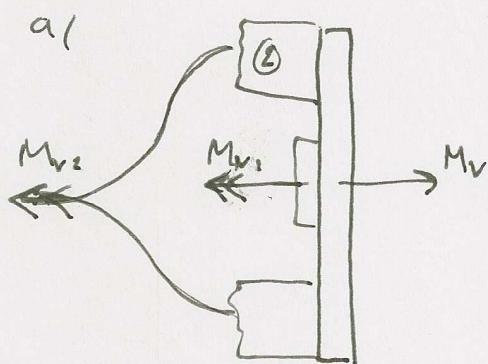


2007-09-14

Sämvikt

$$\rightarrow: M_v - M_{v1} - M_{v2} = 0 \quad (1)$$

Deformationsvilkor:

$$\varphi_1 = \varphi_2 = \varphi \quad (2)$$

Konstitutiva samband:

$$\varphi_1 = \frac{M_1 L}{G K_1} ; \quad \varphi_2 = \frac{M_2 L}{G K_2} \quad (3)$$

Kombinera

(3) i (2)

$$M_{v1} = M_{v2} \frac{K_1}{K_2} \quad \text{insatt i (1)}$$

$$M_{v2} \frac{K_1}{K_2} + M_{v2} = M_v ; \quad M_{v2} = \frac{M}{\frac{K_1}{K_2} + 1}$$

$$M_{v1} = \frac{M_v}{1 + \frac{K_2}{K_1}}$$

$$\varphi = \frac{M_v L}{G(K_1 + K_2)}$$

$$k_1 = \frac{\pi (2a)^4}{32} = \frac{\pi a^4}{2}$$

$$k_2 = \frac{\pi (4a)^4}{32} - \frac{\pi (2b)^4}{32} = \pi 8a^4 - \frac{\pi b^4}{2}$$

$$\varphi = \frac{7,6 \cdot 10^3 \cdot 0,1}{8100 \cdot 10^6 \cdot \pi \left(\frac{0,01}{2} + 8 \cdot 0,01^4 - \frac{0,012^4}{2} \right)} = \underline{\underline{0,040 \text{ [rad]}}}$$

b) GL s:z 57:

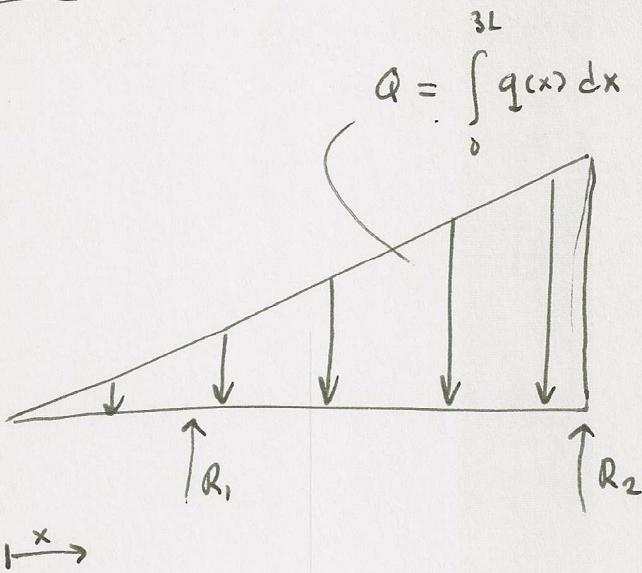
$$\tau_v = \frac{M_v}{W_v}$$

$$W_{v1} = \frac{\pi a^3}{2} \quad ; \quad W_{v2} = \frac{\pi ((2a)^4 - b^4)}{2 \cdot 2a}$$

$$\tau_{v1} = \frac{M_v}{1 + \frac{k_e}{k_i}} \cdot \frac{2}{\pi a^3} = \frac{7,6 \cdot 10^3}{1 + \frac{1}{0,0418}} \cdot \frac{2}{\pi \cdot 0,01^3} = 324 \text{ [MPa]}$$

$$\tau_{v2} = \frac{M}{\frac{k_i}{k_e} + 1} \cdot \frac{4 \cdot 0,01}{\pi (16 \cdot 0,01^4 - 0,012^4)} = 648 \text{ [MPa]}$$

