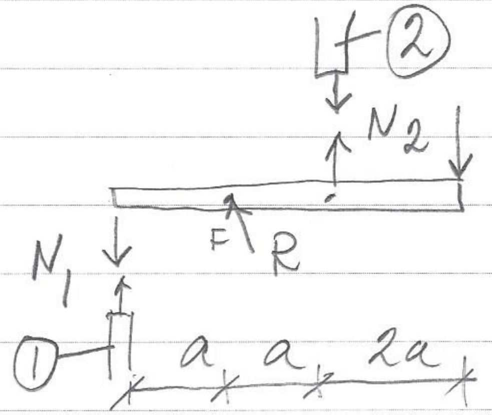
Hållfasthetslära Z2 2014-05-26

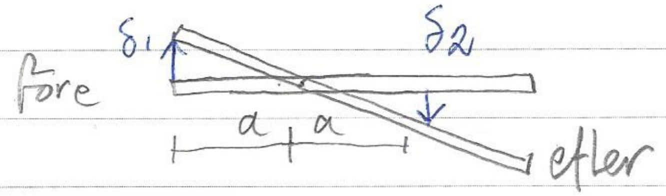
1) Se LB p 25-27

Frilägg den stela balken, inför stångkrafter



Jämvikt

$\curvearrowleft F \quad N_1 \cdot a + N_2 \cdot a - P \cdot 3a = 0$ 1)



Deformationer

Likformiga trianglar ⟹

$$\frac{\delta_1}{a} = \frac{\delta_2}{a}$$ 2)

Materialsamband (LB p27), samma längd L

$$\delta_1 = \frac{N_1 L}{EA}$$ 3)

$$\delta_2 = \frac{N_2 L}{EA}$$ 4)

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1) forts 3)&4) i 2) ⇒ $N_1 = N_2$ i 1) ⇒

$$2 N_1 a = 3 P a \rightarrow N_1 = \frac{3}{2} P$$

varmed $\delta_1 = \frac{3}{2} \frac{PL}{EA}$

Vinkeländring $\theta \approx \frac{\delta_1}{a} = \frac{3}{2} \frac{PL}{EAa}$

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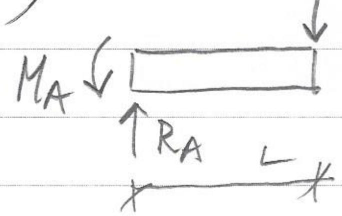
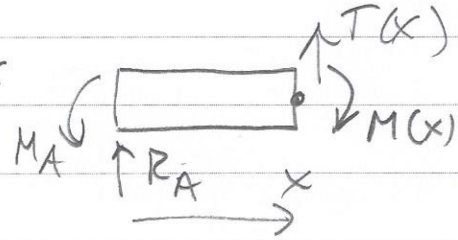
2) För balken gäller



$R_A = P$, $M_A = PL$ (FS 6.4)

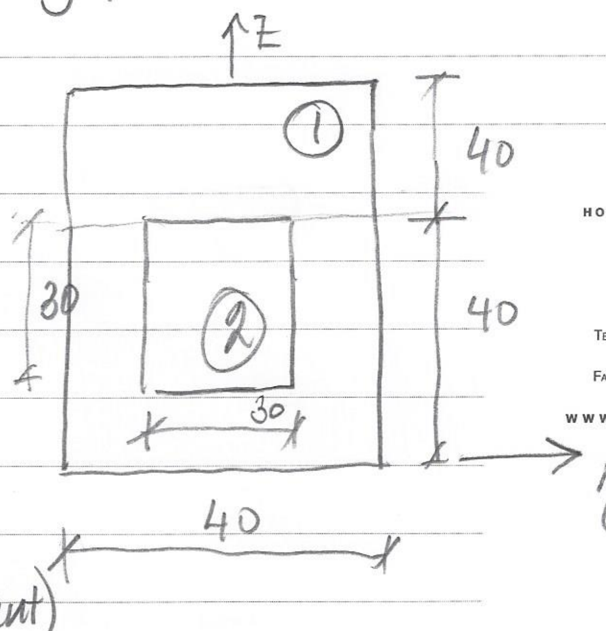
snitt vid x



$$\curvearrowleft: \quad M_A - R_A x - M(x) = 0$$

$$M(x) = M_A - R_A = PL - Px$$

Tvärsnittets TP och I_y , se LB p 80-82



$$Z_{tp} = \frac{Z_1 A_1 - Z_2 A_2}{A_1 - A_2} =$$

$$= \frac{40 \cdot 40 \cdot 80 - 25 \cdot 30 \cdot 30}{40 \cdot 80 - 30 \cdot 30}$$

