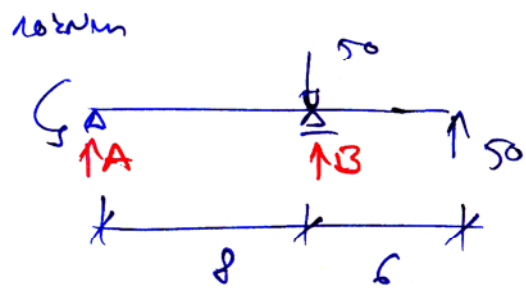
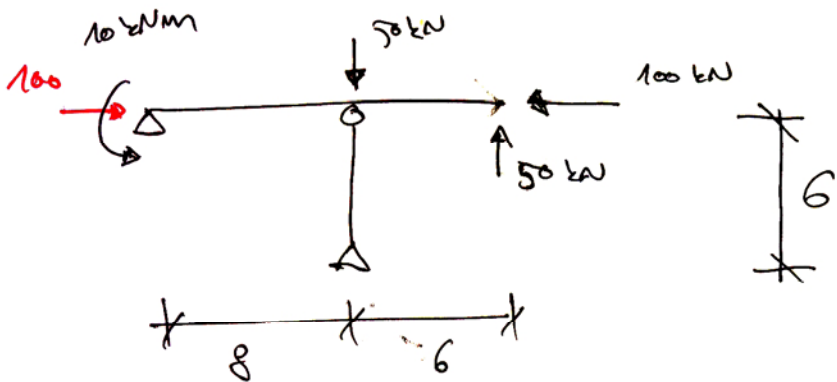


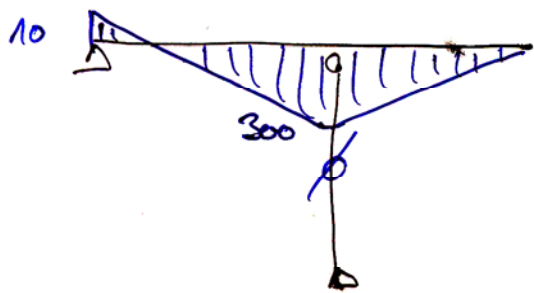
(P)

Na dané konstrukcijske yžske prvke M, N, Q, nakerite M, N ekstremi!

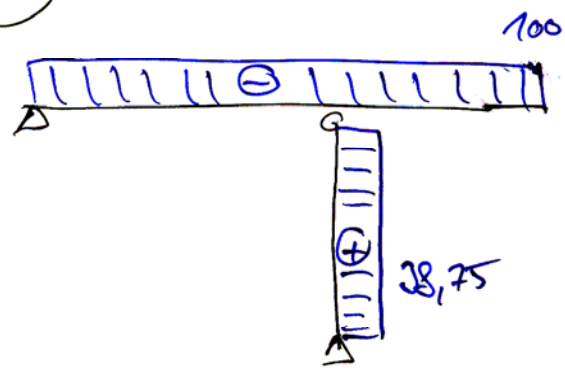
Moment odve = $10 \times 50 \times 6 = 310$
 $\rightarrow B = -\frac{310}{8} = -38,75 \text{ kN}$
 $A = 38,75 \text{ kN}$



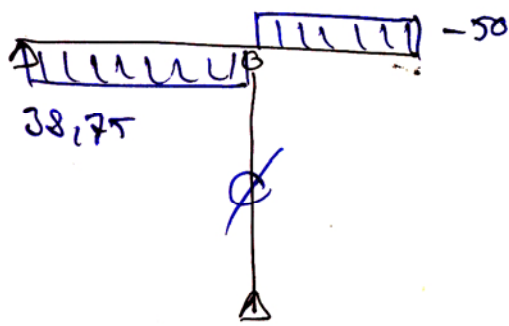
(M)



(N)



(V)



