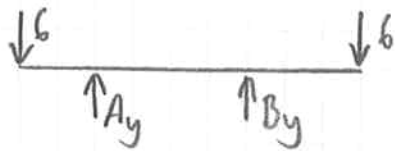
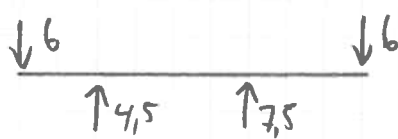


1a) FLD:



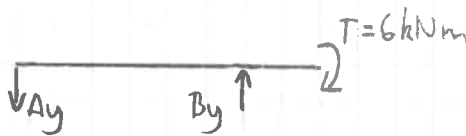
$$\begin{aligned} \sum M_A = 0 &\Rightarrow 6 \cdot 3,5 - B_y \cdot 2 - 6 \cdot 1 = 0 \\ &\Rightarrow \underline{B_y = 7,5 \text{ kN}} \end{aligned}$$

BD:



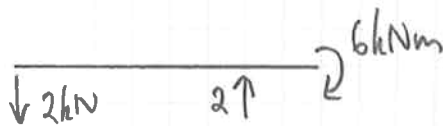
$$\begin{aligned} \sum F_y = 0 &\Rightarrow A_y + 7,5 - 6 - 6 = 0 \\ &\Rightarrow \underline{A_y = 4,5 \text{ kN}} \end{aligned}$$

b) FLD:



$$\begin{aligned} \sum M_B = 0 &\Rightarrow A_y \cdot 3 + 6 = 0 \\ &\Rightarrow \underline{A_y = 2 \text{ kN}} \end{aligned}$$

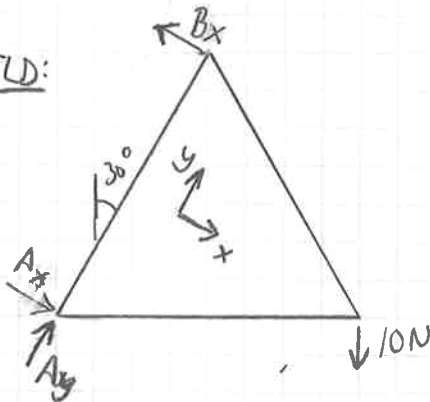
BD:



$$\sum F_y = 0 \Rightarrow A_y = B_y$$

c)

FLD:



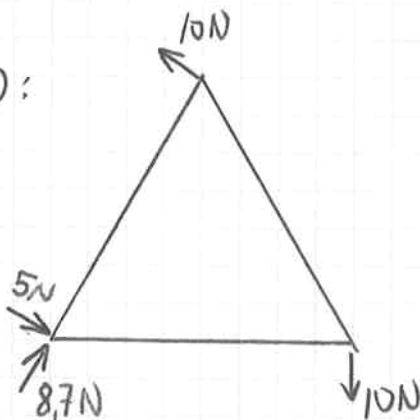
Legger inn et koordinatsystem på skrå.

$$\begin{aligned} \sum M_A = 0 &\Rightarrow 10 \cdot 0,4 - B_x \cdot 0,4 = 0 \\ &\Rightarrow \underline{B_x = 10 \text{ N}} \end{aligned}$$

$$\begin{aligned} \sum F_y = 0 &\Rightarrow A_y - 10 \cos 30 = 0 \\ &\Rightarrow \underline{A_y = 8,7 \text{ N}} \end{aligned}$$

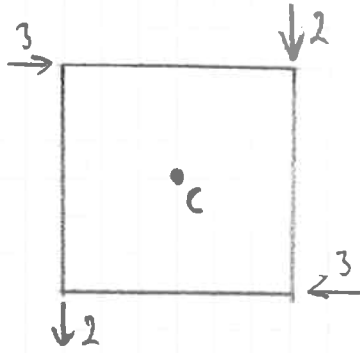
$$\begin{aligned} \sum F_x = 0 &\Rightarrow A_x - 10 + 10 \sin 30 = 0 \\ &\Rightarrow \underline{A_x = 5 \text{ N}} \end{aligned}$$

BD:



* Ax og Ay trenger ikke være skråstilt!

