Eks TKT 4126 MEKANIKK. 2013 Des

oppgave 1

a) ubrukelig fordi punkt A kan gli sideveis og konstr. kollapse.

stavkrefter = 4
opplagerkrefter = 3
knutepunkt = 4 (4×2 likninger)

] 4 + 3 ukjente] $7 \neq 8$

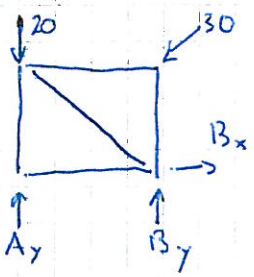
$\Rightarrow$ konstruksjonen er statisk ubestemt.

b) $s = 5$, $r = 3$, $k = 4$

$s + r = 2k$? $2 \times 4 = 5 + 3$ Ok.

$\Rightarrow$ konstruksjonen er statisk bestemt.

$$\Sigma M_B = 0 \Rightarrow A_y \times 4 - 20\,kN \times 4 - \frac{30\,kN}{\sqrt{2}} \cdot 3 = 0$$



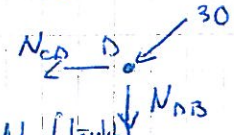
$$A_y = 35{,}9\,kN$$

$$\Sigma F_y = 0 \Rightarrow A_y + B_y - 20 - \frac{30}{\sqrt{2}} = 0$$

$$B_y = 5{,}3\,kN$$

$$\Sigma F_x = 0 \Rightarrow B_x - \frac{30}{\sqrt{2}}\,kN \Leftrightarrow B_x = 21{,}2\,kN$$

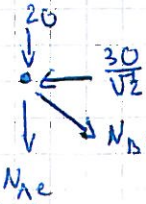
c) Knutepunkt D:



$\Sigma F_y = 0$ $N_{BD} = -\frac{30}{\sqrt{2}}\,kN$ (trykk)

$\Sigma F_x = 0$ $N_{CD} = -\frac{30}{\sqrt{2}}\,kN$ (trykk)

Knutepunkt C:



$\Sigma F_x = 0$ $N_{BC} \cdot \frac{4}{5} = \frac{30}{\sqrt{2}}$

$N_{BC} = 26{,}5\,kN$ (strekk)

$\Sigma F_y = 0$ $N_{AC} + 20 + N_{BC}\frac{3}{5} = 0$

$N_{AC} = -35{,}9\,kN$ (strekk)

problem 2

a) $A_y = q\,2 = 10\,kN$

$A_x = 0$

$T_A = R_q \cdot 0{,}5 = 5 \cdot (2) \cdot 0{,}5 = 5\,kNm = T_A$

b) schnitt 1-1

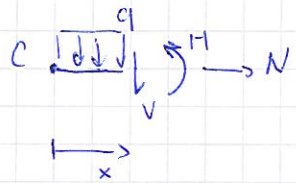
$N(x) = 10\,kN$

$V(x) = 0$

$M(x) + 5 = 0 \quad \Rightarrow M(x) = -5\,kNm$

B, A: $M(0) = M(x = 3\,m) = -5\,kNm$

schnitt 2-2



$N = 0$

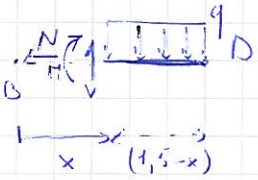
$V = -qx \qquad V(0) = 0 \qquad V(0{,}5) = -2{,}5\,kN$

