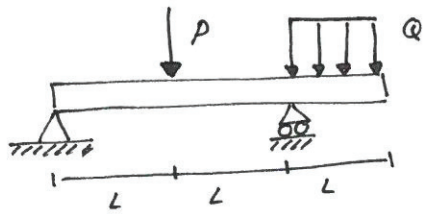
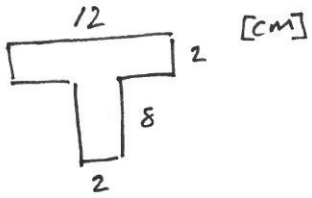
2.4.47 T-balk

Givet



- $P = 40\ kN$
- $Q = 30\ kN$
- $L = 50\ cm$

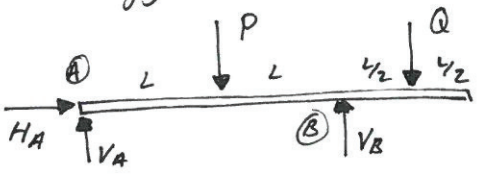
Tvärsnitt:



Sökt Max drag- och tryckspänning

Lösning

1. Frilägg



2. Jmv

$\uparrow: V_A - P + V_B - Q = 0 \Rightarrow V_A + V_B = P + Q$

$\rightarrow: H_A = 0$

$\circlearrowright_A: -P \cdot L + V_B \cdot 2L - Q \cdot 2.5L = 0$

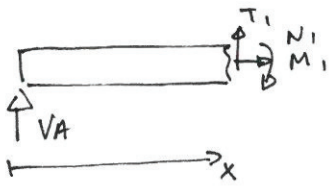
$\Rightarrow V_B = \left(Q \cdot \frac{5}{2} + P\right) \cdot \frac{1}{2} = \frac{5Q}{4} + \frac{P}{2}$

$\Rightarrow V_A = P + Q - V_B = P - \frac{P}{2} + Q - \frac{5Q}{4} = \frac{P}{2} - \frac{Q}{4} = 12.5\ kN$

$V_B = P + Q - V_A = \ldots = 57.5\ kN$

3. Snitta

Del 1: $0 \le x \le L$



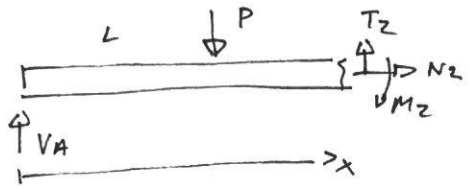
4. Jmv

$\uparrow: V_A + T_1 = 0 \Rightarrow T_1 = -V_A = -12.5\ kN$

$\rightarrow: N_1 = 0$

$\circlearrowright_x: -V_A \cdot x - M_1 = 0 \Rightarrow M_1(x) = -V_A \cdot x$

Del 2: $L \le x \le 2L$

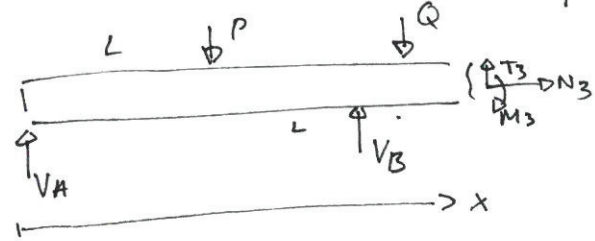


$\uparrow: V_A - P + T_2 = 0 \Rightarrow T_2 = P - V_A = 27.5\ kN$

$\rightarrow: N_2 = 0$

$\circlearrowright_x: -V_A \cdot x + (x - L) \cdot P - M_1 = 0 \Rightarrow M_1(x) = V_A \cdot x - (x - L) \cdot P$

Del 3: $2L \le x \le 3L$



$\uparrow: V_A - P + V_B - Q \cdot \left(\frac{L - x}{L}\right) + T_3 = 0 \Rightarrow T(x) = P - V_A - V_B + Q\left(\frac{L - x}{L}\right)$

$\rightarrow: N_3 = 0$

$\circlearrowright_x: -V_A \cdot x + (x - L) \cdot P + (x - 2L) \cdot V_B - \frac{Q}{L}(x - 2L) \cdot \frac{(x - 2L)}{2} - M_3 = 0$

Hävarm

$\Rightarrow M_3(x) = V_A \cdot x + P(x - L) + V_B(x - 2L) - \frac{Q}{2L}(x - 2L)^2$