Največi' lah ... 38,75 kN

lah ... 100 kN

moment ... 300 kNm

zšp. moment 10 kNm

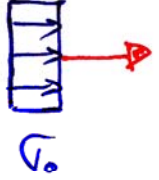
+ kombinace

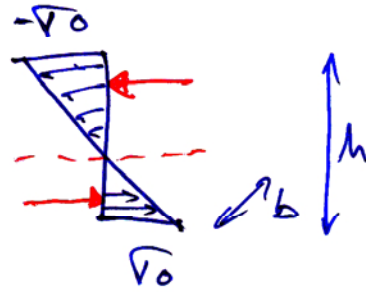
PF

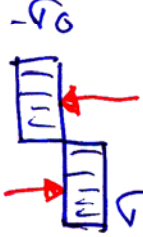
• vrata N_{pl} , M_{el} , M_{pl}

$\sigma_0 = 235 \text{ MPa}$

$\square_{0,25} \quad b=0,1 \quad h=0,25$
0,1

1) N_{pl}  $N_{pl} = \sigma_0 b h = 235 \cdot 10^6 \cdot 0,1 \cdot 0,25 = 5875 \cdot 10^6 \text{ N} = 5875 \text{ MN}$

2) M_{el}  $M_{el} = 2 \cdot b \cdot \frac{h}{2} \cdot \frac{\sigma_0}{2} \cdot \frac{2h}{3} = \sigma_0 \frac{b h^2}{6} = W_{el} \sigma_0$
 $\rightarrow \Sigma F = 0$

3) M_{pl}  $M_{pl} = (2 \cdot b \cdot \frac{h}{2} \cdot \frac{h}{4}) \sigma_0 = \frac{b h^2}{4} \sigma_0 = W_{pl} \cdot \sigma_0$
 $\Sigma F = 0$

$\sigma_0 = \frac{M_{el} \frac{h}{2}}{\frac{1}{12} b h^3} = \frac{6 M_{el}}{b h^2} \Rightarrow M_{el} = \frac{\sigma_0 b h^2}{6}$

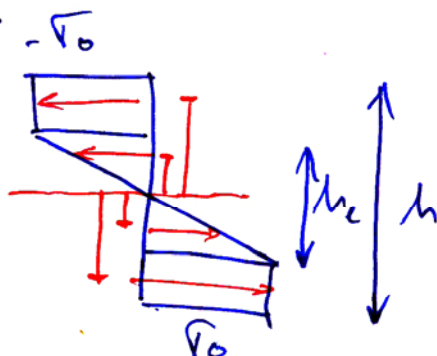
$W_{el} = \frac{b h^2}{6} = \frac{0,1 \cdot 0,25^2}{6} = 0,001042 \text{ m}^3$

$M_{el} = W_{el} \cdot \sigma_0 = 244,792 \text{ kNm}$

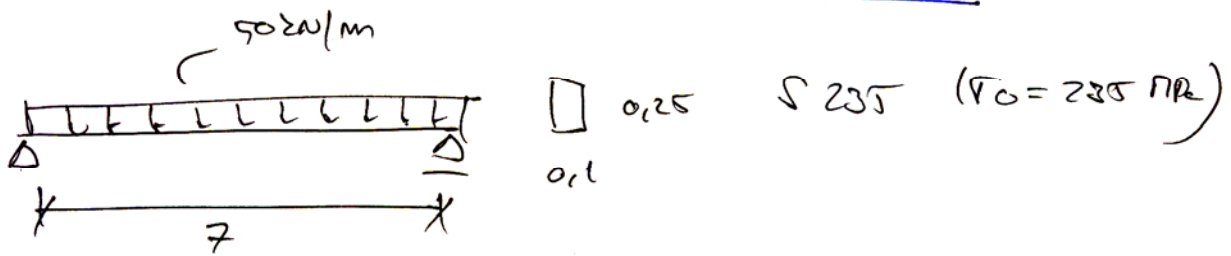
$W_{pl} = \frac{b h^2}{4} = \frac{0,1 \cdot 0,25^2}{4} = 0,001563 \text{ m}^3$

