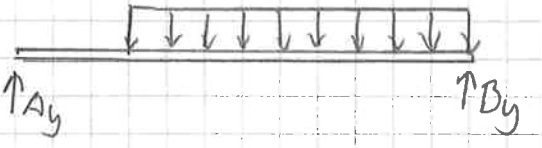
Eksamen Mekanikk 25/2-2008, Løsning

Oppg. 1

a)



$\curvearrowright \Sigma M_A = 0$ gir $25 \cdot 1{,}5 \cdot 1{,}25 - B_y \cdot 2{,}0 = 0 \Rightarrow \underline{B_y = 23{,}4\,kN}$

$\Sigma F_y = 0$ gir $A_y + 23{,}4 - 25 \cdot 1{,}5 = 0 \Rightarrow \underline{A_y = 14{,}1\,kN}$

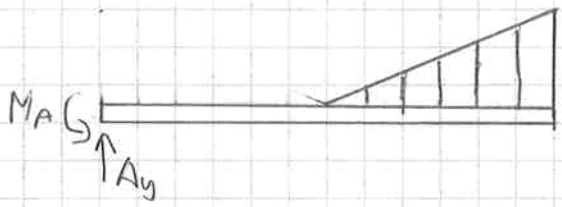
b)

$\Sigma \vec{F}_x = 0$ gir $A_x - 80 \cdot \cos 60^\circ = 0 \Rightarrow \underline{A_x = 40\,kN}$

$\curvearrowleft \Sigma M_A = 0$ gir $1{,}0 \cdot 80 \sin 60 - B_y \cdot 2{,}0 = 0 \Rightarrow \underline{B_y = 34{,}6\,kN}$

$\uparrow \Sigma F_y = 0$ gir $A_y + 34{,}6 - 80 \sin 60^\circ = 0 \Rightarrow \underline{A_y = 34{,}6\,kN}$

c)



$\uparrow \Sigma F_y = 0$ gir $\underline{A_y} = \frac{1}{2} 20 \cdot 1{,}0 = \underline{10\,kN}$

$\curvearrowleft \Sigma M_A = 0$ gir $\underline{M_A} = \frac{1}{2} \cdot 20 \cdot 1{,}0 \cdot 1{,}67 = \underline{16{,}7\,kNm}$

Oppgave 2

a) Loddets vekt: $G_1 = \rho g h \cdot \frac{\pi}{4} d^2 = 2{,}3 \cdot 9{,}81 \cdot 1{,}5 \cdot \frac{\pi}{4} \cdot 1{,}5^2 = \underline{59{,}8\,kN}$

Dimensjoneringskriterium: $\frac{F_F}{F_x} = 1{,}8$

$F_F = M F_N = 0{,}25(59{,}8 - F \sin 30)$

$F_x = F \cdot \cos 30$

$\Rightarrow \quad 0{,}25(59{,}8 - F \sin 30) = 1{,}8 \cdot F \cdot \cos 30$

$14{,}95 = F(1{,}8 \cdot \cos 30 + 0{,}25 \cdot \sin 30)$

$\underline{\underline{F = 8{,}88\,kN}}$

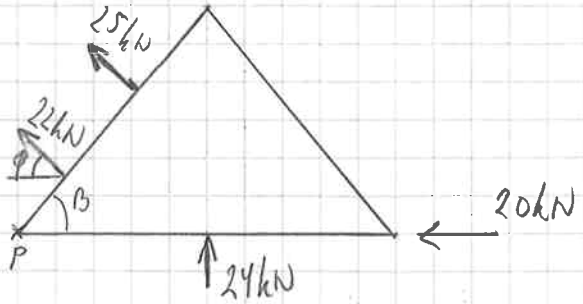
b) Dimensjoneringskriterium: $\frac{M_S}{M_V} = 1{,}8$

$M_S = 59{,}8 \cdot 0{,}75 = 44{,}85\,kNm$

$M_V = 1{,}7 \cdot F \cdot \cos 30° + 0{,}75 \cdot F \cdot \sin 30° = 1{,}85F$

$1{,}8 \cdot 1{,}85F = 44{,}85 \quad \Rightarrow \quad \underline{\underline{F = 13{,}5\,kN}}$

c)



$\tan\beta = \frac{3,0}{2,5} \Rightarrow \underline{\beta = 50,2°} \Rightarrow \underline{\varphi} = 90 - \beta = \underline{39,8°}$