$M + qx\frac{x}{2} = 0 \qquad M = -q\frac{x^2}{2}$

C: $M(0) = 0$

B: $M(x = 0{,}5) = -0{,}625\,kNm$

schnitt 3-3



$N = 0$

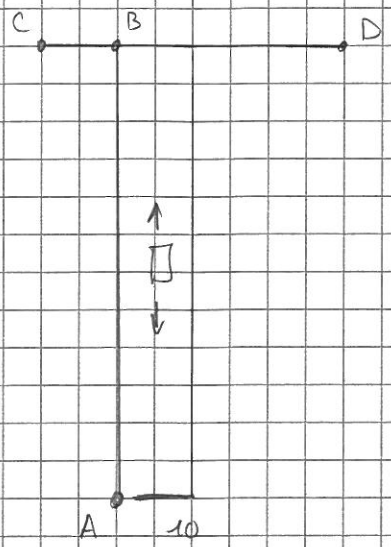
$V = -q(x - 1{,}5) \qquad V(0) = 7{,}5\,kN \qquad V(1{,}5) = 0$

$M + q\frac{(1{,}5 - x)^2}{2} = 0 \qquad M(x) = -q\frac{(1{,}5 - x)^2}{2}$

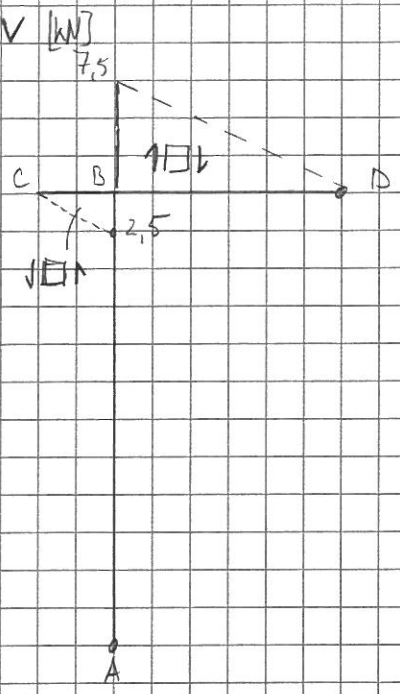
B: $M(0) = -5{,}625$

C: $M(1{,}5) = 0$

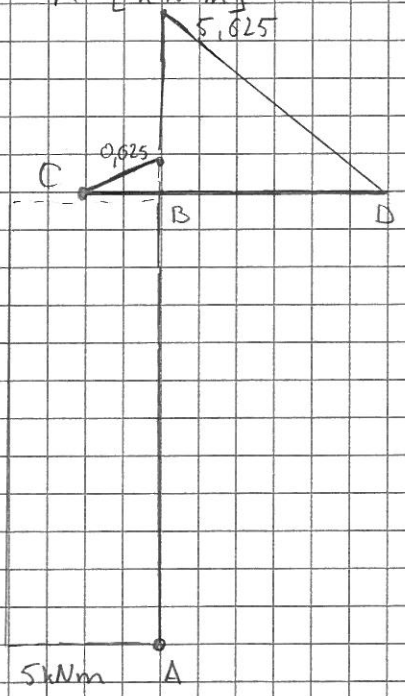
N [kN]



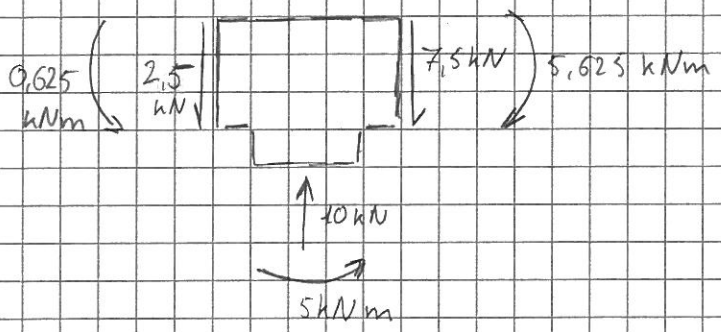
V [kN]



M [kNm]



d) hornet B



Opgave 3:

a) $\varepsilon_{45} = \frac{\varepsilon_x + \varepsilon_y}{2} + \frac{\varepsilon_x - \varepsilon_y}{2} \cos(2 \cdot 45°) + \frac{1}{2} \gamma_{xy} \sin(2 \cdot 45°)$

