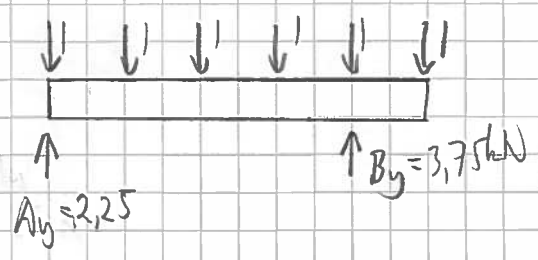
MEKANIKK, Eksamen 18.12.2012 Løsning

Oppgave 1

a)



$\curvearrowright \sum M_A = 0 \Rightarrow (1+2+3+4+5) \cdot 1 - B_y \cdot 4 = 0$

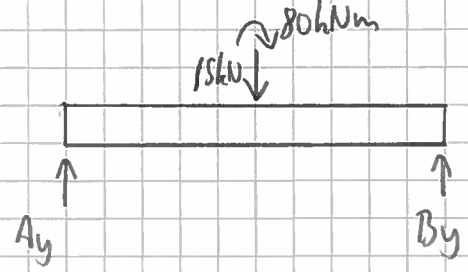
$B_y = 3,75$

$\uparrow \sum F_y = 0 \Rightarrow 3,75 + A_y - 6 = 0$

$A_y = 2,25$

b)

FLD:



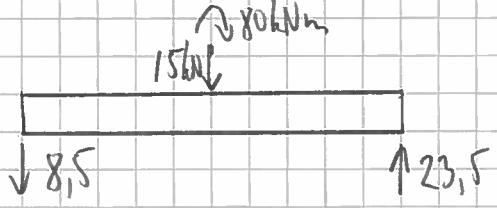
$\curvearrowright \sum M_A = 0 \Rightarrow 15 \cdot 2,5 + 80 - 5 \cdot B_y = 0$

$B_y = 23,5$

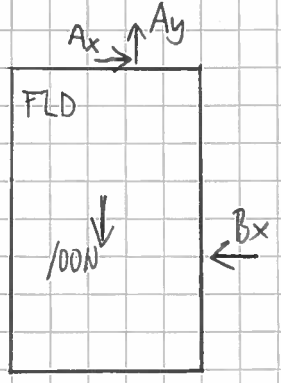
$\uparrow \sum F_y = 0 \Rightarrow A_y + 23,5 - 15 = 0$

$A_y = -8,5$

BD:



c)



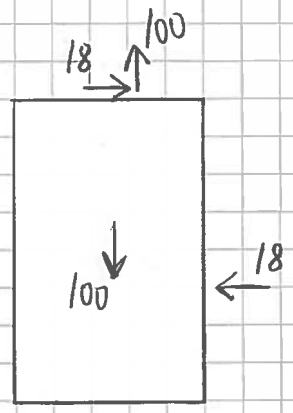
$\curvearrowright \sum M_A = 0 \Rightarrow B_x \cdot 250 - 100 \cdot 45 = 0$

$B_x = 18N$

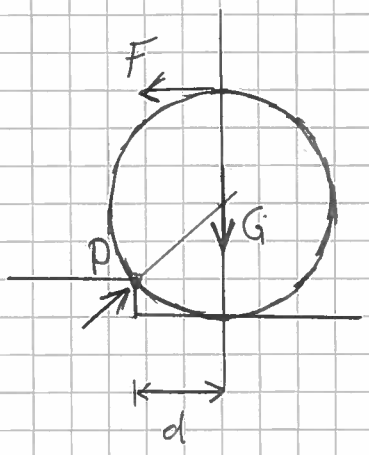
$\sum F_x = 0 \Rightarrow A_x = B_x$

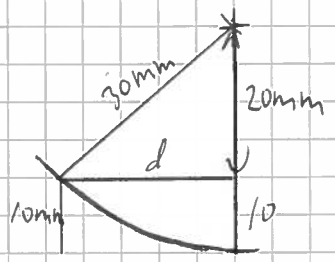
$\uparrow \sum F_y = 0 \Rightarrow A_y = G$