$Z_{tp} = 45.9$ mm

(räknat från underkant)

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2) forts

$$I_y = I_{y_1} - I_{y_2} = \left(\frac{40 \cdot 80^3}{12} + 40 \cdot 80 \cdot 5{,}9^2\right) - \left(\frac{30 \cdot 30^3}{12} + 30 \cdot 30 \cdot 20{,}9^2\right) = 1{,}36 \cdot 10^6 \text{ mm}^4$$

Böjspänningen $\sigma(x) = \frac{M(x) \cdot z}{I_y}$, $M(x)_{max} = PL \ (x=0)$

se LB p 79-80

Drag, ovansida $z_{max} = 80 - 45.9 = 34{,}1$ mm

Tryck, undersida $z_{min} = -45.9 = -45{,}9$ mm

$$\Rightarrow \sigma_{tilld} = 120 = \frac{P \cdot 10^3 \cdot 34{,}1}{1{,}36 \cdot 10^6} \rightarrow P = 4{,}78 \cdot 10^3 \text{ N}$$

$$\sigma_{tillt} = -150 = \frac{-P \cdot 10^3 \cdot 45{,}9}{1{,}36 \cdot 10^6} \rightarrow \underline{P} = 4{,}44 \cdot 10^3 \text{ N}$$

$\rightarrow$ Tryck dimensionerande

$$P_{till} = 4{,}44 \cdot 10^3 \text{ N}$$

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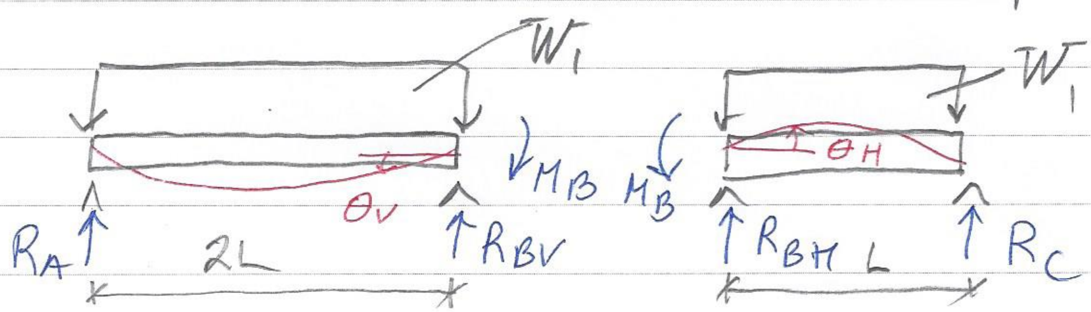
3) Dela balken vid mittstödet (LB p98)



Inför M_B, Använd elementarfall FS 6.3, $w_1 = \frac{Q}{3L}$

$$\theta_V = \frac{Q}{3L}\frac{(2L)^3}{24EI} - \frac{M_B 2L}{3EI}$$

$$\theta_H = -\frac{Q}{3L}\frac{L^3}{24EI} + \frac{M_B L}{3EI}$$

$$\theta_V = \theta_H \Rightarrow \frac{Q}{3L}\cdot\frac{L^3}{24EI}(8+1) = \frac{M_B L}{3EI}(1+2)$$

$$\rightarrow M_B = \frac{QL}{8}$$

Stödreaktioner

$$R_A = \frac{Q}{3L}\cdot\frac{2L}{2} - \frac{QL}{8\cdot 2L} = \frac{13}{48}Q$$

$$R_{BV} = \frac{Q}{3L}\cdot\frac{2L}{2} + \frac{QL}{8\cdot 2L} = \frac{19}{48}Q$$

