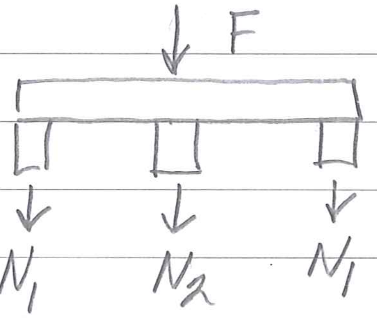
CHALMERSSKA HUSET

Z2 Hållfasthetslära TME017 2015-04-14

1) Ställ upp jämvikt (Antag F så stor att det blir kontakt vid B)



$$\uparrow: -2N_1 - N_2 - F = 0 \quad 1)$$

eller $2\sigma_1 A_1 + \sigma_2 A_2 = -F \quad 1)'$

deformationssamband, centrisk last F

$$\delta_1 = \delta_2 + \Delta \quad 2) \qquad \Delta = \text{gap} = 0.1 \text{ mm}$$

materialsamband, LB p 9-11

$$\varepsilon_1 = \frac{\sigma_1}{E_1} = \frac{\delta_1}{L} \quad 3) \qquad \varepsilon_2 = \frac{\sigma_2}{E_2} = \frac{\delta_2}{L} \quad 4)$$

$$3), 4) \text{ i } 2) \Rightarrow \quad \frac{\sigma_1 L}{E_1} = \frac{\sigma_2 L}{E_2} + \Delta \Rightarrow$$

$$\sigma_1 = \sigma_2 \frac{E_1}{E_2} + \frac{\Delta E_1}{L} \quad \text{i } 1) \Rightarrow$$

$$\sigma_2 = \frac{-F - \frac{2\Delta E_1 A_1}{L}}{2A_1 \frac{E_1}{E_2} + A_2} = -240 \text{ MPa}$$

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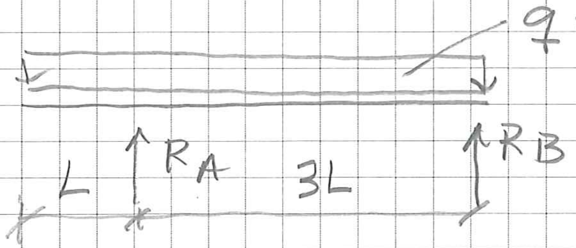
2) Bestäm stödreaktioner:



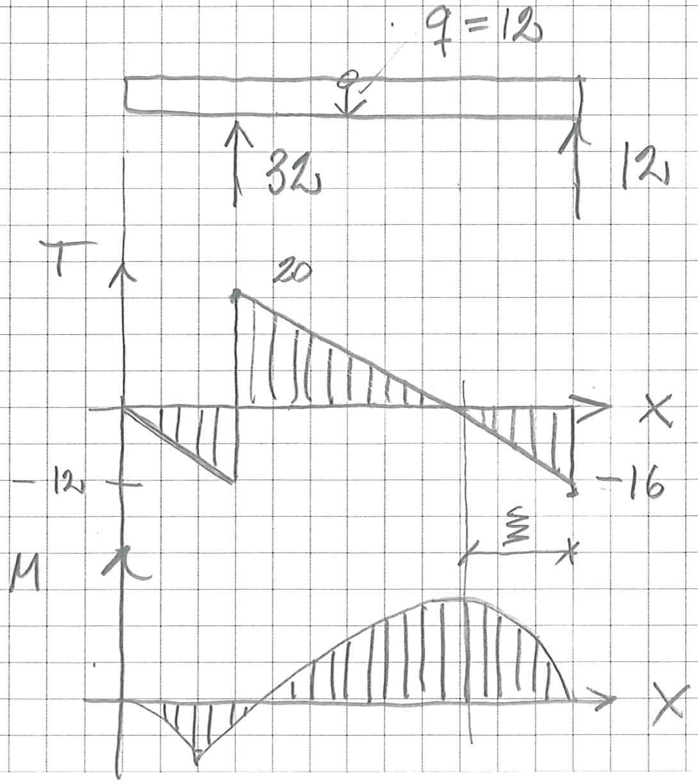
$$\uparrow: \quad R_A + R_B - q\,4L = 0$$
$$\curvearrowleft_B: \quad q \cdot 4L \cdot 2L - R_A\, 3L = 0$$
$$\Rightarrow \quad R_A = \frac{8}{3} qL = 32\,kN, \qquad R_B = \frac{4}{3} qL = 16\,kN$$

Rita tvärkraft & momentdiagram

Använd LB p 70

$$\frac{dT}{dx} = -q \rightarrow T(x_2) - T(x_1) = -\int_{x_1}^{x_2} q(x)\,dx$$

$$\frac{dM}{dx} = T \rightarrow M(x_2) - M(x_1) = \int_{x_1}^{x_2} T(x)\,dx$$



$T_{max} = 20\,kN$

Hitta M_{max}

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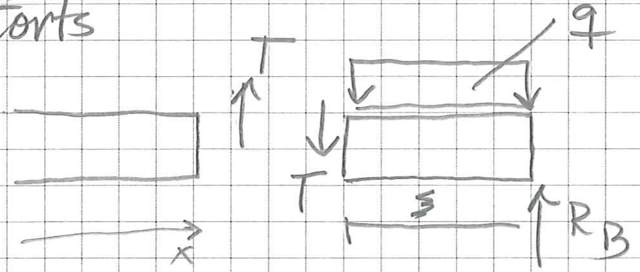
2) forts