BD:



d)





Bestemmer posisjonen d til "veltepunktet":

$$d = \sqrt{30^2 - 20^2} = 22{,}4\,mm$$

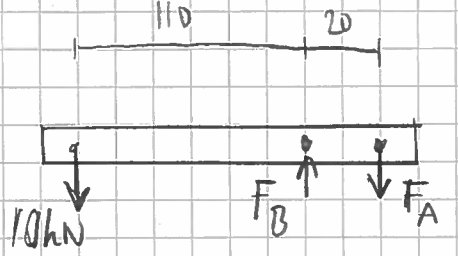
I det klossen løfter seg er det kun F og G som gir momentlikevekt om P

$$\left.\begin{aligned} M_S &= 10 \cdot 22{,}4 = 224\,Nmm \\ M_V &= F \cdot 50 \end{aligned}\right\} \quad M_S = M_V$$

$$M_S = M_V \Rightarrow \quad F = 224/50 = \underline{\underline{4{,}47\,N}}$$

Oppgave 2

a)



$\curvearrowleft \Sigma M_B = 0 \Rightarrow F_A \cdot 0{,}2 - 10 \cdot 1{,}1 = 0 \Rightarrow F_A = 55\,kN$

$\uparrow \Sigma F_y = 0 \Rightarrow F_B - 10 - 55 = 0 \Rightarrow F_B = 65\,kN$

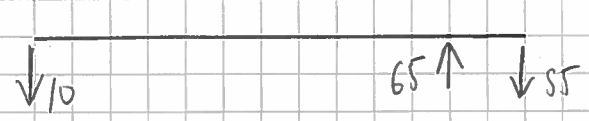
$$\tau_{BOLT} = \frac{65000}{\frac{\pi}{4} 16^2} = 323\,MPa$$

$$\sigma_j = \sqrt{3}\,\tau = 560\,MPa$$

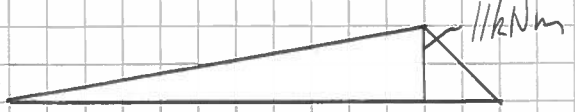
$$n_{Flyt} = \frac{640}{560} = 1{,}14$$

b)

BD:

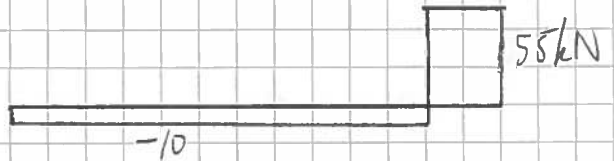


M:



$$\sigma_{B_{max}} = \frac{11 \cdot 10^6}{\frac{1}{6} \cdot 10 \cdot 150^2} = 293\,MPa$$

V:

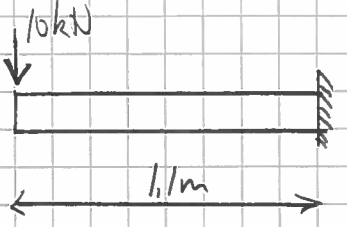


$$\tau_{max} = 1{,}5\,\frac{V}{A} = 1{,}5 \cdot \frac{55000}{150 \cdot 10} = 55\,MPa$$

$$\sigma_j = \sqrt{3}\,\tau = 95\,MPa$$

$$n_{Flyt} = \frac{355}{293} = 1{,}2$$

c)

