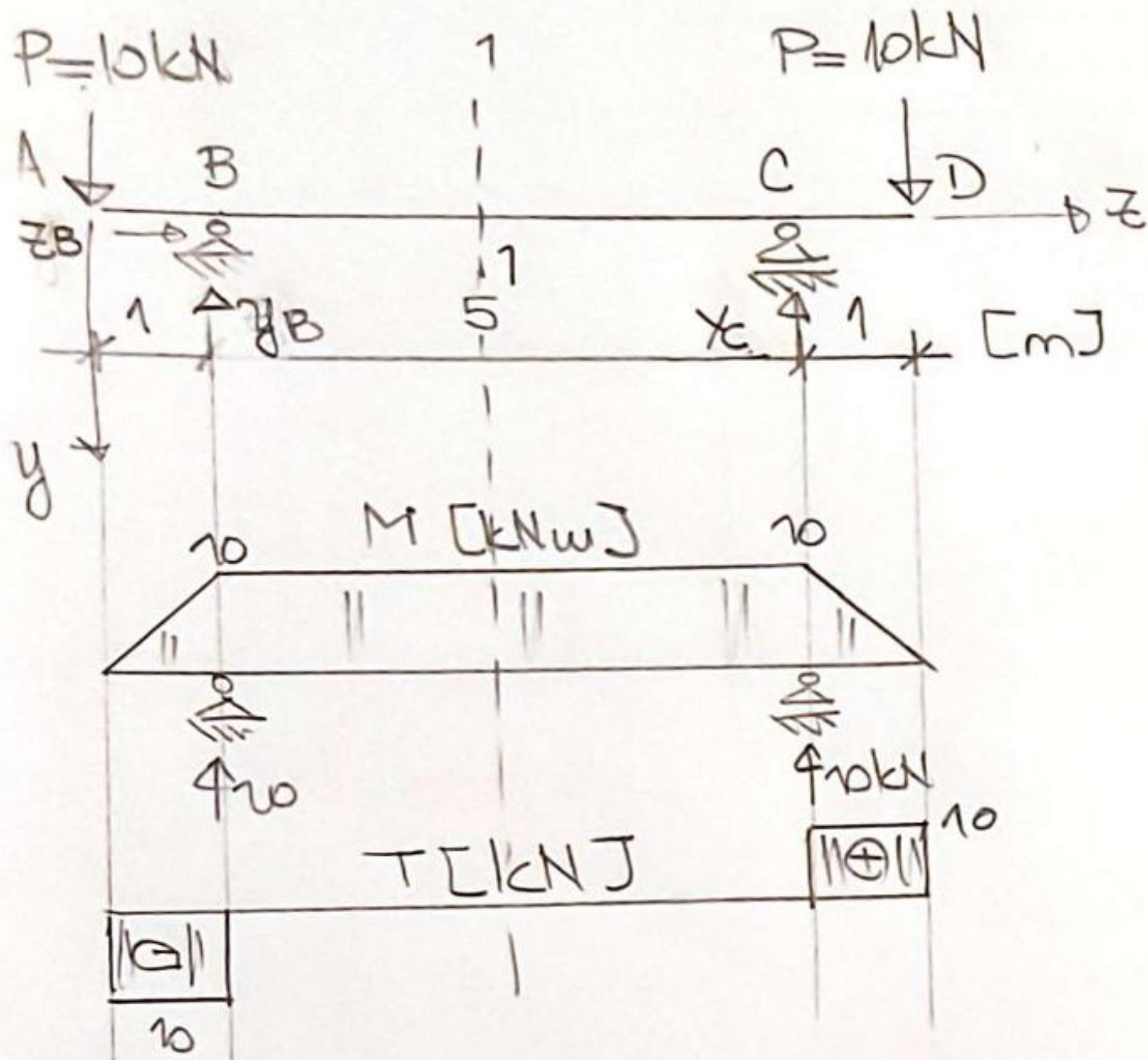


1. Dimenzionisati nosač na slici, a zatim nacrtati dijagram normalnog napona u presjecu 1-1:
 $\sigma_{doz} = 120 \text{ MPa}$



Uslouvi ravnoteže:

$$\sum \varepsilon = 0 \dots (1), \quad \varepsilon_B = 0$$

$$\sum \gamma = 0 \dots (2)$$

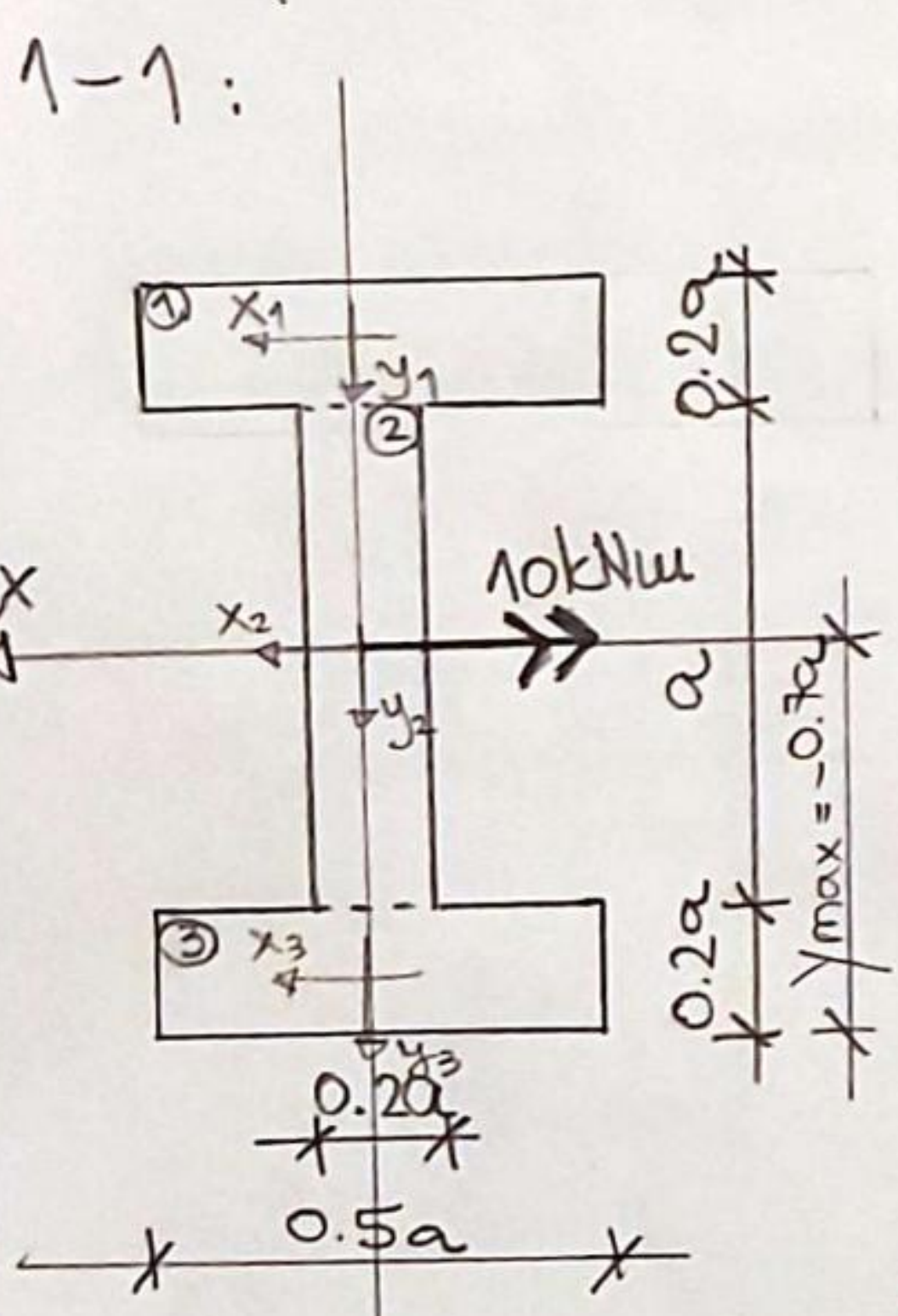
$$-10 + y_B + y_C - 10 = 0, \quad y_B + y_C = 20$$

$$\oplus \sum M_C = 0$$

$$-10 \cdot 6 + y_B \cdot 5 + 10 \cdot 1 = 0, \quad y_B = 10 \text{ kN}$$

$$\text{iz (2)} \Rightarrow y_C = 10 \text{ kN}$$

* Geometrijske karakteristike presjeka:



$$A_1 = A_3 = 0,5a \cdot 0,2a = 0,1a^2$$

$$A_2 = 0,2a \cdot a = 0,2a^2$$

$$I_x = \frac{(0,2a)^3 \cdot 0,5a}{12} + 0,1a^2 \cdot (-0,6a)^2 + \frac{a^3 \cdot 0,2a}{12} + 0 + \frac{(0,2a)^3 \cdot 0,5a}{12} + (0,6a)^2 \cdot 0,1a^2$$

$$I_x = \frac{0,004a^4}{12} + 0,036a^4 + \frac{0,2a^4}{12} + 3,3 \cdot a^4 \cdot 10^{-4} + 0,036a^4$$

$$I_x = 0,089333 \cdot a^4 \quad ; \quad W_x = \frac{I_x}{y_{max}} = \frac{0,089333a^4}{0,7a} = 0,12762a^3$$

$$\sigma_{z, max} = \frac{|M_x|}{I_x} \cdot y_{dmax} = \frac{M_x}{W_x} = \frac{10 \cdot 100}{0,12762a^3} \leq 12 \frac{\text{kN}}{\text{cm}^2} = \sigma_{doz}$$