$M_{pl} = W_{pl} \cdot \sigma_0 = 0,001563 \cdot 235 \cdot 10^6 = 367188 \text{ Nm} = 367,2 \text{ kNm}$

$M_{dpl} = \frac{1}{12} b \sigma_0 [3h^2 - h_c^2]$



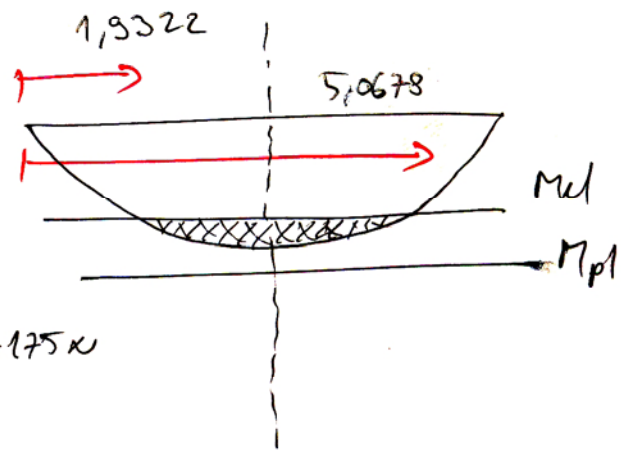
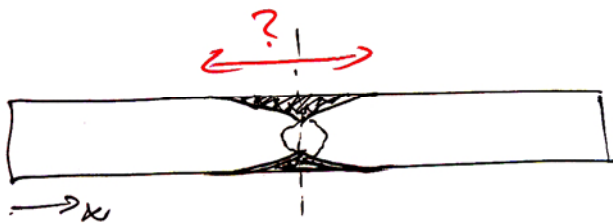
Pro danou konstrukci určete délku plastického oblasti



$M_{el} = 244,792 \text{ kNm}$ $M_{pl} = 367,2 \text{ kNm}$

$M_{max} = \frac{1}{8} q L^2 = \frac{50 \cdot 7^2}{8} = 306,25 \text{ kNm}$

$M_{el} < M_{max} < M_{pl}$



$M(x) = 50 \cdot 3,5 \cdot x - \frac{1}{2} 50 \cdot x^2 = -25x^2 + 175x$

Hledáme x , pro které $M(x) = M_{el}$

$-25x^2 + 175x = M_{el} = 244,792 \quad | : -25$

$x^2 - 7x + 9,792 = 0$

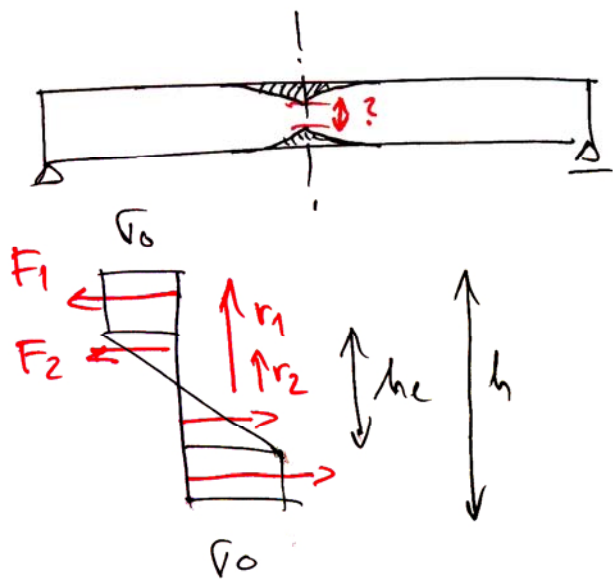
$x_{1,2} = \frac{7 \pm \sqrt{49 - 4 \cdot 9,792}}{2} = \begin{cases} 5,0678 \text{ m} \\ 1,9322 \text{ m} \end{cases}$

Plastická oblast má délku $5,0678 - 1,9322 = 3,1356 \text{ m}$

PF

Pope, str. 4, cv. 7

Pro stejnou konstrukci upevněte uštku elastické oblasti
uprostřed nosníku!