$(\leftarrow)\quad F_{Rx} = 20 + 22\cos 39,8° + 25\cos 39,8° = 56,1\,kN$

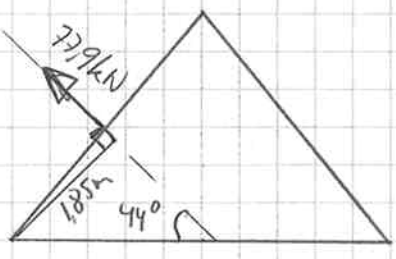
$(\uparrow)\quad F_{Ry} = 24 + 22\sin 39,8° + 25\sin 39,8° = 54,1\,kN$

$\underline{\underline{F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2} = 77,9\,kN}}$

$\tan\alpha_R = \frac{F_{Ry}}{F_{Rx}} = \frac{54,1}{56,1} = 0,96 \Rightarrow \underline{\underline{\alpha_R = 44,0°}}$

$F_R \cdot a_R = 22 \cdot 1,0 + 25 \cdot 2,5 + 24 \cdot 2,5 = 144,5$

$\underline{\underline{a_R = \frac{144,5}{77,9} = 1,85\,m}}$



d)

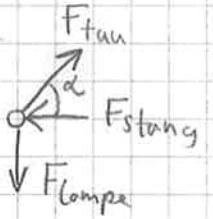
oppg	Antall ukjente (r)	Antall element (e)	r = 3e ?
1	3	1	r = 3e dvs statisk bestemt
2	4	1	r > 3e dvs statisk ubestemt
3	10	3	r > 3e dvs statisk ubestemt
4	6	2	r = 3e dvs statisk bestemt
5	6	2	r = 3e dvs statisk bestemt
6	3	1	r = 3e dvs statisk bestemt

Oppgave 3

a) Stålkabelens retning:

$$\tan\alpha = \frac{0,6}{1,2} \Rightarrow \alpha = 26,6°$$

Likevekt av knutepunkt A:



$$\Sigma F_y = 0 \text{ gir } F_{tau} \cdot \sin\alpha = F_{kompa}$$

$$F_{tau} = \frac{2,0}{\sin 26,6°} = 4,47\,kN$$

$$\Sigma F_x = 0 \text{ gir } \underline{\underline{F_{stang}}} = F_{tau} \cdot \cos\alpha = \frac{2,0}{0,5} = \underline{\underline{4,0\,kN}}$$

b) Dimensjoneringskriterium:

$$F_{stang} = F_K / n$$

$$F_K = \frac{\pi^2 E I}{l_k^2} \quad \text{og} \quad I = \frac{\pi}{64} d^4 \text{ (for massiv sirkulær stang)}$$

$$\Rightarrow F_{stang} = \frac{\pi^2 E I}{n l_k^2} = \frac{\pi^3 E d^4}{64 n l_k^2}$$

$$\Rightarrow \underline{\underline{d}} = \sqrt[4]{\frac{64 n l_k^2 F_{stang}}{\pi^3 E}} = \sqrt[4]{\frac{64 \cdot 2,0 \cdot 4000^2 \cdot 4000}{\pi^3 \cdot 206000}} = \underline{\underline{33,7\,mm}}$$

Velger derfor Ø35

c) Hookes lov:

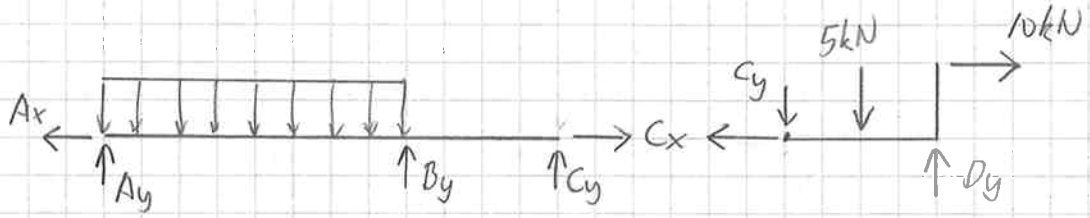
$$\sigma = E\varepsilon$$

$$\Rightarrow \frac{F}{A} = E\frac{\Delta l}{l}$$

$$\underline{\underline{\Delta l}} = \frac{Fl}{AE} = \frac{Fl}{\frac{\pi}{4}d^2E} = \frac{4\cdot 4000\cdot 4000}{\pi\cdot 35^2\cdot 206000} = \underline{\underline{0{,}08\,mm}}$$