2004-08-26



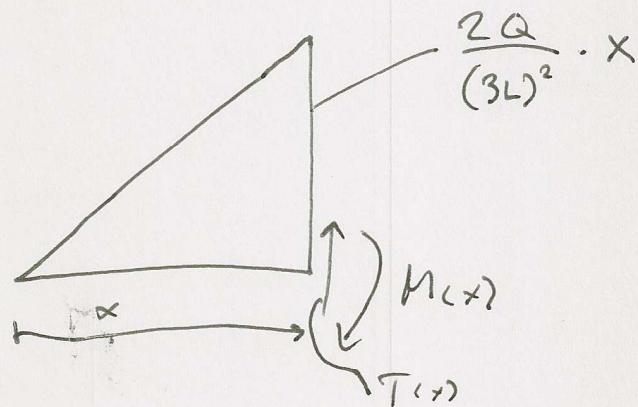
Jämrikt:

$$\uparrow: R_1 + R_2 - Q = 0$$

$$\widehat{R}_1: QL - R_2 \cdot 2 \cdot L = 0 \Rightarrow R_1 = R_2 = \frac{Q}{2}$$

Träkraft $T(x)$

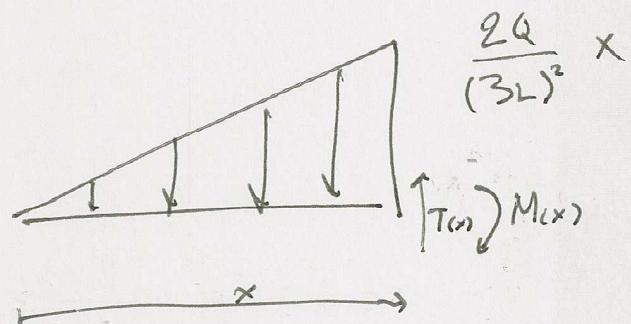
$$0 < x < L$$



$$\uparrow: T(x) - \left[\frac{\frac{2Q}{(3L)^2}}{2} \cdot x \right] x \Rightarrow T(x) = \frac{Qx^2}{aL^2}$$

$$T(0) = 0 \quad T(L_0) = \frac{Q}{a}$$

$$L < x < 3L$$



$$\uparrow: T(x) - \frac{Q x^2}{9 L^2} + \frac{Q}{2} = 0$$

$$T(x) = \frac{Q x^2}{9 L^2} - \frac{Q}{2}$$

$$T(L) = -\frac{7}{18} Q$$

$$T(3L) = \frac{Q}{2}$$

Lokala min och max av $T(x)$ där

$$T'(x) = 0$$

$$\Rightarrow \text{Båda } x=0 \text{ ger } T=0$$

\Rightarrow Max och min i särpunktarna

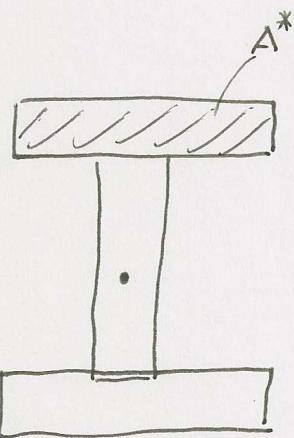
dvs $T(0)$, $T(L)$ och $T(3L)$

$$\max |T(x)| = \frac{Q}{2}$$

Bögskjuerspänning (GL S:2 88 del 7-48)