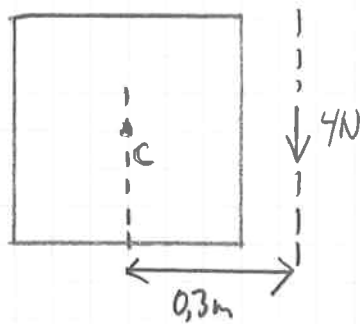
d)



$$R = 4 \text{ N (nedover)}$$

$$\sum M_c = 3 \cdot 0,2 \cdot 2 = 1,2 \text{ Nm}$$

$$a_R = \frac{\sum M_c}{R} = \frac{1,2}{4} = 0,3 \text{ m}$$

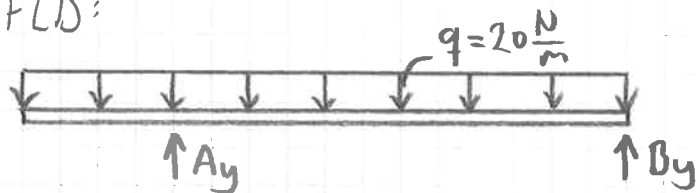


Oppgave 2

$$a) \quad q = \rho g h b \Rightarrow h = \frac{q}{\rho g b} = \frac{20000 \frac{\text{N}}{\text{m}}}{800 \frac{\text{kg}}{\text{m}^3} \cdot 9,81 \frac{\text{N}}{\text{kg}} \cdot 1,2 \text{ m}} = 2,12 \text{ m}$$

b)

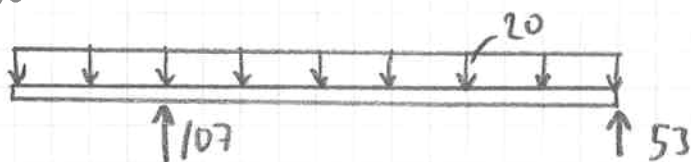
FLD:



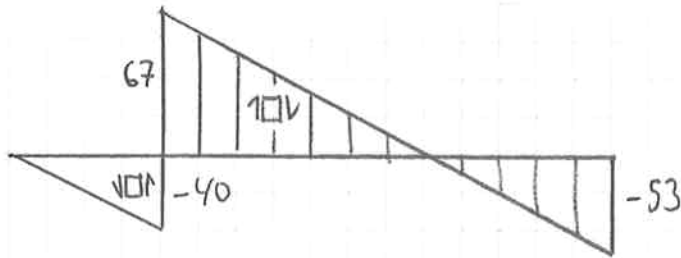
$$\sim \sum M_B = 0 \Rightarrow A_y \cdot 6 - 20 \cdot 8 \cdot 4 = 0 \Rightarrow A_y = 107 \text{ kN}$$

$$\uparrow \sum F_y = 0 \Rightarrow 107 + B_y - 20 \cdot 8 = 0 \Rightarrow B_y = 53 \text{ kN}$$

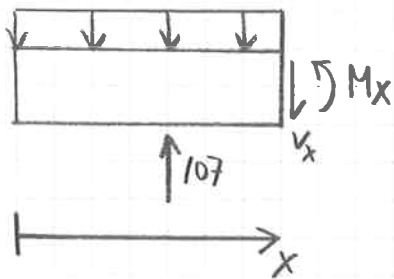
BD



c) V-diagram



$$x \in \langle 2, 8 \rangle:$$



$$M_x = 107(x-2) - 20x \cdot \frac{x}{2}$$

$$= -10x^2 + 107x - 214$$

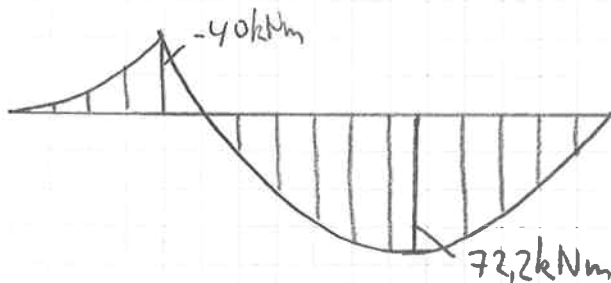
$$M_x' = -20x + 107$$

$$M_x' = 0 \Rightarrow x = 5,35$$

$$x = 5,35 \Rightarrow M_x = 72,2 \text{ kNm}$$

$$x = 2 \Rightarrow M_x = -40 \text{ kNm}$$

M-diagram



d)

$$\sigma_{\text{tillatt}} = \frac{R_e}{n} = \frac{355}{1,4} = 253,6 \text{ MPa}$$