$$M = b \left[\underbrace{2 \sigma_0 \left(\frac{h-h_c}{2} \right)}_{\text{síla } F_1} \cdot \underbrace{\left(\frac{h_c}{2} + \left(\frac{h-h_c}{4} \right) \right)}_{\text{vzdálenost } r_1} + 2 \cdot \underbrace{\frac{h_c}{2} \sigma_0 \frac{1}{2}}_{\text{síla } F_2} \cdot \underbrace{\frac{2}{3} \frac{h_c}{2}}_{\text{vzdálenost } r_2} \right] =$$

$$= b \left[\sigma_0 (h-h_c) \left(\frac{h_c}{4} + \frac{h}{4} \right) + \sigma_0 \frac{h_c^2}{6} \right] = b \sigma_0 \left[\frac{h^2}{4} - \frac{1}{6} h_c^2 \right] =$$

$$= \frac{1}{12} \sigma_0 b [3h^2 - h_c^2] \quad W_{elpl} = \frac{(3h^2 - h_c^2)b}{12}$$

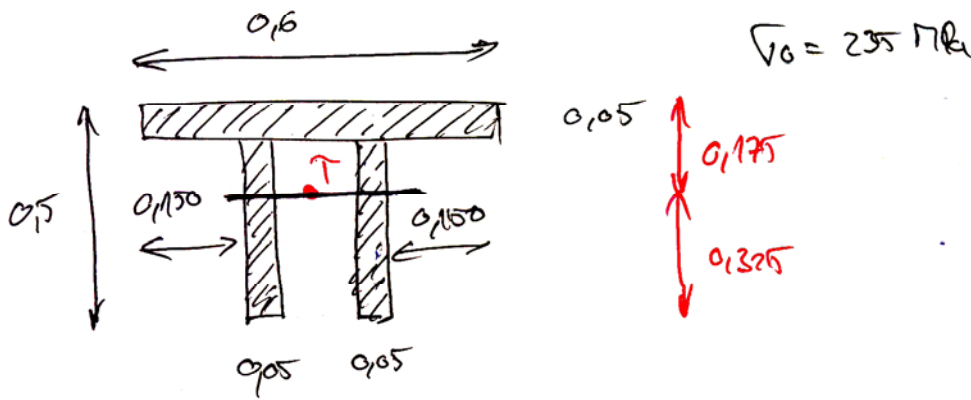
$$M_{elpl} = M_{max} = 306,25 \text{ Nm} = \frac{\sigma_0 b (3h^2 - h_c^2)}{12}$$

$$h_c = \sqrt{\left(\frac{12 \cdot M_{max}}{\sigma_0 b} - 3h^2 \right) \cdot (-1)} = \sqrt{3 \cdot 0,125^2 - \frac{12 \cdot 306,25 \cdot 10^3}{235 \cdot 10^6 \cdot 0,1}} = \underline{\underline{0,1764 \text{ m}}}$$

Elastická oblast uprostřed nosníku má uštku 0,1764 m.

Pi

Uvčete σ_{pl} , N_{pl} + σ_{rel} (max+min)! P_{pr} , ω , f , σ_{str}



$$\sigma_0 = 235 \text{ MPa}$$

Plachna prirca $A = 0,6 \cdot 0,05 + 2 \cdot 0,05 \cdot 0,45 = 0,1075 \text{ m}^2$

Statisticky moment z hornim vlnenim $S_y = 0,6 \cdot 0,05 \cdot 0,025 + 2 \cdot 0,05 \cdot 0,45 \cdot (0,05 + \frac{0,45}{2}) = 0,013125 \text{ m}^3$

$$z_c = \frac{S_y}{A} = \frac{0,013125}{0,1075} = 0,1225 \text{ m}$$

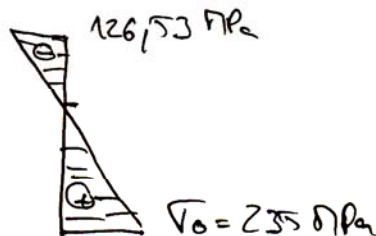
$$I_y = \frac{1}{12} \cdot 0,6 \cdot 0,05^3 + 0,6 \cdot 0,05 \cdot (0,1225 - 0,025)^2 + \frac{1}{12} \cdot 2 \cdot 0,05 \cdot 0,45^3 + 2 \cdot 0,05 \cdot 0,45 \cdot (0,1225 - \frac{0,45}{2})^2 = 0,001890625 \text{ m}^4$$