$$\tau = \frac{S_A^* \cdot T}{I \cdot b} \quad \text{där}$$

$$S_A^* = y_{ta} \cdot \text{Parstund}$$

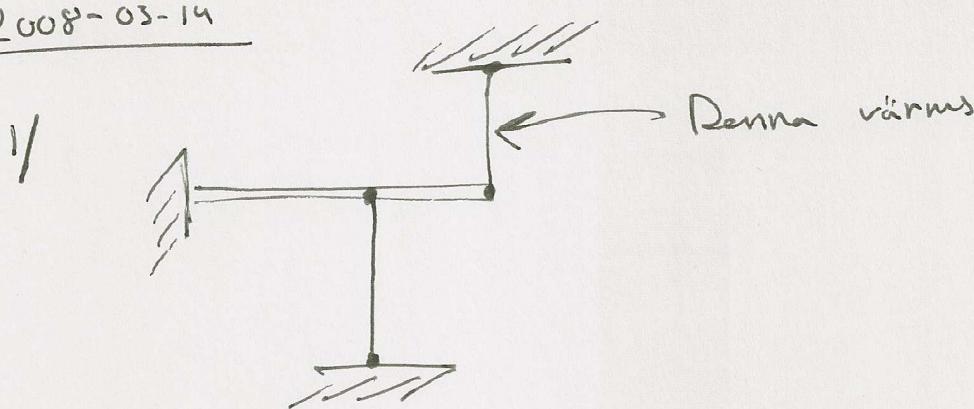


$$S_A^* = 5t \cdot t \left(\frac{5t}{2} + \frac{t}{2} \right) = 15t^3$$

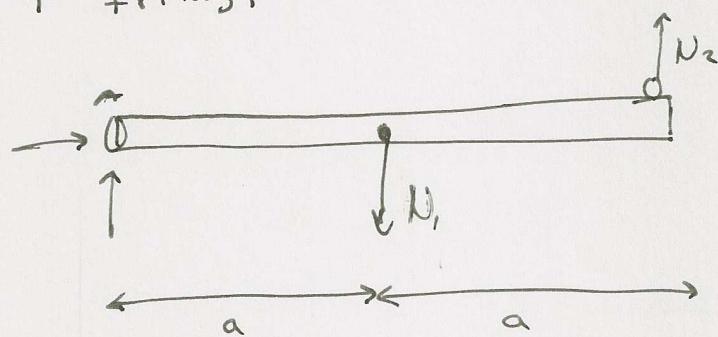
$$I = t \frac{(5t)^3}{12} + 2 \left[\frac{5t \cdot t^3}{12} + (5t \cdot t) \left(\frac{t}{2} + \frac{5t}{2} \right)^2 \right] = \frac{405t^4}{4}$$

$$T_{\max} = \frac{15t^2 \frac{Q}{2}}{\frac{405t^4}{4} t} = \frac{Q}{t^2} \cdot \frac{2}{27}$$

2008-03-14



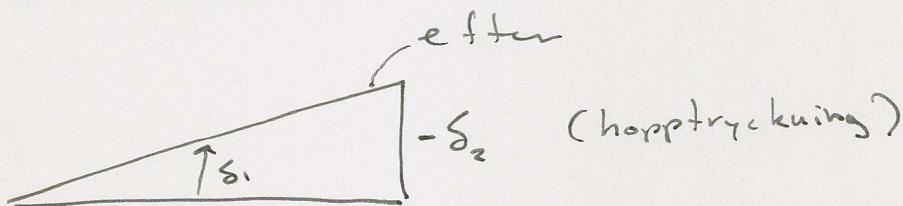
a) Friktion om statisk balans



$$\text{R}: N_1 a - N_2 a$$

(1)

Kompatibilitet



$$\text{balcken raka} \Rightarrow \frac{\delta_1}{a} = -\frac{\delta_2}{2a}$$

(2)

$$2\delta_1 = -\delta_2$$

Konstitutiva samband

Ls eler (2-14) och (5-3)

$$\epsilon_1 = \frac{\delta_1}{L} = \frac{N_1}{EA} ; \quad \delta_1 = \frac{N_1 L}{EA} \quad (3)$$

$$\epsilon_2 = \frac{\delta_2}{L} = \frac{N_2}{EA} + \alpha T ; \quad \delta_2 = \frac{N_2 L}{EA} + \alpha T L \quad (4)$$

(3) och (4) : (2) ger:

$$2 \frac{N_1 L}{EA} = - \frac{N_2 L}{EA} - \alpha \tau L \quad (5)$$

(1) : (5) ger:

$$2 \frac{2 N_2 L}{EA} = - \frac{N_2 L}{EA} - \alpha \tau L ; \quad \delta_z = \frac{N_2 L}{EA} + \alpha \tau L \quad (4)$$

: (4) ger

$$\delta_z = \frac{4}{5} \alpha \tau L \quad \text{positiv} \Rightarrow \text{nedat}$$

b) Risk för knäckning

$$b) \text{ sid } 124 + (8-27) \text{ eller sid } 141$$

$$P_{kr} = \frac{\pi^2 EI}{L^2}$$

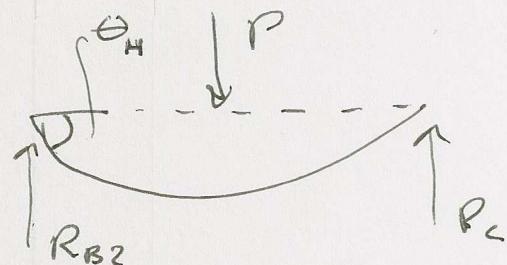
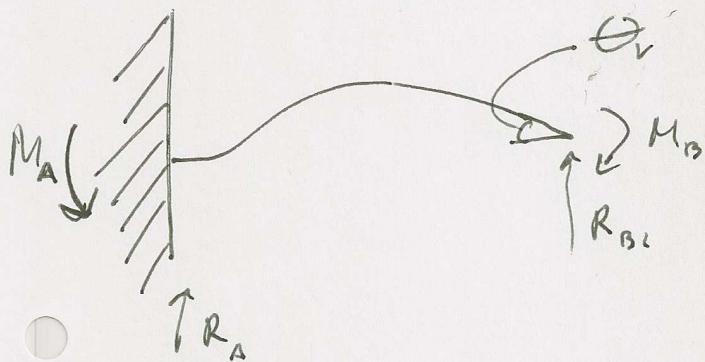
$$|N_1| > |N_2| \quad N_1 = 2 N_2$$

$$2 \frac{1}{5} EA \alpha \tau = \frac{\pi^2 EI}{L^2}$$

$$\tau = \frac{5\pi^2 I}{2 A \alpha L^2}$$

2008-03-14

S/ Gör snitt vid mittstödet. In för snittmoment
 M_0 och sätt upp ; jämviktsrelationer.



