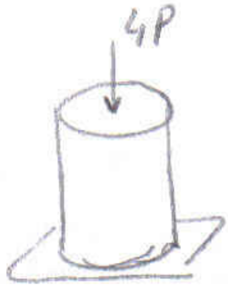
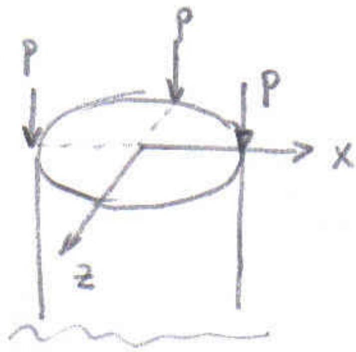
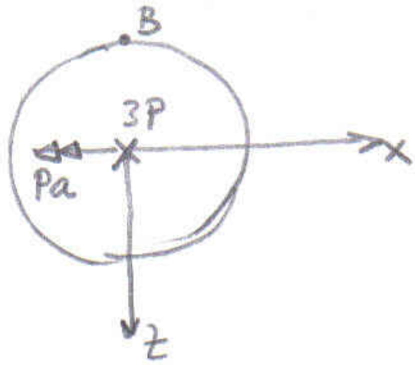
1) a)



$$\sigma = -\frac{4P}{\pi a^2} = -\frac{4 \cdot 1}{\pi \cdot 1^2} = -1{,}273 \ \frac{kN}{cm^2} = -12{,}73 \text{MPa}$$

b)



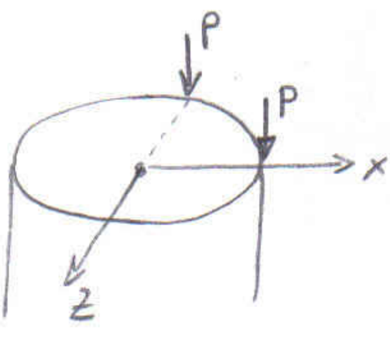


$$\sigma_y = \frac{Pa}{I_x} z - \frac{3P}{A}$$

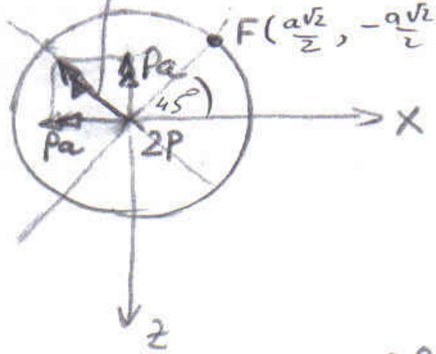
$$\sigma_y^{max} = \sigma_y^B = \frac{Pa}{I_x}(-a) - \frac{3P}{A} = -\frac{Pa^2}{\pi a^4/4} - \frac{3P}{\pi a^2} = -\frac{7P}{\pi a^2}$$

$$= -\frac{7 \cdot 1}{\pi \cdot 1^2} = -2{,}228 \ kN/cm^2 = -22{,}28 \text{ MPa}$$

c)



$M = Pa\sqrt{2}$

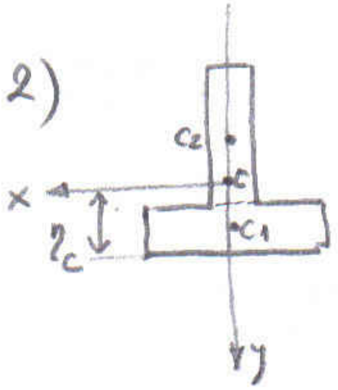


$$\sigma_y = \frac{Pa}{I_x} z - \frac{Pa}{I_z} x - \frac{2P}{A}$$

or $$\sigma_y^{max} = \sigma_y^F = \frac{Pa}{I_x}\left(-\frac{a\sqrt{2}}{2}\right) - \frac{Pa}{I_z}\left(\frac{a\sqrt{2}}{2}\right) - \frac{2P}{A}$$

$$= -\frac{Pa^2\sqrt{2}}{\pi a^4/4} - \frac{2P}{\pi a^2} = -\frac{2+4\sqrt{2}}{\pi}\,\frac{P}{a^2} = -2{,}437\,\frac{kN}{cm^2} = -24{,}37 \text{MPa}$$

2)



$$\eta_c = \frac{\eta_{c_1} A_1 + \eta_{c_2} A_2}{A_1 + A_2} = \frac{7{,}5 \times (40\times15) + 45\times(60\times15)}{40\times15 + 60\times15}$$