$$W_x = 0,12762a^3 \geq \frac{1000}{12}$$

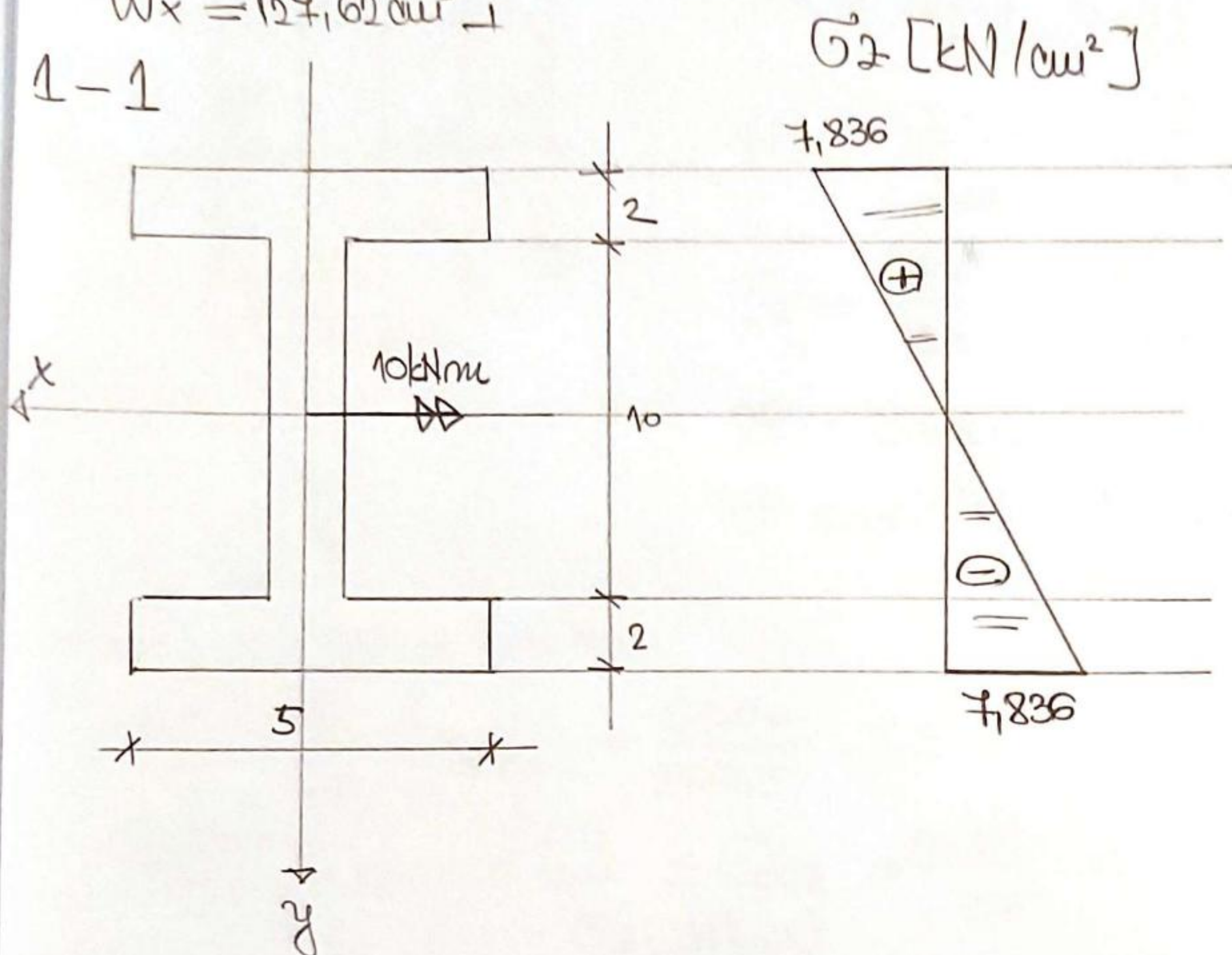
$$0,12762a^3 \geq 83,33 \text{ cm}^3$$

$$a^3 \geq 652,98 \text{ cm}^3$$

$$a \geq 8,67 \text{ cm}, \quad \underline{a = 10 \text{ cm}}$$

$$\sigma_{z, \max} = \frac{1000}{127,62} = 7,836 \leq \sigma_{\text{doz}} = 12 \text{ kN/cm}^2$$