$$\sigma_{\text{tillatt}} = \frac{M_{\text{dim}}}{I_{\text{krav}}} \cdot y_0 \Rightarrow I_{\text{krav}} = \frac{M_{\text{dim}}}{\sigma_{\text{tillatt}}} \cdot y_0 = \frac{72,2 \cdot 10^6}{253,6} \cdot 90$$

$$I_{\text{krav}} = 2562 \text{ cm}^4$$

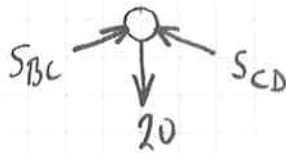
Velger HVP 180x180x10 med $I = 3017 \text{ cm}^4$

Oppgave 3

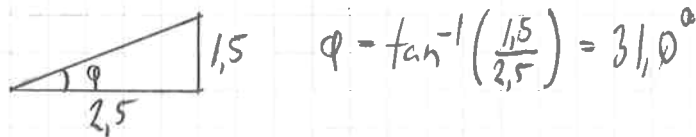
- a) Antall elementer : $e = 4$
Antall likninger : $3e = 12$
Antall reaksjoner : $r = 3 + 2 + 2 + 2 + 3 = 12$

$3e = r$ dvs statisk likerekt

Knutepunkt C:



- Elementene BC og CD får kun aksiallast (staver)
- Symmetri tilfører at $S_{BC} = S_{CD}$

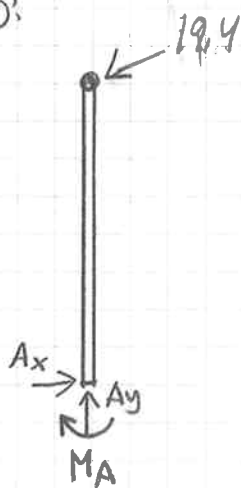


$$\uparrow \sum F_y = 0 \Rightarrow 2 \cdot S_{BC} \cdot \sin 31^\circ - 20 = 0 \Rightarrow S_{BC} = 19,4 \text{ kN}$$

b) Element AB:

$$B_y = 10, B_x = 10 \cdot \frac{2,5}{1,5} = 16,7 \text{ kN}$$

FLD:

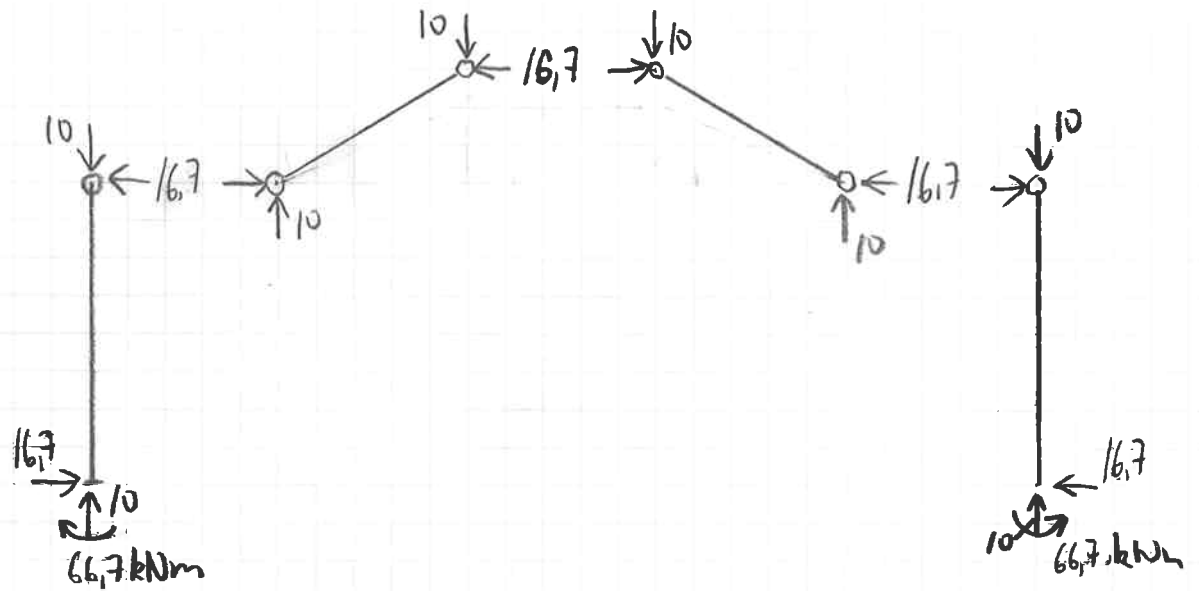


$$\Rightarrow \sum F_x = 0 \Rightarrow A_x - 16,7 = 0$$
$$\underline{A_x = 16,7 \text{ kN}}$$