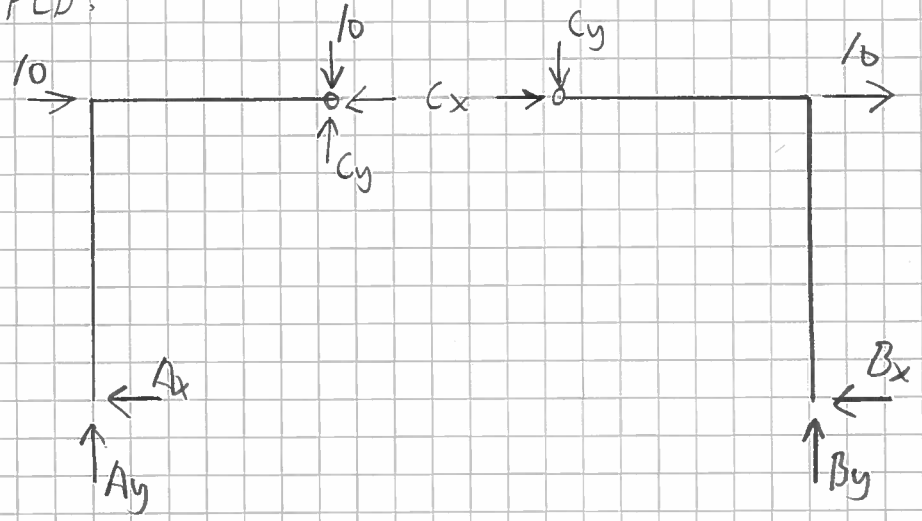


$$u_{MAKS} = \frac{FL^3}{3EI} = \frac{10000 \cdot 1100^3}{3 \cdot 210000 \cdot \frac{1}{12} \cdot 10 \cdot 150^3} = \underline{\underline{7,5\ mm}}$$

(N, mm^3; $\frac{N}{mm^2}$, mm^4)

Oppgave 3

a) FLD:



Likevekt av hele konstr:

$\curvearrowright \Sigma M_A = 0 \Rightarrow 2 \cdot 10 \cdot 2 + 10 \cdot 1{,}6 - B_y \cdot 3{,}2 = 0 \quad \Rightarrow \underline{B_y = 17{,}5 kN}$

$\uparrow \Sigma F_y = 0 \Rightarrow A_y + 17{,}5 - 10 = 0 \quad \Rightarrow \underline{A_y = -7{,}5 kN}$

Likevekt av venstre halvdel:

$\curvearrowright \Sigma M_c = 0 \Rightarrow (-7{,}5) \cdot 1{,}6 + A_x \cdot 2 = 0 \quad \Rightarrow \underline{A_x = 6 kN}$

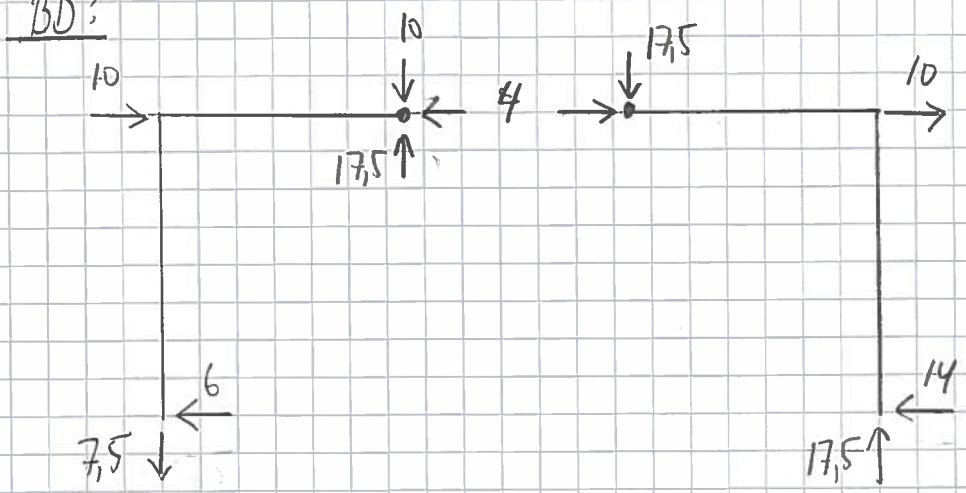
$\uparrow \Sigma F_y = 0 \Rightarrow (-7{,}5) + C_y - 10 = 0 \quad \Rightarrow \underline{C_y = 17{,}5 kN}$