$\sigma_0 = \frac{M \cdot z}{I}$ W_{el}^{-1} $z = -0,1225 \Rightarrow W_{el}^- = \frac{0,001890625}{0,1225} = 0,015434 \text{ m}^3$
 $\Rightarrow M = \sigma_0 \cdot W_{el}^- = 235 \cdot 10^6 \cdot 0,015434 = 3627 \text{ kNm}$

$z = 0,325 \Rightarrow W_{el}^+ = \frac{0,001890625}{0,325} = 0,005817 \text{ m}^3$

$\Rightarrow M = \sigma_0 \cdot W_{el}^+ = 235 \cdot 10^6 \cdot 0,005817 = 1,367 \text{ MNm}$

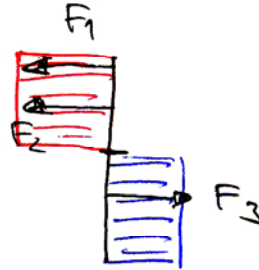
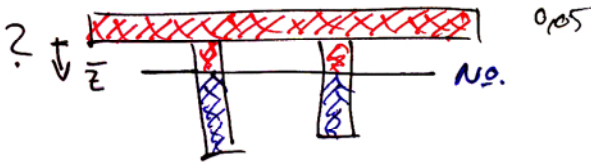
maximálny elastický moment ... 1367 kNm



$$N_{pl} = A \cdot \sigma_0 = 0,075 \cdot 235 = \underline{17,625 \text{ kN}}$$

Maximální ohybový moment

1) musí být splněna podmínka $\Sigma F = 0$



$$F_1 + F_2 = F_3$$

$$\sigma_0 A_1 + \sigma_0 A_2 = \sigma_0 A_3$$

$$A_1 = 0,16 \cdot 0,05 = 0,03 \text{ m}^2$$

$$A_2 = 0,1 \cdot z\text{-bar} = 0,0075 \text{ m}^2$$

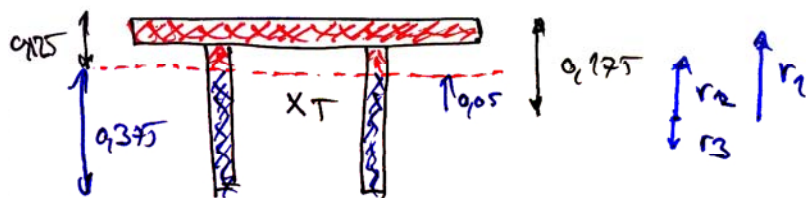
$$A_3 = 0,1(0,15 - z\text{-bar}) = 0,0345 \text{ m}^2$$

$$0,03 + 0,1z\text{-bar} = 0,1(0,15 - z\text{-bar})$$

$$0,12z\text{-bar} = 0,015$$

$$\underline{z\text{-bar} = 0,025 \text{ m}}$$

2) K těžiškové ose P určíme výslednou sílu



$$r_1 = 0,175 - \frac{0,05}{2} = 0,15 \text{ m}$$

$$r_2 = 0,05 + 0,075/2 = 0,0875 \text{ m}$$

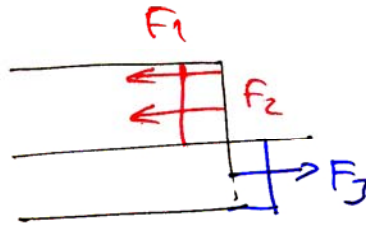
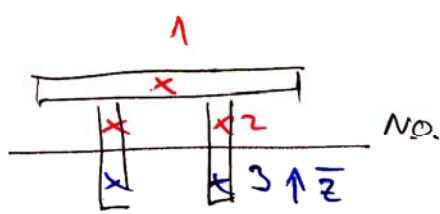
$$r_3 = \frac{0,375}{2} - 0,05 = 0,1375 \text{ m}$$