$$\left(\begin{array}{l} \uparrow : R_A + R_{B1} = 0 \\ \curvearrowleft : M_A - M_B + R_B : L \\ \end{array} \right) \quad \left(\begin{array}{l} R_{B2} - P + R_2 = 0 \\ M_B - P \frac{L}{2} + R_2 L = 0 \end{array} \right)$$

Geometriskt villkor:

$$\theta_v = \theta_H \quad \text{efter elementfall}$$

6.5 och 6.3 ger:

$$\theta_v = M_B \frac{L}{4EI}$$

$$\theta_H = \frac{PL^2}{16EI} - M_b \cdot \frac{L}{3EI}$$

$$\text{Eftersum } \theta_v = \theta_H$$

$$\frac{M_0}{4} = \frac{PL}{16} - \frac{M_B}{3} ; \quad M_B = \frac{3PL}{28}$$

Stöckreaktionen

$$M_A = \frac{1}{2} M_b = \frac{3PL}{56}$$

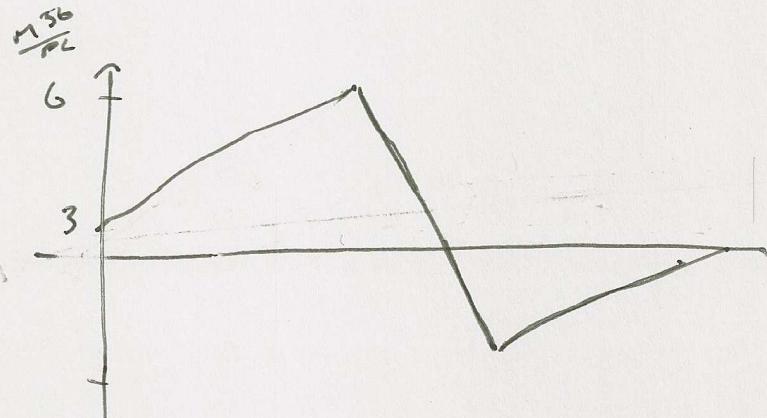
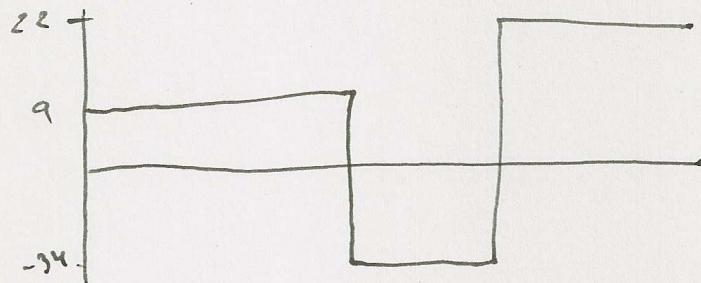
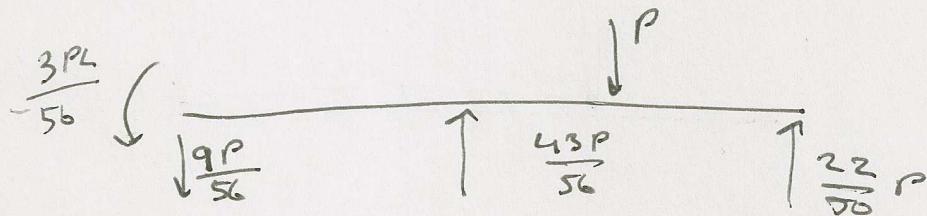
$$R_A = \frac{3}{2L} (-M_b) = -\frac{9P}{56}$$

$$R_{B1} = -R_A = \frac{9P}{56}$$

$$R_{B2} = \frac{P}{2} + \frac{M_b}{L} = \frac{14}{22} P + \frac{3P}{28} = \frac{17P}{28}$$

$$R_c = \frac{P}{2} - \frac{M_b}{L} = \frac{11}{28} P$$

$$R_B = R_{B1} + R_{B2} = \frac{9P}{56} + \frac{34P}{56} = \frac{43P}{56}$$



Momentdiagramm

$$\sigma_b = \frac{M_b}{W_b} = \frac{\frac{M_b}{\pi d^3}}{\frac{16}{56}} = \frac{11 PL}{56} \cdot \frac{32}{\pi d^3}$$

$$P = \frac{\sigma \cdot 56 \pi d^3}{11 \cdot L \cdot 3 \cdot 2} = \frac{150 \cdot 56 \cdot \pi \cdot 12^3}{11 \cdot 200 \cdot 32} = 648 \quad [N]$$