$\rightarrow \Sigma F_x = 0 \Rightarrow 10 - 6 - C_x = 0 \quad \Rightarrow \underline{C_x = 4 kN}$

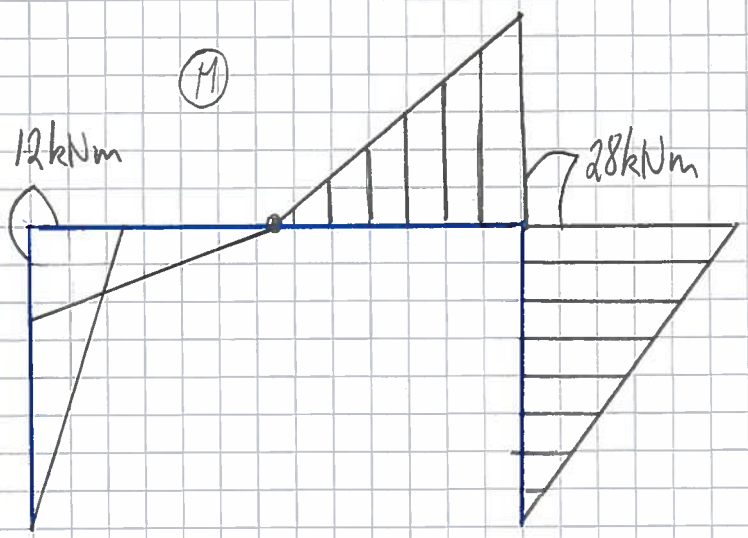
Likevekt av hele konstr:

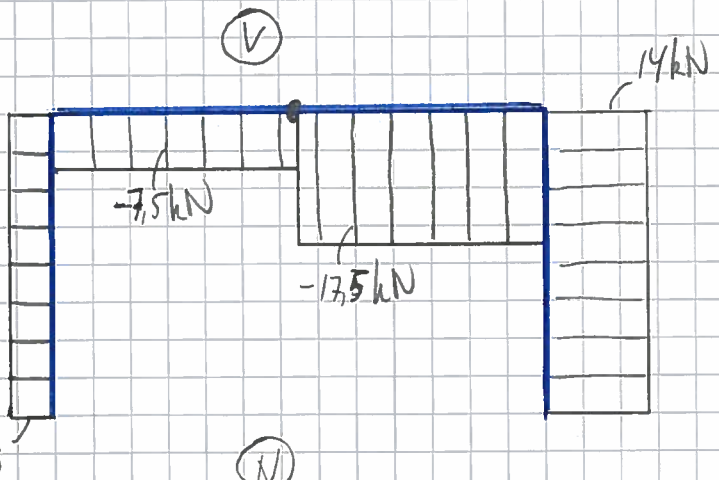
$\rightarrow \Sigma F_x = 0 \Rightarrow 4 + 10 - B_x = 0 \quad \Rightarrow \underline{B_x = 14 kN}$

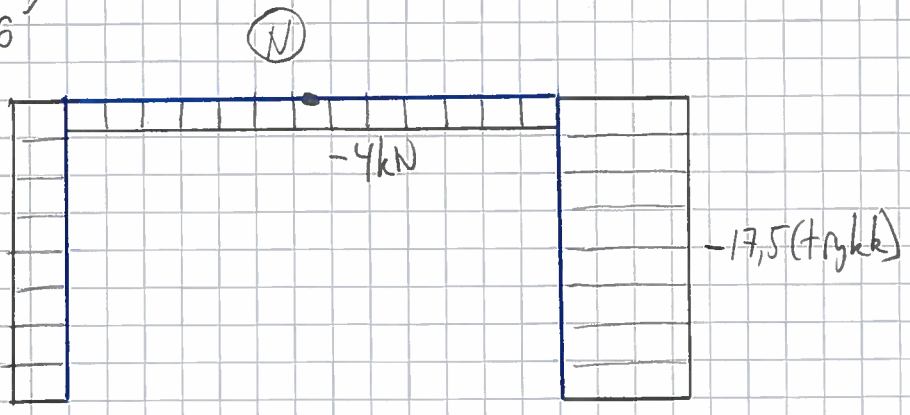
BD:


10
10
17,5
4
17,5
10
6
7,5
14
17,5

b)


M
12kNm
28kNm


V
14kN
-7,5kN
-17,5kN
6


N
-4kN
7,5
-17,5 (trykk)

c) $\sigma_{tillatt} = \frac{R_e}{n} = \frac{355}{1,35} = 263\,MPa$

$W_{krav} = \frac{M_{dim}}{\sigma_{tillatt}} = \frac{28 \cdot 10^6}{263} = 106,4\,cm^3$

Prøver IPE160 med $W_y = 109\,cm^3$ og $A = 20,1\,cm^2$

$\sigma_A = \frac{N}{A} = \frac{17500}{2010} = 8,7\,MPa$

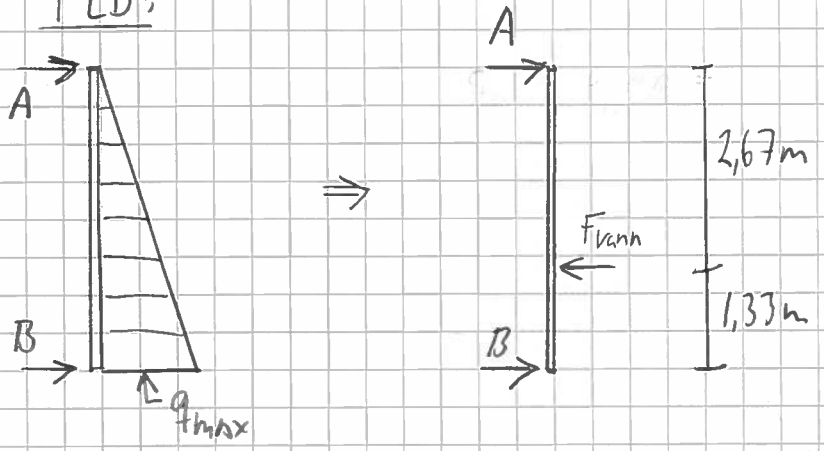
$\sigma_B = \frac{M}{W} = \frac{28 \cdot 10^6}{109 \cdot 10^3} = 256,9\,MPa$

$\sigma_A + \sigma_B = 265,6\,MPa > \sigma_{tillatt}$

Velger <u>IPE180</u>

Oppgave 4

a) FLD:



$$q_{fmax} = \rho g h b = 1{,}025 \cdot 9{,}81 \cdot 4 \cdot 0{,}6 = 24{,}1 \text{ kN/m}$$

Regner om den fordelte lasten til en punktlast:

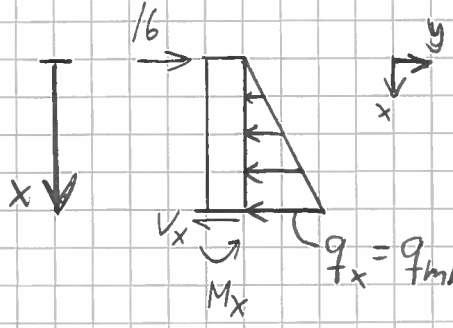
$$F_{vann} = \frac{1}{2} \cdot q_{fmax} \cdot h = \frac{1}{2} \cdot 24{,}1 \cdot 4 = 48{,}2 \text{ kN}$$