$\uparrow: -T - q\cdot\xi + R_B = 0$

$T(\xi) = R_B - q\xi$

$T(\xi) = 0 \rightarrow \xi = \dfrac{R_B}{q} = \dfrac{4}{3}L = 1.33\ m$

$\rightarrow M(4L) - M(\xi) = \int_{\xi}^{4L} T(x)\,dx = \frac{1}{2}(-16)\cdot 1.33 = 10.64\,kNm$

För rektangulärt tvärsnitt $I_y = \dfrac{bh^3}{12}$ $A = bh$

LB p 80-82 $\Rightarrow$ $\sigma_{max} = \dfrac{M_{max}}{W_b} = \dfrac{M_{max}\cdot 6}{bh^2}$

LB p 89 $\Rightarrow$ $\tau_{max} = \dfrac{3}{2}\dfrac{T_{max}}{A} = \dfrac{3}{2}\dfrac{T_{max}}{b\cdot h}$

här är $h = 1{,}5b$ $\sigma_{till} = 9\ MPa$ $\tau_{till} = 0.6\ MPa$

varmed $\sigma_{till} \geq \dfrac{M_{max}\,6}{b(1{,}5b^2)} \rightarrow b \leq \sqrt[3]{\dfrac{6M_{max}}{2{,}25\,\sigma_{till}}} = 147\ mm$

$\tau_{till} \geq \dfrac{T_{max}\,3}{2b\cdot 1{,}5b} \rightarrow b \leq \sqrt{\dfrac{T_{max}}{\tau_{till}}} = 183\ mm$

$\rightarrow$ skjuvning dimensionerande

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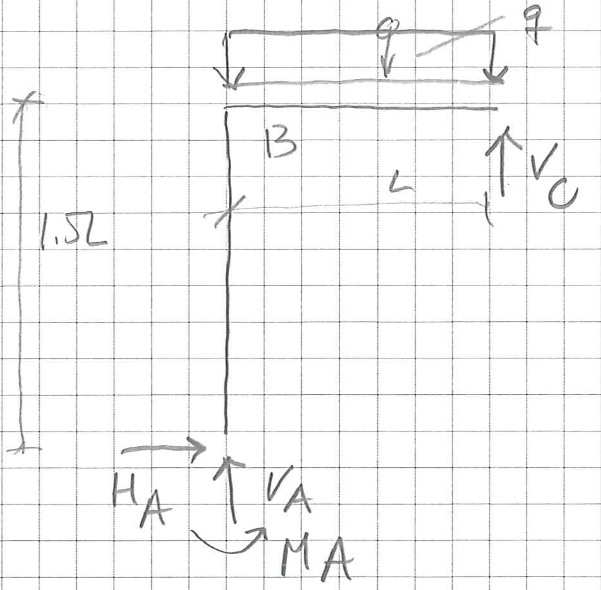
3) Inför stödreaktioner



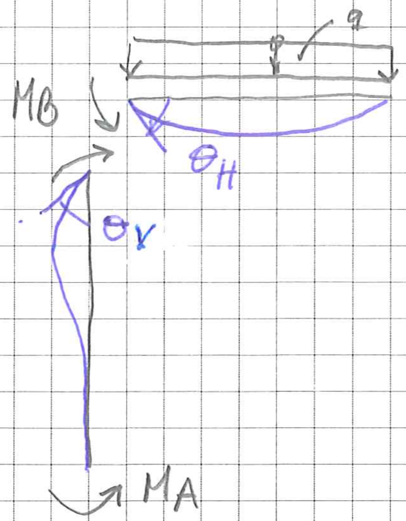
Jämvikt för frilagd ram

$\rightarrow: \quad H_A = 0 \qquad 1)$

$\uparrow: \quad V_A + V_C - Q = 0 \qquad 2)$

$\curvearrowleft B: \quad H_A \cdot 1.5L + V_C \cdot L + M_A - \frac{QL}{2} = 0 \qquad 3)$

Bestäm M_A och moment vid B
se deformationssamband (FS 6.3 & 6.5)