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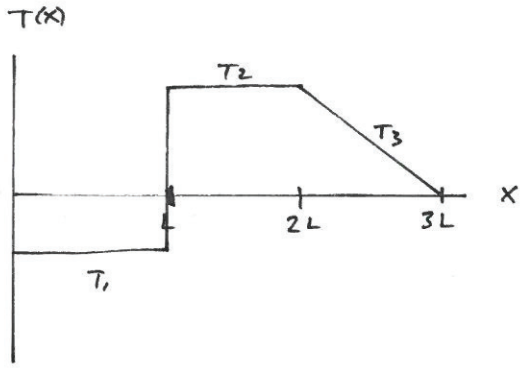
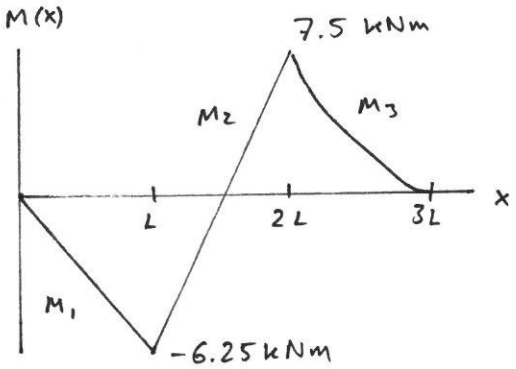
forts!

5. Diagram



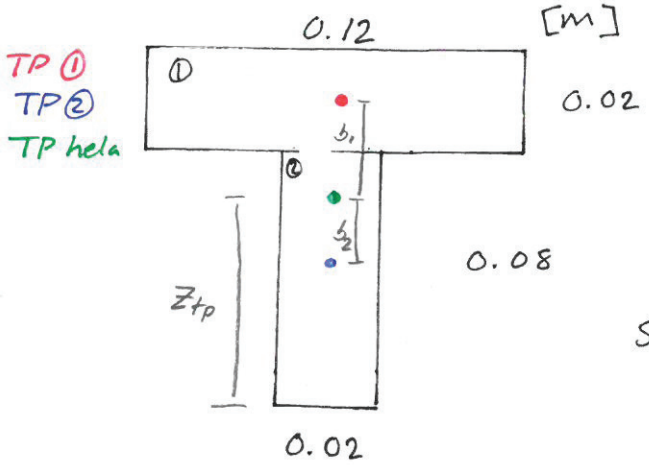
T-diagram



M-diagram

6. Normalspänning

$$\left[\sigma_x(z) = \frac{M}{I_y} \cdot z \right] \quad \Longrightarrow \text{Behöver } I_y !$$



Tyngdpunktens läge:

$$z_{tp} \cdot A_{tot} = z_{tp1} \cdot A_1 + z_{tp2} \cdot A_2$$

$$\Longrightarrow \ldots z_{tp} = 0.07\,m$$

Sammansatt tvärsnitt $\Longrightarrow$ Steiners satz:

$$\left[I_{tot} = \sum_i I_{y,i} + b_i^2 A_i \right] \quad \text{FS. 30.5}$$

där $I_{y,i}$ tas för rektangulärt tvärsnitt, se FS tab 30.1.1

$$\left[I_y = \frac{bh^3}{12} \right]$$

$$\Longrightarrow I_{tot} = \frac{10}{3} \cdot 10^{-6}\,m^4$$

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forts. 2

$x = L$:

$$\begin{cases} \sigma(z=0.03) = \dfrac{-6.25\cdot 10^3}{\frac{10}{3}\cdot 10^{-6}} \cdot 0.03 = -56.25 \text{ MPa} \\ \sigma(z=-0.07) = \dfrac{-6.25\cdot 10^3}{\frac{10}{3}\cdot 10^{-6}} \cdot (-0.07) = 131.25 \text{ MPa} \end{cases}$$

$x = 2L$:

$$\begin{cases} \sigma(z=0.03) = \dfrac{7.5\cdot 10^3}{\frac{10}{3}\cdot 10^{-6}} \cdot 0.03 = 67.5 \text{ MPa} \\ \sigma(z=-0.07) = \dfrac{7.5\cdot 10^3}{\frac{10}{3}\cdot 10^{-6}} \cdot (-0.07) = -157.5 \text{ MPa} \end{cases}$$

Dvs största dragspänning är 131.25 MPa
tryckspänning är -157.5 MPa