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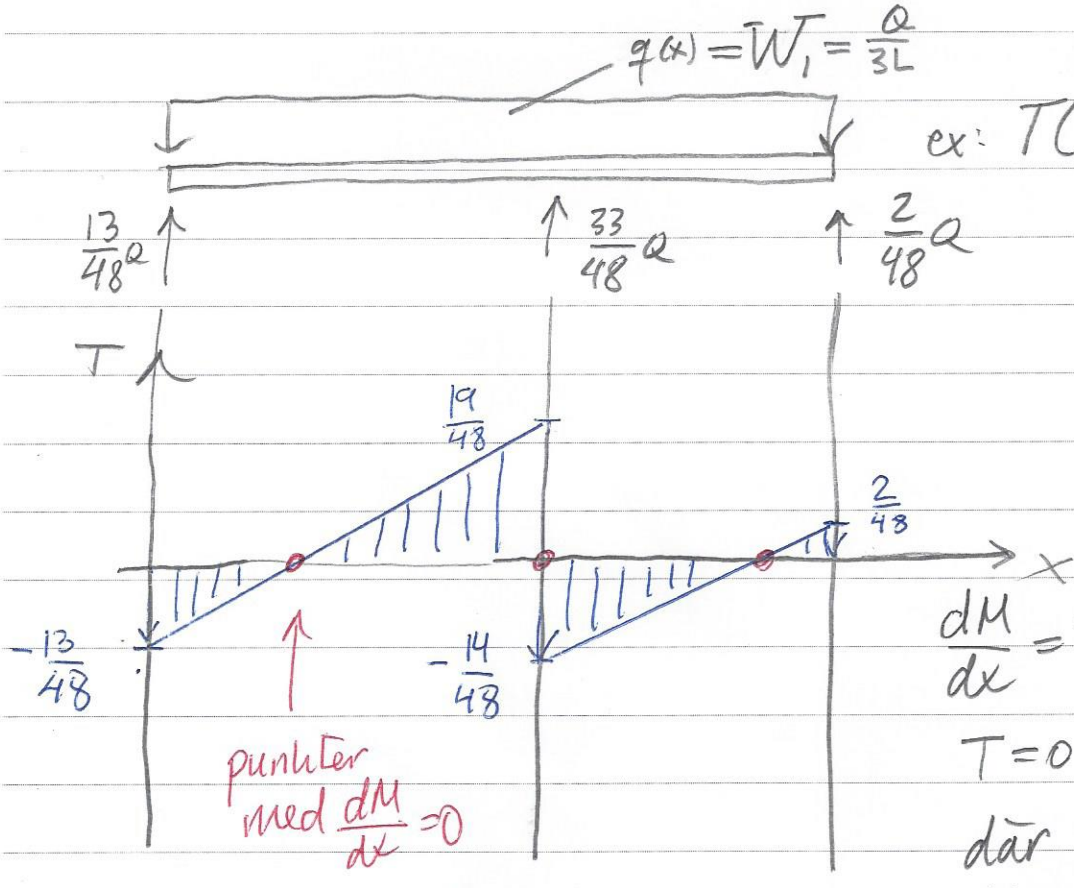
3) forts $R_{BH} = \frac{Q}{3L}\frac{L}{2} + \frac{QL}{8L} = \frac{14}{48}Q$

$R_C = \frac{Q}{3L}\cdot\frac{L}{2} - \frac{QL}{8L} = \frac{2}{48}Q$

$\rightarrow R_B = R_{BV} + R_{BH} = \frac{33}{48}Q$

Rita T-diagram. LB p 70-72 $\Rightarrow$

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



ex: $T(2L) - T(0^+) =$

$= -\left(-\frac{Q}{3L}\cdot 2L\right)$

$= \frac{32}{48}Q$

$\frac{dM}{dx} = T \Rightarrow$

$T = 0$ är lägen där $M(x)$ kan vara

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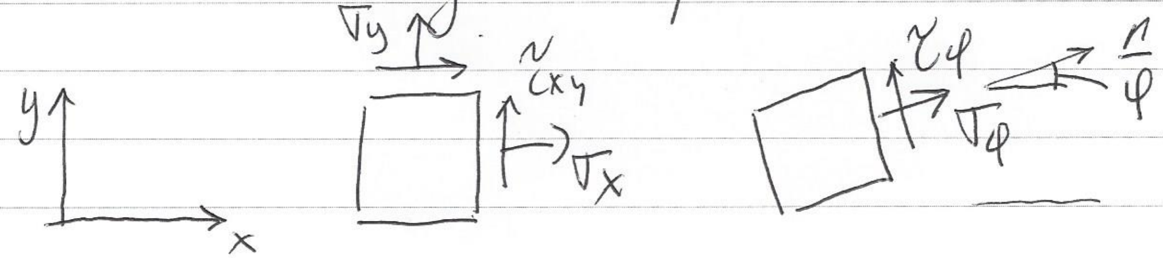
4 Vi har enligt LB p 170-171



$$\sigma_\varphi = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\varphi + \tau_{xy}\sin 2\varphi$$

$$\rightarrow \sigma_\varphi = \frac{5-5}{2} + \frac{5-(-5)}{2}\cos 2\varphi + 7\sin 2\varphi$$

$$\sigma_\varphi = 0 \Rightarrow \tan 2\varphi = \frac{-5}{7} \rightarrow \varphi = -18^\circ$$

då fås $\tau_\varphi = -\frac{\sigma_x - \sigma_y}{2}\sin 2\varphi + \tau_{xy}\cos 2\varphi =$

$$= -\frac{5(-5)}{2}\sin(-35{,}5^\circ) + 7\cos(-35{,}5^\circ) = 8{,}6\ \text{MPa}$$