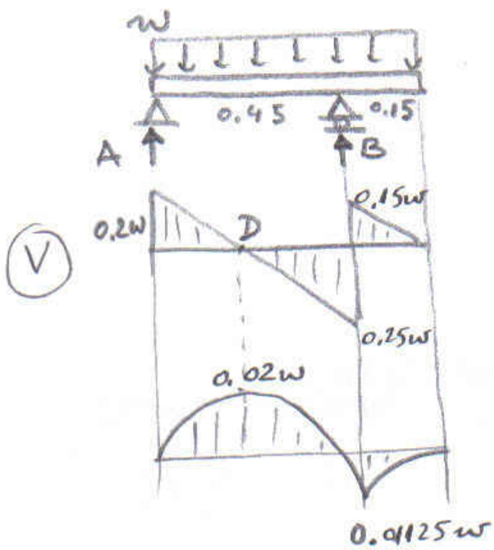
$$\eta_c = 30\ \text{mm}.$$

$$I_x = I_x^{(1)} + I_x^{(2)}$$

$$I_x^{(1)} = \frac{1}{12} 40\times15^3 + (30-7{,}5)^2 (40\times15)$$

$$I_x^{(2)} = \frac{1}{12} 15\times60^3 + (30-15)^2 (60\times15)$$

$$I_x = 787.5\times10^{-9}\ \text{m}^4$$



$$\left.\begin{aligned} A + B - w\cdot 0.6 &= 0 \\ B\cdot 0.45 - w\cdot 0.6\cdot 0.3 &= 0 \end{aligned}\right\} \Rightarrow \begin{aligned} A &= 0{,}2w \\ B &= 0{,}4w \end{aligned}$$

$$M(z) = A\cdot z - w\frac{z^2}{2} \quad , 0 \le z \le 0{,}45$$

$$V(z) = A - wz \quad , \quad -\text{''}-$$

$$V(z) = 0 \rightarrow z = \frac{A}{w} = 0{,}2\ \text{m}.$$

$$M(0{,}2) = 0{,}2w\cdot 0{,}2 - w\cdot\frac{0{,}2^2}{2} = 0{,}02w$$

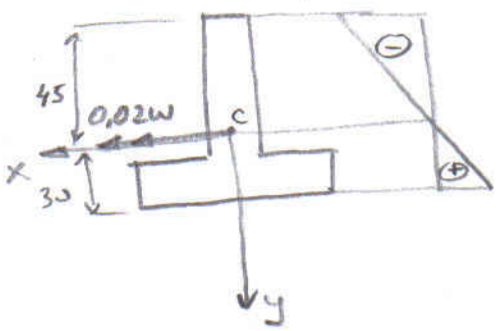
$$M_B = -\frac{1}{2} w\cdot\frac{0{,}15^2}{2} = -0{,}01125w$$

$$V_{max} = 0{,}25w \quad \& \quad M^+_{max} = 0{,}02w = M_D$$

$$M^-_{max} = 0{,}01125w = M_B$$

Normal Stress

Section D : $\sigma_z = \dfrac{0{,}02w}{I_x} y$



$$\sigma^+_{z,max} = \frac{0{,}02w}{I_x}\cdot 0{,}03 \le \sigma^+_{all}$$

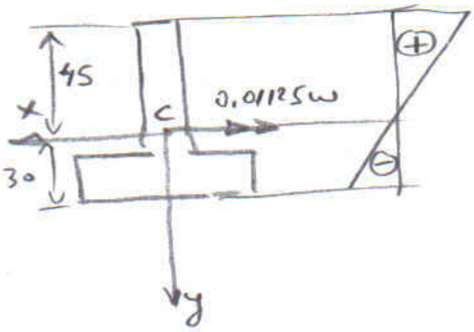
$$w \le \frac{70\times10^6 \times 787{,}5\times10^{-9}}{0{,}02\times0{,}03}$$

$$w \le 91{,}9\ \text{kN/m}$$

$$\sigma^-_{z,max} = \frac{0{,}02w}{I_x}\cdot 0{,}045 \le \sigma^-_{all} \Rightarrow w \le \frac{130\times10^6\times787{,}5\times10^{-9}}{0{,}02\times0{,}045} = 113{,}8\ \frac{\text{kN}}{\text{m}}$$

Section B

$$\sigma_z = -\frac{0.01125w}{I_x}y$$



$$\sigma^+_{z,max} = \frac{0.01125w}{I_x}\cdot 0.045 \leq \sigma^+_{all}$$

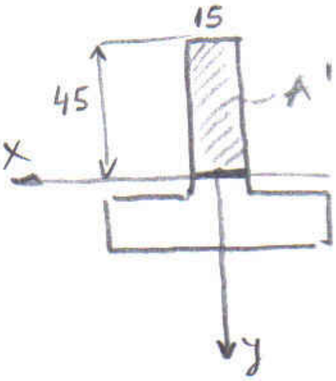
$$w \leq \frac{70\times10^6 \times 787.5\times10^{-9}}{0.01125\times0.045} = 108.9\ \frac{kN}{m}$$

$$\sigma^-_{z,max} = \frac{0.01125w}{I_x}\,0.03 \leq \sigma^-_{all}$$

$$w \leq \frac{130\times10^6 \times 787.5\times10^{-9}}{0.01125\times0.03} = 303\ kN/m$$

Shear stress

Section B (to the left), $V_{max} = 0.25w$



$$\tau_{max} = \frac{V\cdot Q'}{I_x\cdot b} \leq \tau_{all}$$

$$Q' = (45\times15)\cdot\frac{45}{2} = \dots = 15.188\times10^{-6}\,m^3$$

$$b = 15\,mm = 0.015\,m$$

$$\tau_{max} = \frac{0.25w\times15{,}188\times10^{-6}}{787.5\times10^{-9}\times0.015} \leq 60\times10^6$$

$$w \leq 186.7\ kN/m$$

The smallest of all calculated w is

$$w = 91.9\ kN/m.$$