$\gamma_{xy} = 2\varepsilon_{45} - \varepsilon_x - \varepsilon_y$

$\gamma_{xy} = 828 \cdot 10^{-6}$

$\varepsilon_{1,2} = \frac{\varepsilon_x + \varepsilon_y}{2} \pm \sqrt{\left(\frac{\varepsilon_x + \varepsilon_y}{2}\right)^2 + \left(\frac{1}{2}\gamma_{xy}\right)^2}$

$\varepsilon_1 = 736 \cdot 10^{-6}$

$\varepsilon_2 = -100 \cdot 10^{-6}$

b) $\sigma_x = \frac{E}{1-\nu^2}(\varepsilon_x + \nu \varepsilon_y) = 81{,}8 \text{ MPa}$

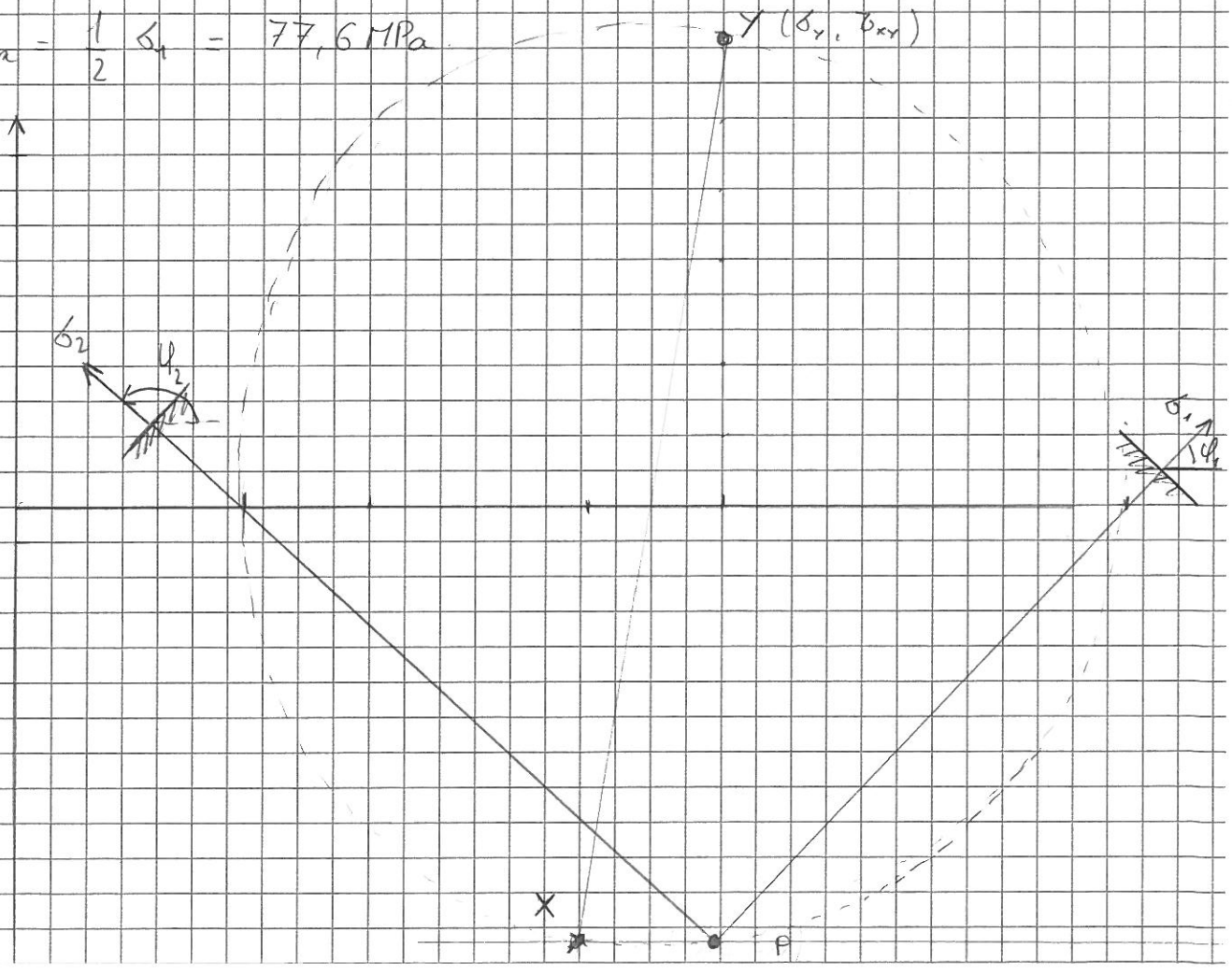
$\sigma_y = 99{,}9 \text{ MPa}$

$\tau_{xy} = G \gamma_{xy} \qquad G = \frac{E}{2(1+\nu)}$

$\tau_{xy} = 63{,}7 \text{ MPa}$

$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$ $\quad \sigma_1 = 155 \text{ MPa} \quad \sigma_2 = 26{,}5 \text{ MPa}$

$\tau_{max} = \frac{1}{2}\sigma_1 = 77{,}6 \text{ MPa}$



c) $T = \tau_{xy}\, 2\pi r^2 t$

$T = 20\,kNm$

$\sigma_y = \frac{pr}{t} \qquad p = \sigma_y \frac{t}{r} = 5\,MPa$

$\sigma_x = \sigma_x^P + \sigma_x^N \qquad \sigma_x^P = \frac{\sigma_y}{2} \qquad \sigma_x^N = \frac{N}{2\pi r t}$

$\Rightarrow N = \left(\sigma_x - \sigma_y \cdot \frac{1}{2}\right) 2\pi r t = 100\,kN$