Oppgave 4

a) Fritt-legeme-diagram



b) Høyre del:

$\sum \tilde{M}_D = 0$ gir $-C_y\cdot 2 + 10\cdot 1 - 5\cdot 1 = 0 \Rightarrow \underline{C_y = 2{,}5kN}$

$\sum F_x = 0$ gir $\underline{C_x = 10kN}$, $\sum F_y = 0$ gir $\underline{D_y} = C_y + 5 = \underline{7{,}5kN}$

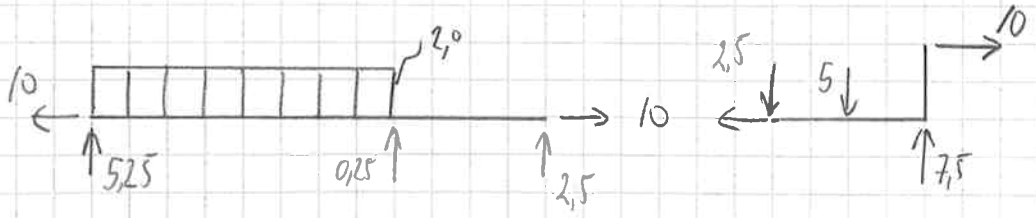
Venstre del:

$\sum \tilde{M}_B = 0$ gir $A_y\cdot 4 - 2\cdot 2\cdot 4 - C_y\cdot 2 = 0 \Rightarrow \underline{A_y = 5{,}25kN}$

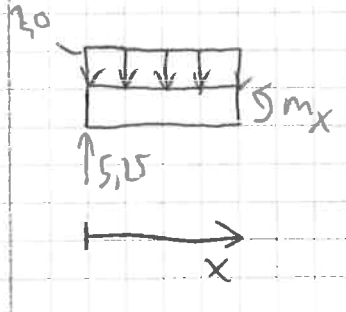
$\sum F_y = 0$ gir $A_y + B_y + C_y = 2\cdot 4 \Rightarrow \underline{B_y = 0{,}25kN}$

$\sum F_x = 0$ gir $A_x = 10kN$

Belastningsdiagram:



c) Indre bøyemoment mellom A og B:



$\sum \hat{M}_x = 0$ gir $m_x = 5{,}25x - 2{,}0 \cdot x \cdot \frac{x}{2}$

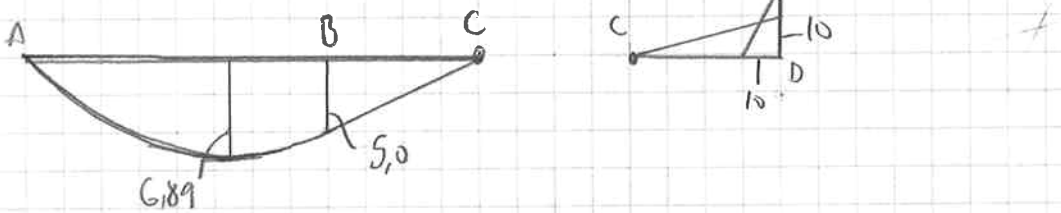
$= 5{,}25x - x^2$

$m_x' = 5{,}25 - 2x$

$m_x' = 0$ gir $5{,}25 - 2x = 0 \Rightarrow x = 2{,}625\,m$

$x = 2{,}625 \Rightarrow m_x = 5{,}25 \cdot 2{,}625 - 2{,}625^2 = 6{,}89\,kNm$

M_B-diagram:



d) Største bøyemoment: $M_B = 10\,kNm$

$\sigma_B = \frac{M_B}{W} \Rightarrow W = \frac{10 \cdot 10^6}{160} = 62500\,mm^3 = 62{,}5\,cm^3$

INP140 har $W_x = 81{,}9\,cm^3$ og $A = 18{,}3\,cm^2$

Sjekker aksialspenningene: $\sigma_A = \frac{F}{A} = \frac{10000}{1830} = 5{,}46\,MPa$

$\sigma_B = \frac{M_B}{W} = \frac{10 \cdot 10^6}{81{,}9 \cdot 10^3} = 122{,}1\,MPa$

$\sigma_A + \sigma_B = 127{,}6\,MPa < 160\,MPa$

Dvs INP140 kan brukes