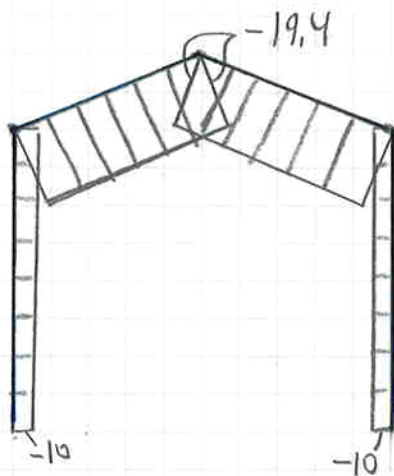
$$\uparrow \sum F_y = 0 \Rightarrow A_y - 10 = 0$$
$$\underline{A_y = 10 \text{ kN}}$$

$$\curvearrow \sum M_A = 0 \Rightarrow M_A - 16,7 \cdot 4 = 0$$
$$\underline{M_A = 66,7 \text{ kNm}}$$

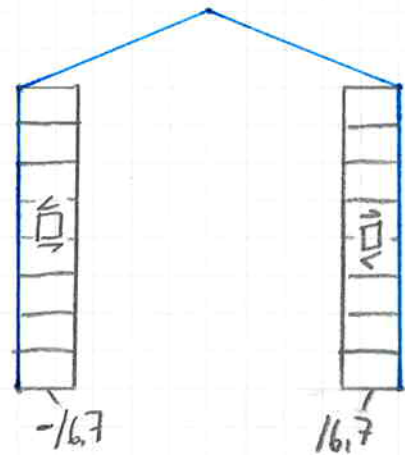
Belastningsdiagram (kan givas på forskjellige måter)



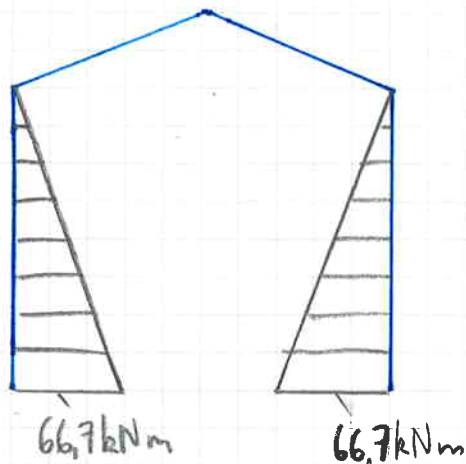
c) N-diagram:



V-diagram:



M-diagram:



d) $M_{Dim} = 66,7 \text{ kNm}$, $N = 10 \text{ kN}$

HUP 200 x 200 x 10; $A = 7260 \text{ mm}^2$

$I = 4251 \cdot 10^4 \text{ mm}^4$

$$\sigma_{st\ddot{a}rkt} = \frac{M}{I} y + \frac{N}{A} = \frac{66,7 \cdot 10^6}{4251 \cdot 10^4} \cdot 100 + \frac{10 \cdot 10^3}{7260} = 156,9 + 1,4$$

$\sigma_{st\ddot{a}rkt} = 158,3 \text{ MPa}$

$$n = \frac{R_e}{\sigma_{st\ddot{a}rkt}} = \frac{355}{158,3} = 2,24$$

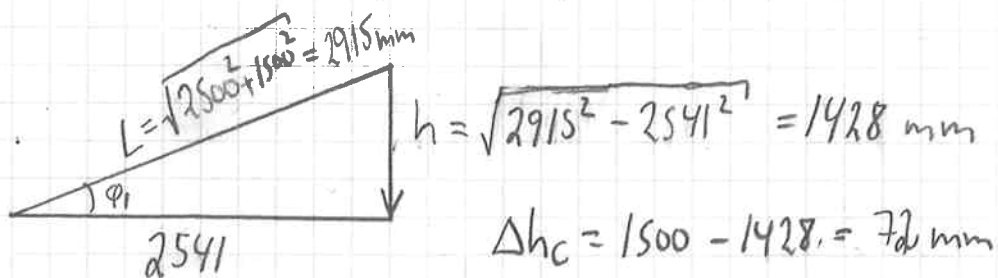
e)