τ_φ då $\sigma_\varphi = 0$ är också radien i Mohrs cirkel LB p 175

$$\tau_\varphi = \tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = 8.6\ \text{MPa}$$

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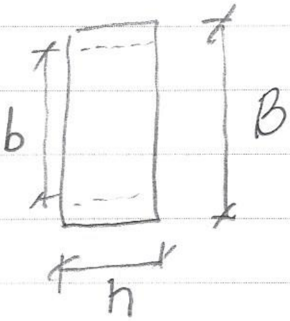
Stångens tvärsnittsarea $A = h \cdot b$



$$\rightarrow \sigma = \frac{F_0}{A} + \frac{F_0}{2A} \sin \omega t \Rightarrow$$

$$\sigma_m = \frac{250 \cdot 10^3}{40 \cdot 80} = 78 \text{ MPa}, \; \sigma_a = 39 \text{ MPa}$$

Använd reducerat Haigh diagram LB p 250, 255

λ: ej gjutet $\rightarrow \lambda = 1$

K_d: vi har anvisning $\rightarrow K_d = 1$

K_r: LB p 254 $\left.\begin{matrix} R_a = 10 \mu m \\ R_m = \sigma_B = 540 \text{ MPa} \end{matrix}\right\} \Rightarrow \frac{1}{K_r} \approx 0{,}87$

K_t: LB Fig 159a $\left.\begin{matrix} \frac{B}{b} = \frac{100}{80} \\ \frac{\rho}{b} = \frac{10}{80} \end{matrix}\right\} \rightarrow K_t \approx 2{,}2$

Fig 160 $\Rightarrow$ $\left.\begin{matrix} \rho = 10 \text{ mm} \\ R_m = \sigma_B = 540 \end{matrix}\right\} \Rightarrow q \approx 0{,}9$

$$\rightarrow K_f = 1 + q(K_t - 1) = 1 + 0{,}9 \cdot 1{,}2 = 2{,}1$$

$$\sigma_{u,red} = \pm \sigma_u \frac{\lambda}{K_r K_f K_d} = \pm 180 \frac{1 \cdot 0{,}87}{1 \cdot 2{,}1} = 75 \text{ MPa}$$

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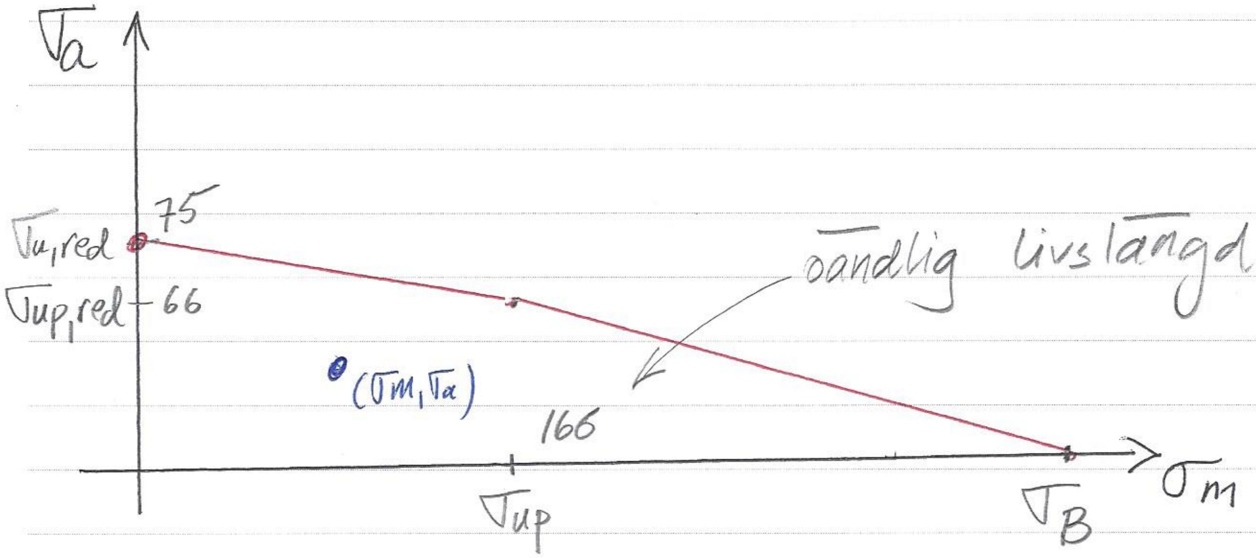
$$\sigma_{up,red} = 160 \pm 160 \cdot \frac{1 \cdot 0{,}87}{1 \cdot 2{,}1} =$$

$$= 160 \pm 66 \text{ MPa}$$



⟹ ingen risk för utmattning