$$N_{pl} = \sigma_0 [A_1 r_1 + A_2 r_2 + A_3 r_3] \Rightarrow$$

$$\Rightarrow W_{pl} = 0,03 \cdot 0,15 + 0,0075 \cdot 0,0875 + 0,0345 \cdot 0,1375 = 0,010313 \text{ m}^3$$

$$M_{pl} = \sigma_0 W_{pl} = 235 \cdot 10^6 \cdot 0,010313 = 2,42356 \cdot 10^6 \text{ Nm} = \underline{2,42356 \text{ MNm}}$$

Určte max. moment, bude-li současně působit TLAKOVÁ síla 10 N



$$= \leftarrow 10 \text{ N} \curvearrow \uparrow M$$

$$A_1 = 0,05 \cdot 0,1 = 0,005 \text{ m}^2$$

$$A_2 = 0,1(0,05 - \bar{z})$$

$$A_3 = 0,1 \bar{z}$$

$$F_1 + F_2 - F_3 = 10 \text{ N}$$

$$\sigma_0 (A_1 + A_2 - A_3) = 10 \text{ MN}$$

$$\sigma_0 (0,005 + 0,005 - 0,1 \bar{z} - 0,1 \bar{z}) = 10 \text{ MN}$$

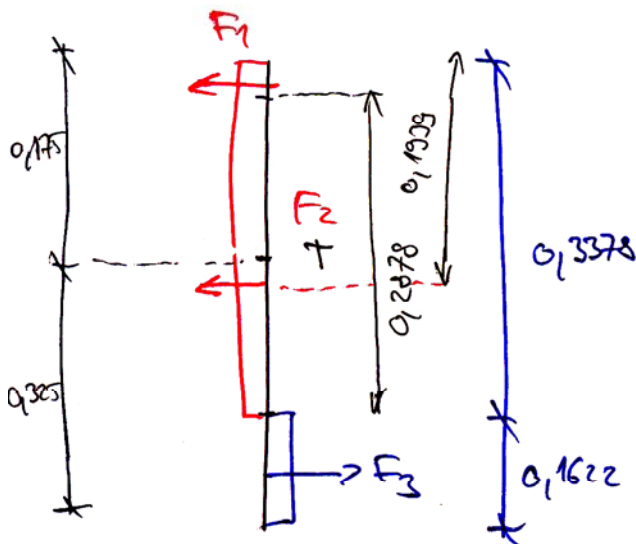
poloha N.O.
$$\bar{z} = \frac{10 - 235(0,005 + 0,005)}{-0,2 \cdot 235} = 0,1622 \text{ m}$$

Zbýva je skýň - určí se výslednou hodnot težištoné osy

$$F_1 = \sigma_0 \cdot A_1 = 235 \cdot 0,005 = 1,175 \text{ N}$$

$$F_2 = \sigma_0 \cdot A_2 = 235 \cdot 0,002877 = 0,67625 \text{ N}$$

$$F_3 = \sigma_0 \cdot A_3 = 235 \cdot 0,1 \cdot 0,1622 = 3,8117 \text{ N}$$



$$r_1 = 0,175 - \frac{0,05}{2} = 0,1125 \text{ m}$$

$$r_2 = 0,1375 - 0,1125 = 0,025 \text{ m}$$

$$r_3 = 0,1622 - \frac{0,1622}{2} = 0,0811 \text{ m}$$

$$M = F_1 r_1 - F_2 r_2 + F_3 r_3 =$$

$$= 1,175 \cdot 0,1125 - 0,67625 \cdot 0,025 +$$

$$+ 3,8117 \cdot 0,0811 = \underline{\underline{1,85936 \text{ Nmm}}}$$