: $(L_1 - x)^2 = L_0^2 + x^2 - 2L_0 x\cos\alpha$

(med vinkel α)

$$L_1^2 - 2L_1 x + x^2 = L_0^2 + x^2 - 2L_0 x\cos\alpha$$

$$\boxed{\cos\alpha = \frac{L_0^2 - L_1(L_1 - 2x)}{2L_0 x} \quad \text{og} \quad \sin\alpha = \sqrt{1-\cos^2\alpha}}$$

Cos-setning: $x^2 = L_0^2 + (L_1 - x)^2 - 2L_0(L_1 - x)\cos\beta$

(med vinkel β)

$$x^2 = L_0^2 + L_1^2 - 2L_1 x + x^2 - 2L_0(L_1 - x)\cos\beta$$

$$\boxed{\cos\beta = \frac{L_0^2 + L_1(L_1 - 2x)}{2L_0(L_1 - x)} \quad \text{og} \quad \sin\beta = \sqrt{1-\cos^2\beta}}$$

Prosedyre:

Gitt L_0, L_1, x, og F

Beregn $\cos\alpha$, $\sin\alpha$, $\cos\beta$ og $\sin\beta$

Beregn N_{AC} og N_{BC} og Δ

Alternativt $\sin\beta = \dfrac{x\sin\alpha}{L_1 - x}$

Innsatt verdiene: $L_0 = 10.5\,m$ $\qquad F = 1\ kN$

$L_1 = 10.8\,m$

$x = 3.6\,m$

Dette gir: $$\cos\alpha = \frac{(10.5)^2 - 10.8(10.8-7.2)}{2\cdot(10.5)\cdot(3.6)} = 0.9440 \Rightarrow \sin\alpha = 0.3299$$

$$\cos\beta = \frac{(10.5)^2 + 10.8(10.8-2\cdot 3.6)}{2\cdot(10.5)(10.8-3.6)} = 0.9863 \Rightarrow \sin\beta = 0.1650$$

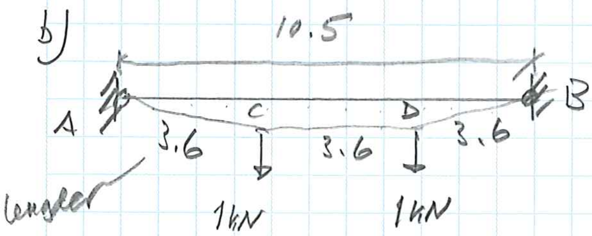
Og dermed:

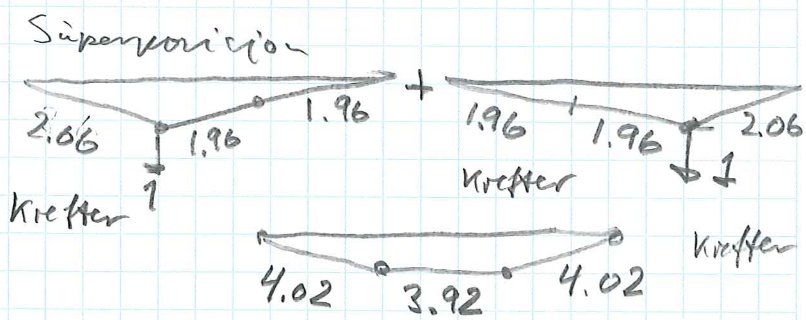
$$N_{AC} = \frac{1}{0.3299 + 0.9440\,\frac{0.1650}{0.9863}} = 2.05\ kN \quad (2.06)$$

$$N_{BC} = \frac{1}{0.1650 + 0.9863\,\frac{0.3299}{0.9440}} = 1.96\ kN$$

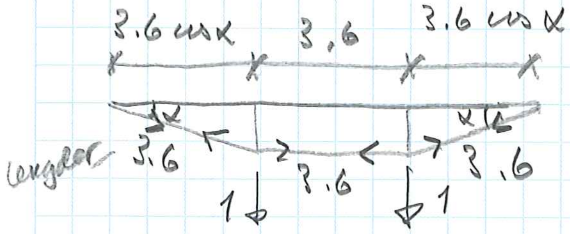
$$\Delta = 3.6 \cdot 0.3299 = 1.188\ m \qquad (\Delta = x \sin\alpha)$$

b)





Likevekt:



$$(3.6 \cos\alpha)\cdot 2 + 3.6 = 10.5$$

$$\cos\alpha = 0.95833\ldots \qquad \alpha = 16.6^\circ$$

$$\uparrow \Sigma K_y = 0 \Rightarrow S_{AC}\sin\alpha = 1 \Rightarrow S_{AC} = \frac{1}{0.28565\ldots} = 3.50\ kN = N_{BD}$$

$$\rightarrow \Sigma K_x = 0 \quad S_{AC}\cos\alpha = S_{CD} \Rightarrow S_{CD} = 3.50 \cdot 0.95833\ldots = 3.35\ kN$$