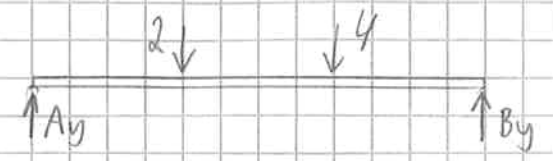
Mekanikk, ordinær eksamen 2008

LØSNING

Oppgave 1

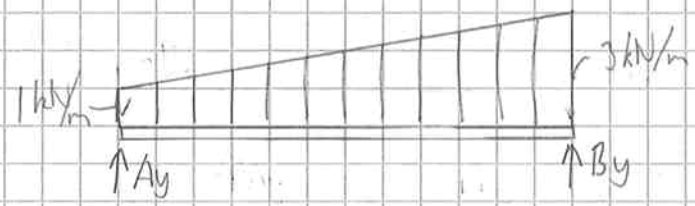
a)



$\curvearrowright \Sigma \tilde{M}_A = 0$ gir $2 \cdot 2 + 4 \cdot 4 - B_y \cdot 6 = 0 \Rightarrow \underline{B_y = 3{,}33 kN}$

$\uparrow \Sigma F_y = 0$ gir $A_y + 3{,}33 - 2 - 4 = 0 \Rightarrow \underline{A_y = 2{,}67 kN}$

b)

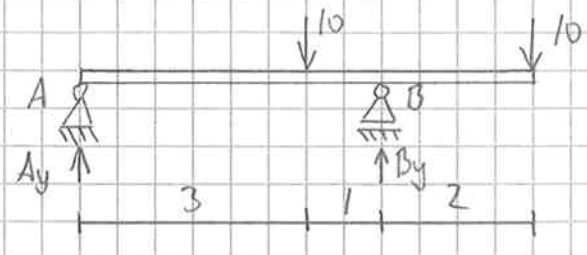


$\curvearrowright \Sigma \tilde{M}_A = 0$ gir $1 \cdot 6 \cdot 3 + \frac{1}{2} \cdot 2 \cdot 6 \cdot 4 - B_y \cdot 6 = 0 \Rightarrow \underline{B_y = 7 kN}$

$\uparrow \Sigma F_y = 0$ gir $A_y + 7 - 1 \cdot 6 - \frac{1}{2} 2 \cdot 6 = 0 \Rightarrow \underline{A_y} = 12 - 7 = \underline{5 kN}$

a)

Oppgave 2



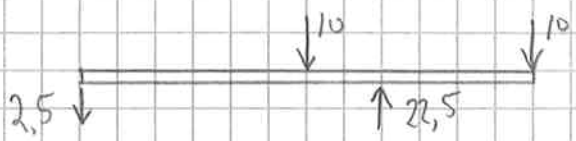
$\sum \overset{\curvearrowright}{M}_A = 0$ gir $10 \cdot 3 + 10 \cdot 6 - B_y \cdot 4 = 0$

$\Rightarrow \underline{B_y = 22{,}5 \text{ kN}}$

$\sum F_y = 0$ gir $A_y + 22{,}5 - 10 - 10 = 0$

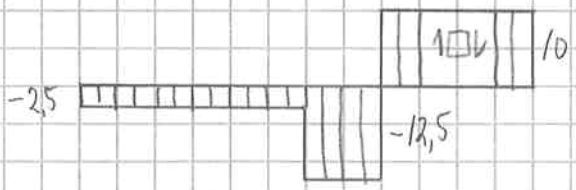
$\Rightarrow \underline{A_y = -2{,}5}$

Belastningsdiagram

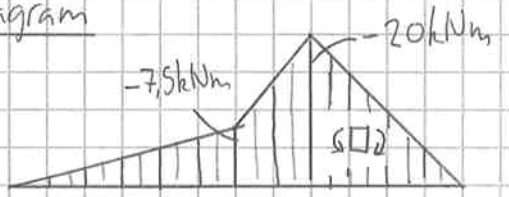


b)

V-diagram:



M-diagram



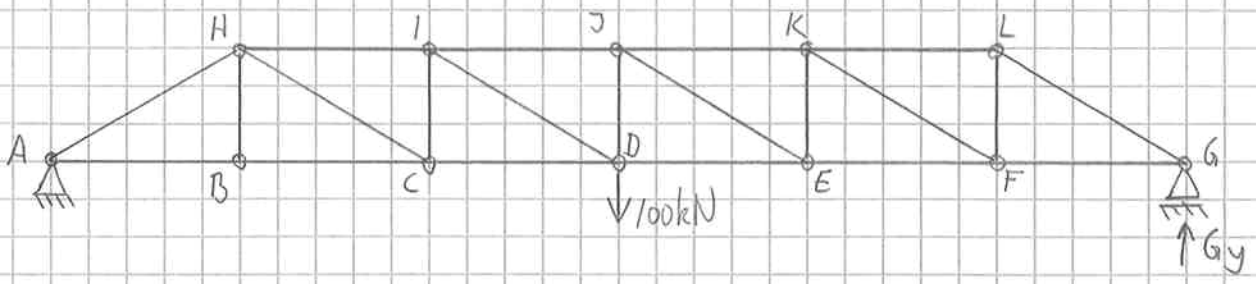
c) $\varnothing 180 \times 8$: $I_x = \frac{\pi}{64}\left(D^4 - d^4\right) = \frac{\pi}{64}\left(180^4 - 164^4\right) = 16{,}0 \cdot 10^6 \text{ mm}^4$

$$\underline{\sigma_{B,max}} = \frac{M_B}{I_x} y_u = \frac{20 \cdot 10^6}{16 \cdot 10^6} \cdot 90 = \underline{112{,}5 \text{ MPa}}$$

$$\underline{n} = \frac{160}{112{,}5} = \underline{1{,}42}$$

Oppgave 3

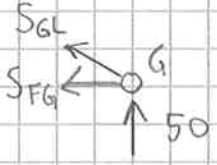
a)



$\tan\alpha = \frac{0,6}{1,0} \Rightarrow \underline{\alpha = 31^\circ}$

$\curvearrowright \Sigma M_A = 0$ gir $\cdot 100 \cdot 3 - G_y \cdot 6 = 0 \Rightarrow \underline{G_y = 50kN}$

Ser på knutepunkt G:



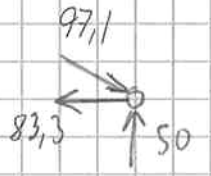
$\uparrow \Sigma F_y = 0$ gir $50 + S_{GL} \cdot \sin 31^\circ = 0$

$\Rightarrow \underline{S_{GL} = -97,1kN}$ (trykk)

$\leftarrow \Sigma F_x = 0$ gir $S_{FG} + (-97,1) \cdot \cos 31^\circ = 0$

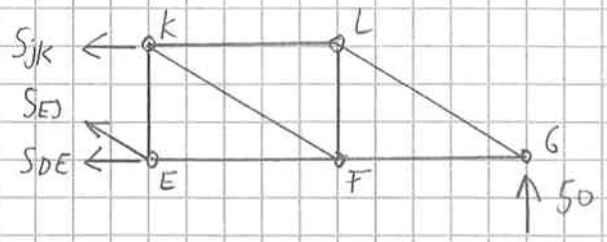
$\Rightarrow \underline{\underline{S_{FG} = 83,3kN}}$ (strekk)

Belastningsdiagram for knutepunkt G



b)

Legger inn et snitt og ser på høyre del.