Här gäller $\theta_H = \theta_V$ (LBp

$$\theta_H = \frac{QL^2}{24EI} - \frac{M_B L}{3EI}$$

$$\theta_V = \frac{M_B 3L}{2 \cdot 4EI}$$

$$\rightarrow \frac{QL}{24} = M_B\left(\frac{3}{8} + \frac{1}{3}\right) \Rightarrow M_B = \frac{QL}{17}$$

$$M_A = -\frac{1}{2} M_B = -\frac{QL}{34}$$

$$3) \Rightarrow V_C = \frac{1}{L}\left(\frac{QL}{2} - M_A\right) = Q\left(\frac{1}{2} + \frac{1}{34}\right) = \frac{18}{34} Q$$

$$2) \Rightarrow V_A = \frac{16}{34} Q$$

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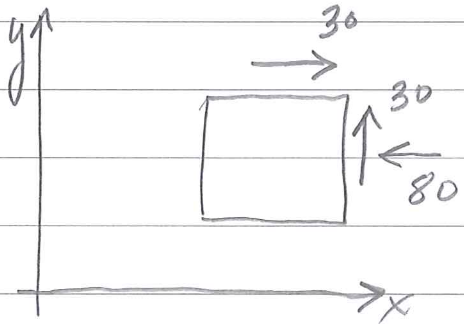
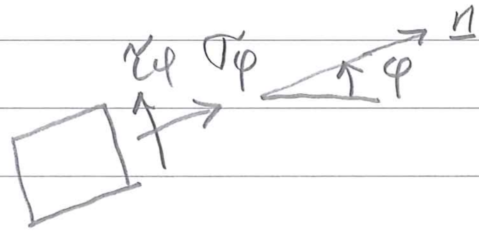
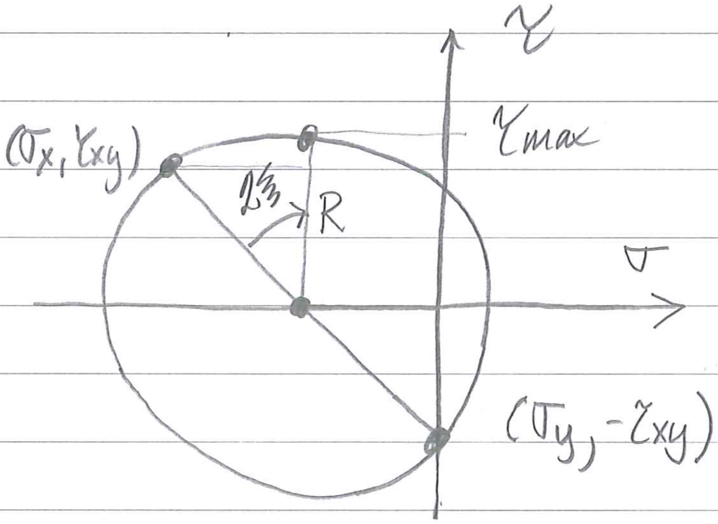
4) Använd Mohrs cirkel LB p 174-175





ie $\sigma_x = -80$, $\sigma_y = 0$, $\tau_{xy} = 30$ MPa

Rita Mohrs cirkel:



Radien i Mohrs cirkel

$R = \tau_{max}$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tau_{max} = \sqrt{\left(\frac{-80-0}{2}\right)^2 + 30^2} = 50 \text{ MPa}$$

$$\tan 2\xi = \frac{\sigma_x - \left(\frac{\sigma_x + \sigma_y}{2}\right)}{\tau_{xy}} = \frac{\sigma_x - \sigma_y}{2\tau_{xy}} = -\frac{80}{60}$$

$$\rightarrow \varphi = \frac{1}{2}\xi = \frac{1}{2}\arctan\left(-\frac{4}{3}\right) = -28^0$$

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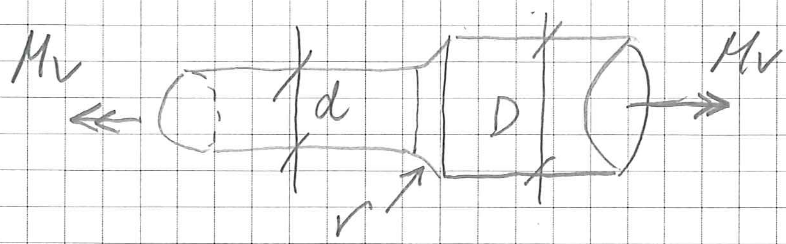
5) Använd LB p 53, 57 & 251-252



$$\tau_{max} = k_t \tau_{nom}$$

$$\tau_{nom} = \frac{M_v}{W_v} = \frac{M_v \cdot 2}{\pi (\frac{d}{2})^3}$$

Dessutom $P = M_v \omega = M_v \frac{2\pi n}{60}$

Här är $\frac{D}{d} = \frac{160}{80} = 2$, $\frac{r}{d} = \frac{4}{80} = 0.05$ $\Rightarrow k_t = 1{,}7$

Med $\tau_{max} = \tau_{till} \Rightarrow M_v = \frac{\tau_{till}}{k_t} \cdot \frac{\pi d^3}{16} = 3{,}25 \cdot 10^3$ Nm

$$P = \frac{\tau_{till}}{k_t} \cdot \frac{\pi d^3}{16} \cdot \frac{2\pi n}{60} = 307 \text{ kW}$$

Öka radien $r = 8$ mm $\Rightarrow$

$\frac{D}{d} = 2$, $\frac{r}{d} = \frac{8}{80} = 0{,}1$ $\Rightarrow k_t = 1{,}45 \Rightarrow P = 385$ kW