$$W_x = 127,62 \text{ cm}^3$$

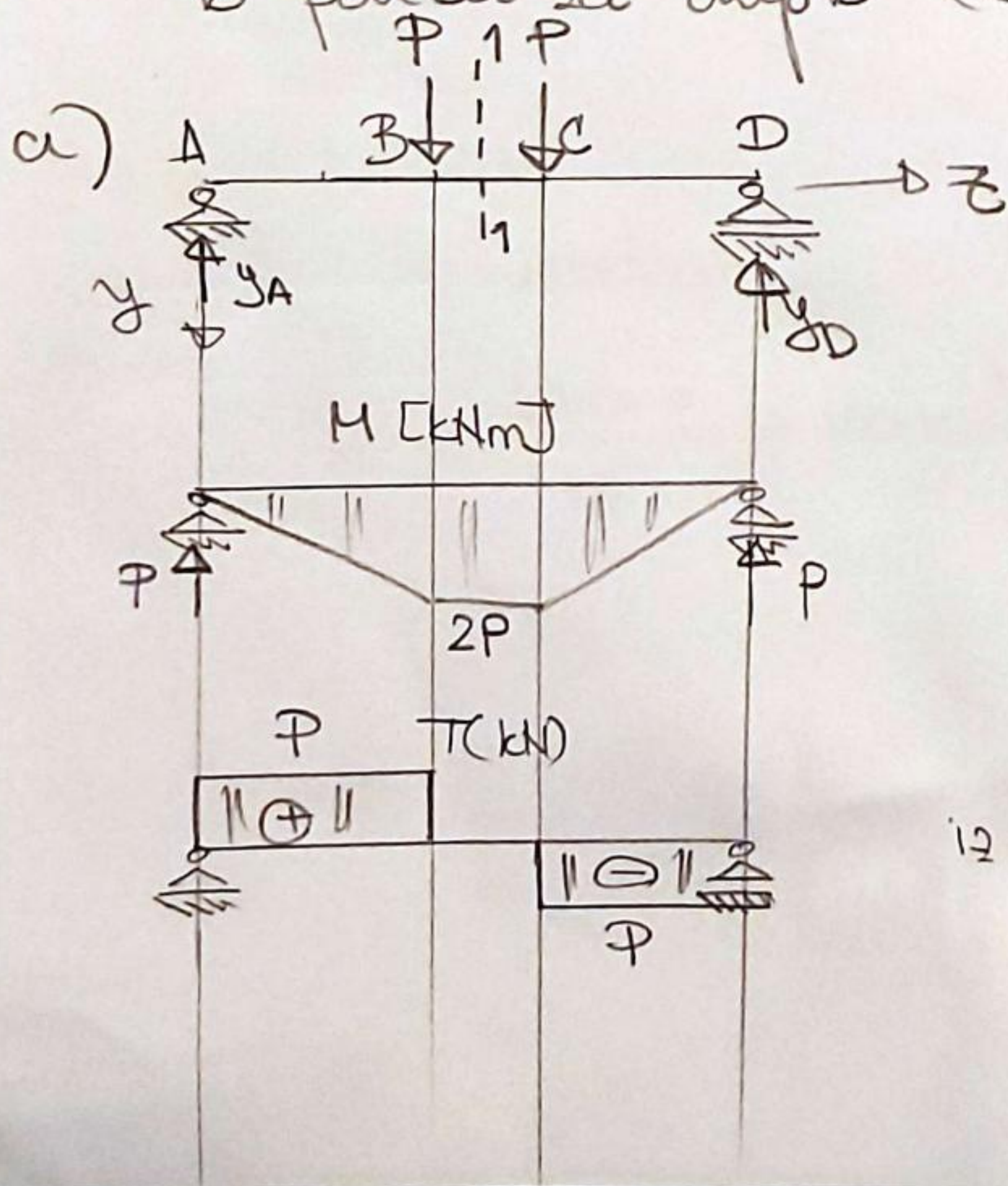


2. a) Odrediti nosivost nosača na slici ($P = ?$)

b) Dijagram normalnih napona u presjeku 1-1

c) Sračunati koliko će se povećati nosivost u slučaju da se h poveća za duplo

d) Sračunati koliko će se povećati nosivost u slučaju da se b poveća za duplo ($\sigma_{\text{doz}} = 16 \text{ kN/cm}^2$)



Uслови ravnoteže:

$$\sum \bar{z} = 0 \dots (1)$$

$$\sum y = 0, \quad y_A - P - P + y_D = 0.$$

$$y_A + y_D = 2P \dots (2)$$

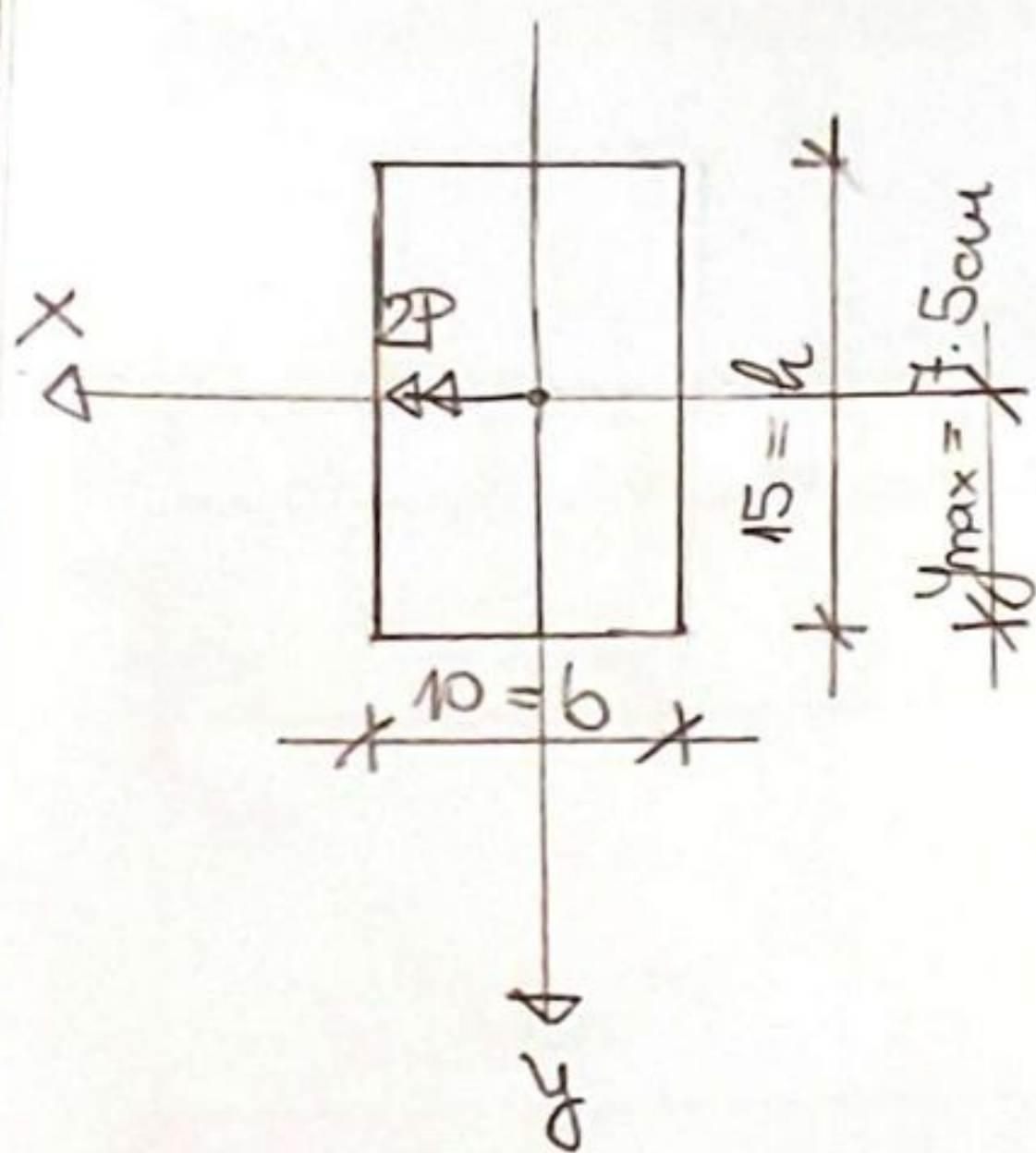
$$\sum M_D = 0 \dots (3)$$

$$y_A \cdot 5 - P \cdot 3 - P \cdot 2 = 0, \quad 5y_A = 5P$$

$$y_A = P$$

$$\text{iz (2)} \Rightarrow y_D = P$$

1-1:



Geom. karakteristike presjeka:

$$I_x = \frac{h^3 b}{12} = \frac{15^3 \cdot 10}{12} = 2812,5 \text{ cm}^4$$

$$W_x = \frac{I_x}{y_{\max}} = \frac{2812,5}{7,5} = 375 \text{ cm}^3$$

$$\sigma_{\pm} = \frac{M_x}{W_x} = \frac{2P}{W_x} \leq \sigma_{\text{doz}} \quad 60 \text{ kNm}$$

$$2P \leq \sigma_{\text{doz}} \cdot W_x, \quad 2P \leq 16 \cdot 375 \quad 2P \leq 6000 \text{ Nm}$$