$$u_{max} = \frac{FL^3}{3EI} = \frac{16700 \cdot 4000^3}{3 \cdot 206000 \cdot 4251 \cdot 10^4} = 40,7 \text{ mm}$$

f) Forkortelse AB: $\Delta L = \frac{FL}{EA} = \frac{10000 \cdot 4000}{206000 \cdot 7260} = 0,03 \text{ mm}$ (neglisjerbar)

Forkortelse BC: $\Delta L = \frac{FL}{EA} = \frac{19470 \cdot 2915}{206000 \cdot 7260} = 0,04 \text{ mm}$ (neglisjerbar)



Fordytningen av C gir større stankrefter som gir større utbygning av B og større momenter i A
 Hvis disse skal beregnes må vi iterere

$$1) \quad B_x = 10 \cdot \frac{2541}{1428} = 17,8 \text{ kN} \Rightarrow u_B = 40,7 \cdot \frac{17,8}{16,7} = 43,5 \text{ mm}$$

$$\Rightarrow h_c = \sqrt{2915^2 - 2543,5^2} = 1424 \text{ mm}$$

$$2) \quad B_x = 10 \cdot \frac{2543,5}{1424} = 17,9 \text{ kN} \quad (\text{trenge ihu iterere mer})$$

$$M_A = M_E = 17,9 \cdot 4 = \underline{71,4 \text{ kNm}}$$

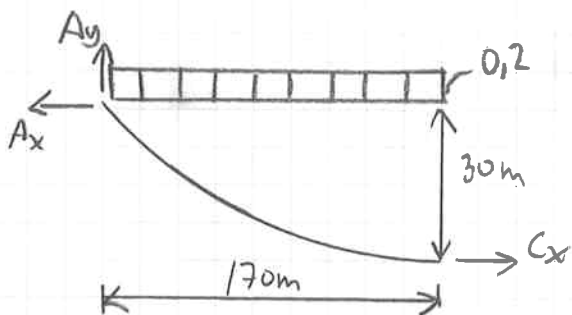
Oppgave 4

a) Kabelens lengde:

$$s = L + \frac{8P_0^2}{3L} = 340 + \frac{8 \cdot 30^2}{3 \cdot 340} = 347 \text{ m}$$

$$q = q_0 \frac{s}{L} = 20 \cdot 9,81 \cdot \frac{347}{340} = 200 \text{ N/m} = 0,2 \text{ kN/m}$$

Ser på halve kabelen:



$$\sum M_A = 0 \Rightarrow 0,2 \cdot 170 \cdot 85 - 30 \cdot C_x = 0$$
$$\Rightarrow \underline{C_x = 96,3 \text{ kN}}$$

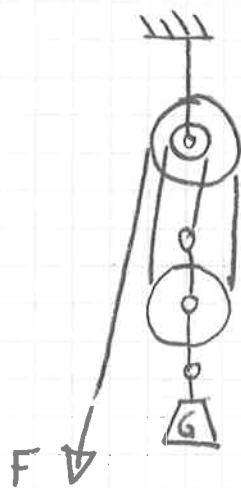
$$\underline{A_x = C_x}$$

$$\sum M_C = 0 \Rightarrow A_y \cdot 170 - 96,3 \cdot 30 - 0,2 \cdot 170 \cdot 85 = 0 \Rightarrow \underline{A_y = 34 \text{ kN}}$$

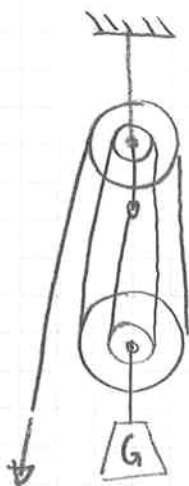
$$A = \sqrt{96,3^2 + 34^2} = \underline{102 \text{ kN}}$$

$$\varphi_A = \tan^{-1}\left(\frac{34}{96,3}\right) = \underline{19,4^\circ}$$

b)



3-skärer



4-skärer

En firskärs talje ökar lyftkraften fyra gånger men reducerar lyftshöjden fyra gånger