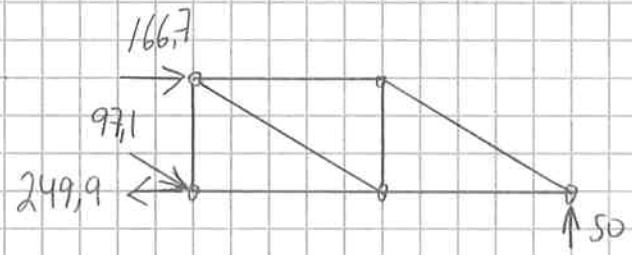


$\circlearrowleft \sum M_E = 0$ gir $S_{JK} \cdot 0{,}6 + 50 \cdot 2{,}0 = 0 \Rightarrow \underline{\underline{S_{JK} = -166{,}7\,kN}}$ (trykk)

$\uparrow \sum F_y = 0$ gir $S_{ED} \cdot \sin 31° + 50 = 0 \Rightarrow \underline{\underline{S_{ED} = -97{,}1\,kN}}$ (trykk)

$\rightarrow \sum F_x = 0$ gir $166{,}7 + 97{,}1 \cos 31° - S_{DE} = 0 \Rightarrow \underline{\underline{S_{DE} = 249{,}9\,kN}}$ (strekk)

Belastningsdiagram



c)

FB120×20 : $\underline{\underline{\sigma_A = \frac{S_{DE}}{A} = \frac{249900}{120 \cdot 20} = 104\,MPa}}$

Forlengelse : $\underline{\underline{\Delta l = \frac{\sigma l}{E} = \frac{104 \cdot 1000}{206000} = 0{,}51\,mm}}$

d) Knekklast :

Stav JK : $\underline{F_k = \frac{\pi^2 E I_0}{l_k^2} = \frac{\pi^2 206000 \cdot \frac{1}{12} \cdot 120 \cdot 20^3}{1000^2} = 162{,}7\,kN}$

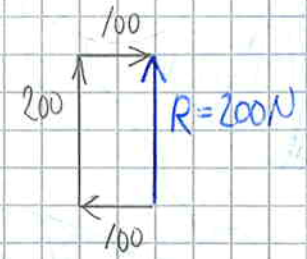
$S_{JK} > F_k$ dvs vi får elastisk knekning med FB120×20

Stav GL og EJ : $l_k = \sqrt{1000^2 + 600^2} = 1166\,mm \Rightarrow F_k = 162{,}7 \cdot \left(\frac{1000}{1166}\right)^2 = 119{,}7\,kN$

$S_{GL} = S_{ED} < F_k$ dvs ok

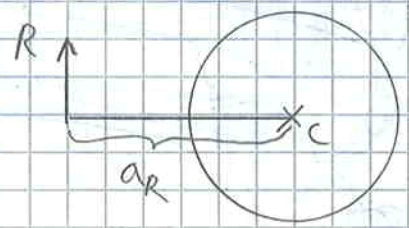
Oppgave 4

Resultantkraftens mål og retning bestemmes som vektorsummen av de tre kreftene:



Resultanten skal ha samme moment om C som enkeltmomentene tilsammen:

$$a_R = \frac{(200 + 2 \cdot 100) \cdot 200}{200} = 400\,\text{mm}$$



Opg. 5

a) I og med at belastningen er lik i hele murens lengde kan vi gjøre beregningene for f.eks. 1,0m av muren:

Støttemurens tyngde: $\underline{G = 2,3 \cdot 9,81 \cdot 4 \cdot \left(\frac{1,5+3,0}{2}\right) = 203,1\,kN/m}$

tyngdepunktets beliggenhet: $\underline{\bar{x} = \frac{\frac{1}{2}1,5 \cdot 4 \cdot 1 + 1,5 \cdot 4 \cdot 2,25}{9} = 1,83m}$

$\underline{M_S = 203,1 \cdot 1,83 = 372\,kNm/m}$

$\underline{M_V = 30 \cdot 4 \cdot 2 = 240\,kNm/m}$

$\underline{\underline{n = \frac{372}{240} = 1,55}}$

b)

$F_N = G = 203,1\,kN/m$

$F_F = 30 \cdot 4 = 120\,kN/m$

$F_{F,max} = M \cdot F_N = 0,5 \cdot 203,1 = 102\,kN/m$

$F_F > F_{F,max}$ dvs støttemuren vil gli ut.