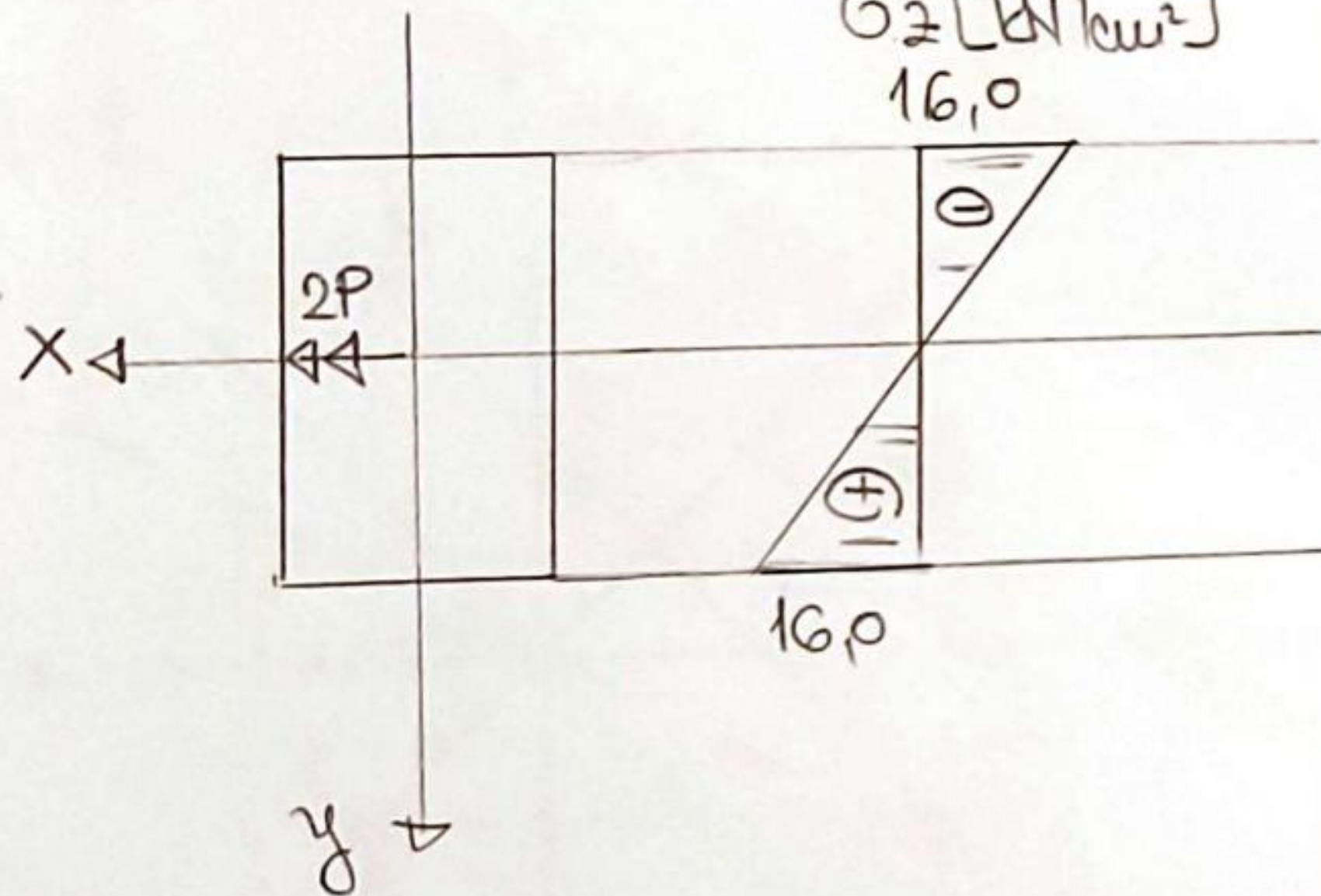
$$2P \leq 60 \text{ kNm} \quad P \leq 30 \text{ kN} \quad \boxed{P = 30 \text{ kN}}$$

$$M_{\max} = 2 \cdot 30 = 60 \text{ kNm}$$

$$b) \quad \sigma_{\pm}^{\max} = \frac{M_x}{I_x} \cdot (y_{\max}) = \frac{6000}{2812,5} \cdot 7,5$$

$$\sigma_{\pm}^{\max} = 16,0 \text{ kN/cm}^2 \leq \sigma_{\text{doz}} = 16 \frac{\text{kN}}{\text{cm}^2}$$