Angrepspunkt er $\frac{2}{3}$ fra toppen

$$\curvearrowleft \sum M_A = 0 \Rightarrow 48{,}2 \cdot 2{,}67 - B \cdot 4 = 0 \Rightarrow \underline{B = 32{,}2 \text{ kN}}$$

$$\rightarrow \sum F_x = 0 \Rightarrow A + 32{,}2 - 48{,}2 = 0 \Rightarrow \underline{A = 16{,}0 \text{ kN}}$$

b)

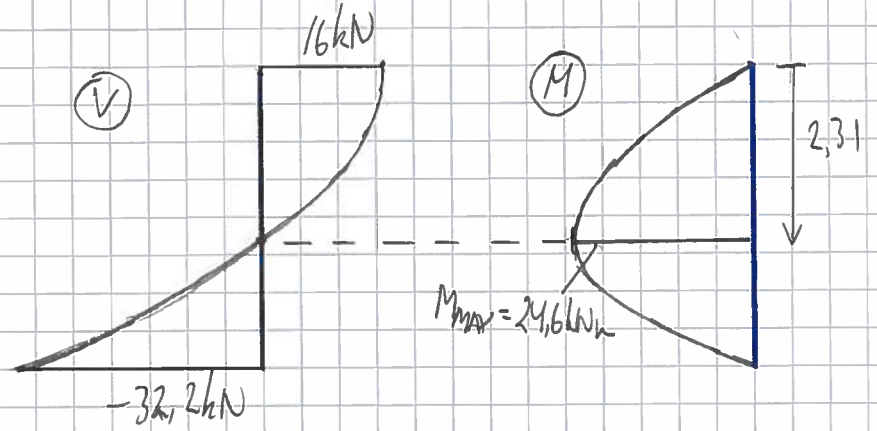


$$\rightarrow \sum F_y = 0 \Rightarrow 16 - V_x - \frac{1}{2} \cdot 6{,}03x \cdot x = 0 \Rightarrow \underline{V_x = 16 - 3{,}0x^2}$$

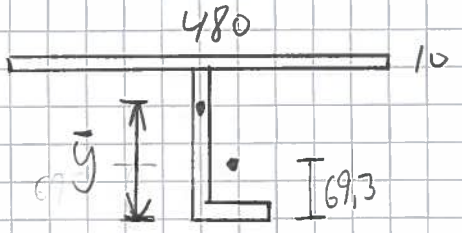
$$\curvearrowleft \sum M_x = 0 \Rightarrow 16x - \frac{1}{2} 6{,}03x \cdot x \cdot \frac{1}{3} x - M_x = 0 \Rightarrow \underline{M_x = 16x - 1{,}0x^3}$$

$V_x = 0 \Rightarrow 16 - 3x^2 = 0 \Rightarrow x = 2{,}31\,m$

$\Rightarrow M_x = 16 \cdot 2{,}31 - 2{,}31^3 = 24{,}6\,kNm$ (max. verdi)



c)



L 200×100×10

$C_y = 69{,}3\,mm$

$I_y = 1220\,cm^4$

$A = 2920\,mm^2$

Nøytralaksens beliggenhet:

$$\bar{y} = \frac{2920 \cdot 69{,}3 + 4800 \cdot 205}{2920 + 4800} = 153{,}7\,mm$$

Annet arealmoment om N.A:

$$I_y = 12{,}2 \cdot 10^6 + 2920 \cdot \underbrace{(153{,}7 - 69{,}3)}_{84{,}4}{}^2 + 4800 \cdot \underbrace{(205 - 153{,}7)}_{51{,}3}{}^2 = 45{,}6 \cdot 10^6\,mm^4$$

$$\sigma_{B,max} = \frac{M_{dim}}{I_y} z_u = \frac{24{,}6 \cdot 10^6}{45{,}6 \cdot 10^6} \cdot 153{,}7 = 82{,}9\,MPa$$