d) $p = 5\,MPa \qquad N = 100\,kN$

$\sigma_y = 100\,MPa \qquad \sigma_x = 81{,}8\,MPa$

$\tau_{xy} = G\gamma_{xy} = \frac{T}{2\pi r^2 t}$

$\sigma_j^2 = \sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2$

flytning når $\sigma_j = 300\,MPa$ eller når $\gamma_{xy} = \gamma_f$

$3(G\gamma_f)^2 = 300^2 + \sigma_x^2 - \sigma_y^2 + \sigma_x\sigma_y$

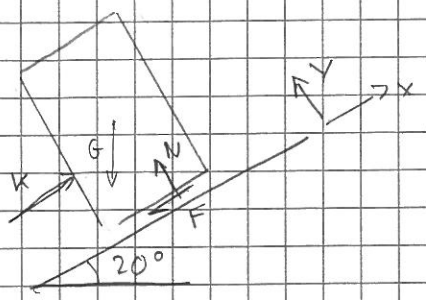
$\gamma_f = \frac{1}{G}\sqrt{\frac{1}{3}\left[300^2 - \sigma_x^2 - \sigma_y^2 + \sigma_x\sigma_y\right]}$

$\gamma_f = \frac{2(1+\nu)}{E}\sqrt{\frac{1}{3}\left[(300MPa)^2 - \sigma_x^2 - \sigma_y^2 + \sigma_x\sigma_y\right]}$

$\underline{\gamma_f = 2143 \cdot 10^{-6}}$

oppgave 4

a)



$F = \mu_s N$

$\Sigma F_y = 0 \Rightarrow N = G \cos 20°$

$\Sigma F_x = 0 \Rightarrow K = F + G \sin 20°$

$K = \mu_s G \cos 20° + G \sin 20°$

$K = G [\mu_s \cos 20° + \sin 20°]$

$\underline{K = 624\ N}$

b) lik fare for vipping $\Sigma M_A = 0$ og N og F går gjennom punkt A

$\Sigma M_A = 0 \Rightarrow K \cdot h = G \cos 20° \cdot 0{,}5 + G \sin 20° \cdot 1$

$\Rightarrow h = \dfrac{\cos 20° \cdot 0{,}5 + \sin 20°}{\mu_s \cos 20° + \sin 20°} = 1{,}3\ m$