$\sigma_{\pm} [\text{kN/cm}^2]$



$$c) \quad h = 15 \cdot 2 = 30 \text{ cm}$$

$$I_x = \frac{30^3 \cdot 10}{12} = 22500 \text{ cm}^4$$

$$W_x = \frac{I_x}{y_{\max}} = \frac{22500}{15} = 1500 \text{ cm}^3$$

$$\sigma_{\pm} = \frac{M_x}{W_x} \leq \sigma_{\text{doz}}$$

$$2P_1 \leq 16 \cdot 1500$$

$$2P_1 \leq 24000 \text{ kNm} = 240 \text{ kNm}$$

$$P_1 \leq 120 \text{ kN}$$

$$P_1/P = 120/30 = \boxed{4} \text{ u}$$

$$d) \quad b = 10 \cdot 2 = 20 \text{ cm}$$

$$I_x = \frac{15^3 \cdot 20}{12} = 5625 \text{ cm}^4$$

$$W_x = \frac{I_x}{y_{\max}} = \frac{5625}{7,5} = 750 \text{ cm}^3$$

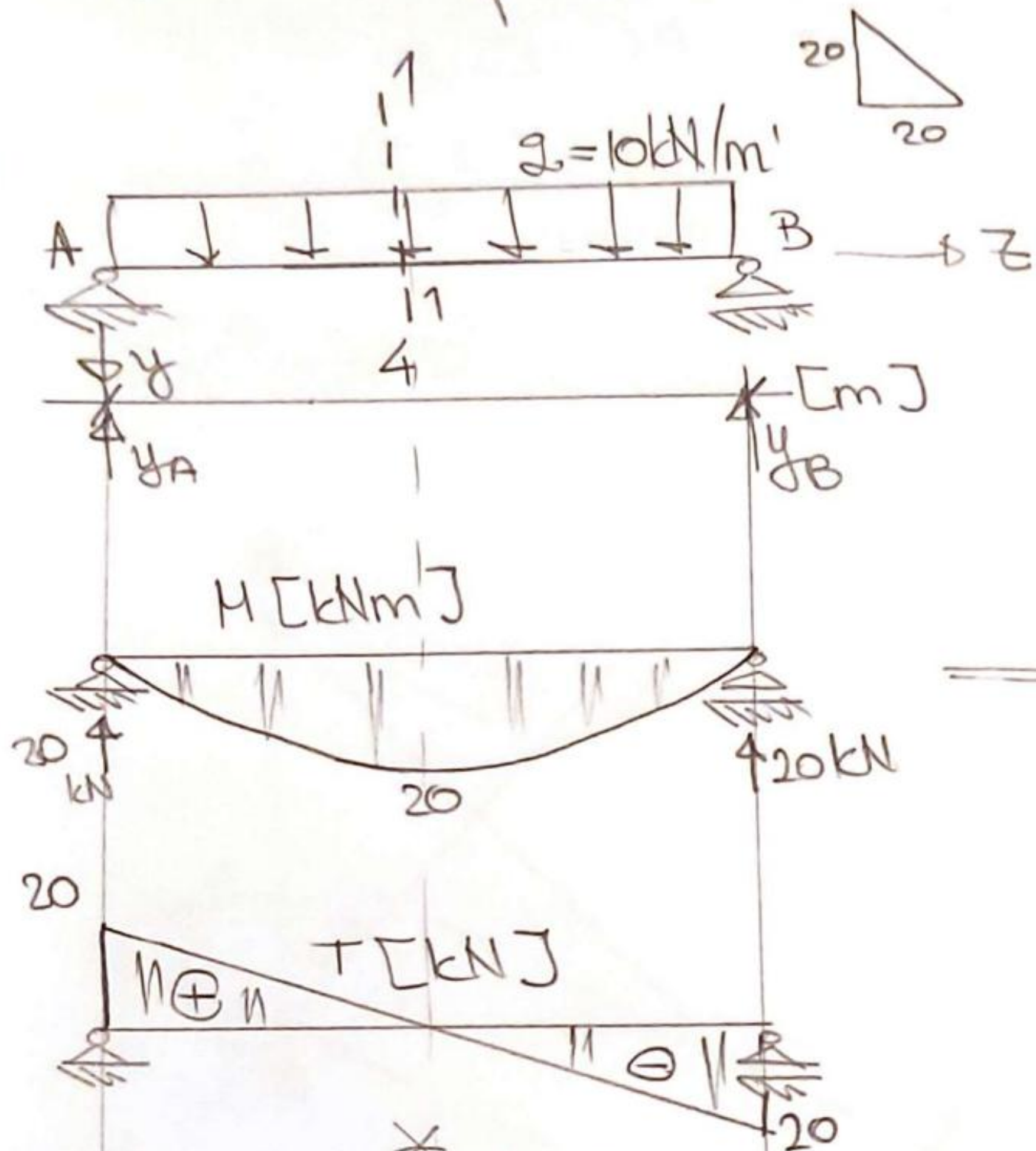
$$2P_1 \leq 16 \cdot 750$$

$$2P_1 \leq 12000 \text{ kNm} = 120 \text{ kNm}$$

$$P_1 \leq 60 \text{ kN} \quad \boxed{P_1 = 60 \text{ kN}}$$

$$P_1/P = 60/30 = \boxed{2} \text{ puta u}$$

3. Za nosač na slici nacrtati dijagram normalnih napona za presjek u sredini nosača:



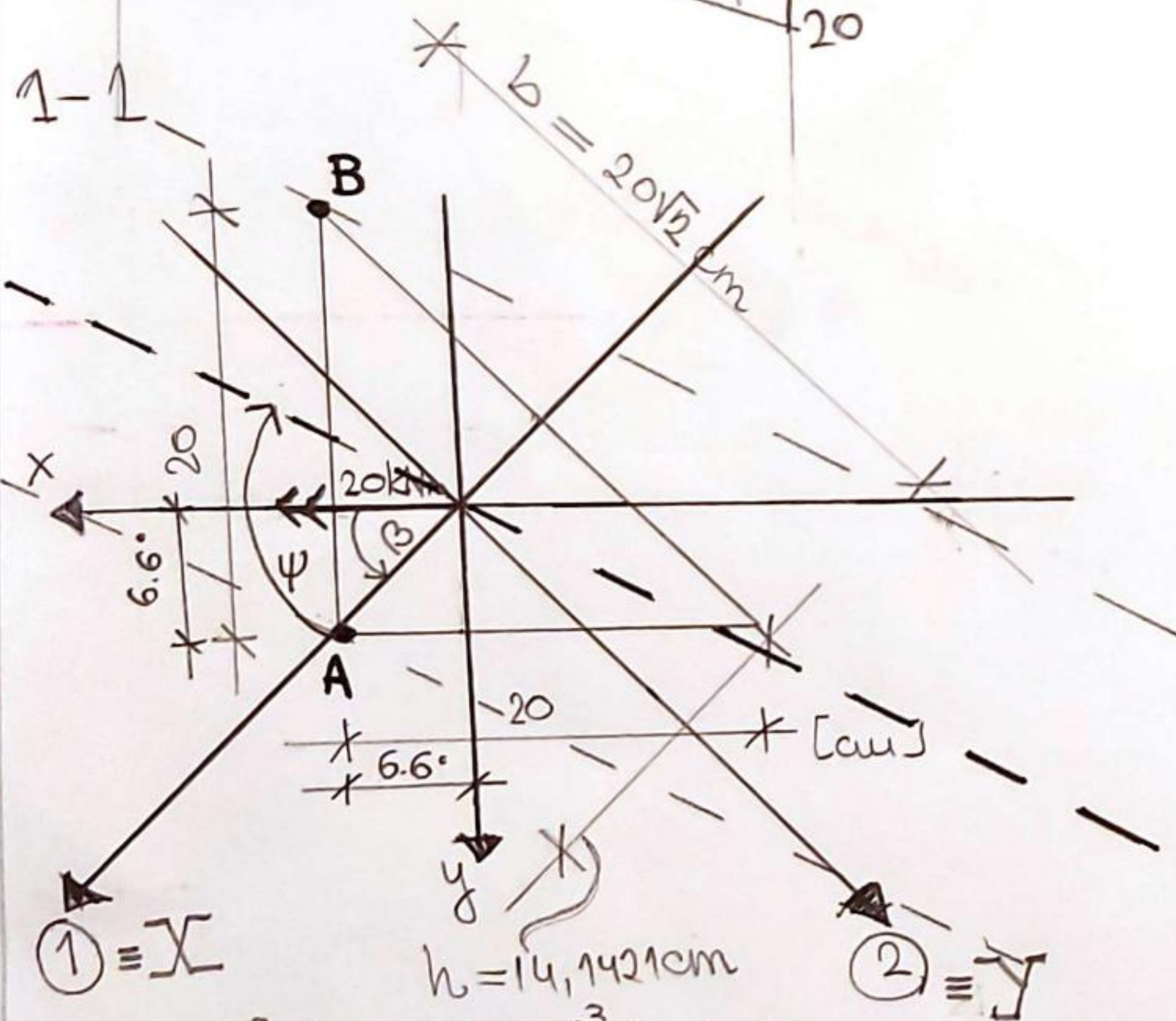
$$\sum z = 0, \quad (1)$$

$$\sum y = 0, \quad y_A + y_B - 10 \cdot 4 = 0 \quad (2)$$

$$\sum M_B = 0 \quad (\oplus) \quad y_A \cdot 4 - 10 \cdot 4 \cdot 2 = 0 \quad (3)$$

$$y_A = 20 \text{ kN}$$

$$\text{iz (2)} \Rightarrow y_B = 20 \text{ kN}$$



$$I_1 = \frac{b^3 \cdot h}{48} = \frac{(20\sqrt{2})^3 \cdot 14,1421}{48} = 6666,65 \text{ cm}^4$$

$$r_h = \sqrt{20^2 - 10^2 \cdot 2} = 14,1421 \text{ cm} \perp$$

$$I_2 = \frac{b^3 \cdot h}{36} = \frac{20\sqrt{2} \cdot 14,1421^3}{36} = 2222,20 \text{ cm}^4$$

$\beta = 45^\circ \rightarrow$ od momenta do gl. ose 1, u smeru supr. kretanja kazaljke na satu.

$$\text{tg } \psi = -\frac{I_1}{I_2} \cdot \text{tg } \beta$$

$$\text{tg } \psi = -\frac{6666,6}{2222,2} \cdot \text{tg } 45^\circ$$

$$\text{tg } \psi = -3, \quad \psi = -71,565^\circ$$

definiše položaj neutralne ose;

$$\textcircled{A} \quad x_A = 9,428 \text{ cm} (\sqrt{6,6^2 + 6,6^2})$$

$$y_A = 0 \quad \underline{\underline{A(9,428; 0)}}$$

\textcircled{B}

$$x_B = -14,1421 + 9,428 = -4,714$$

$$y_B = -14,1421 \text{ cm} \left(-\frac{20\sqrt{2}}{2}\right)$$

$$\underline{\underline{B(-4,714; -14,1421)}}$$

naponi:

$$\sigma_z^A = M \left(\frac{\cos(\theta)}{I_1} y_A + \frac{\sin(\theta)}{I_2} x_A \right) = 20 \cdot 10^2 \cdot \left(\frac{\cos 45^\circ}{6666,6} \cdot 0 + \frac{\sin 45^\circ}{2222,2} \cdot 9,428 \right)$$

$$\sigma_z^A = \underline{\underline{6 \text{ kN/cm}^2}}$$

$$\sigma_z^B = 20 \cdot 10^2 \cdot \left(\frac{\cos 45^\circ}{6666,6} \cdot (-14,1421) + \frac{\sin 45^\circ}{2222,2} \cdot (-4,714) \right) = \underline{\underline{-6 \text{ kN/cm}^2}}$$

