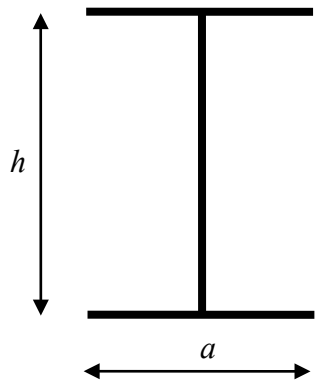
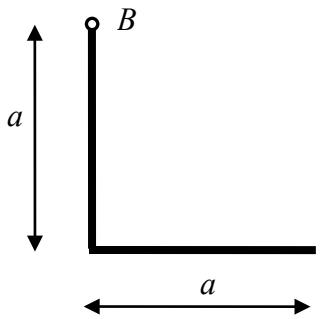
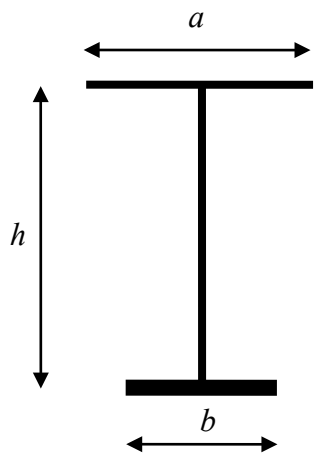


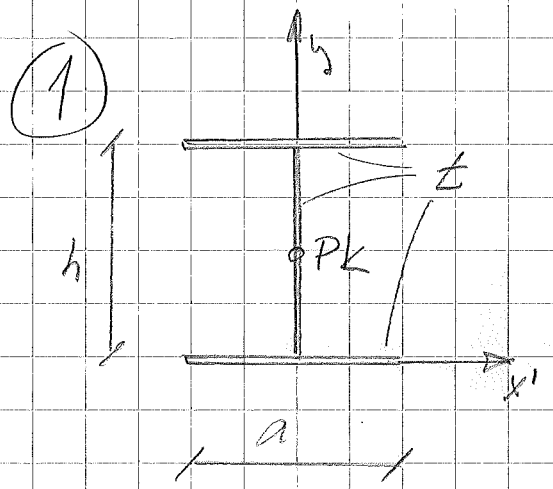
1. Määritä oheisen I-profiilin poikkileikkauksen pintakeskiö, vääntökeskiö, ω-kuvio sekä sektorineliömomentti (käyristymisjäyhyys) I_ω, kun levy paksuus on t.



2. Määritä laskemalla kulmaprofiilin vääntökeskiön paikka. Käytä laskennassa apunapaa B. Levyn paksuus on t.



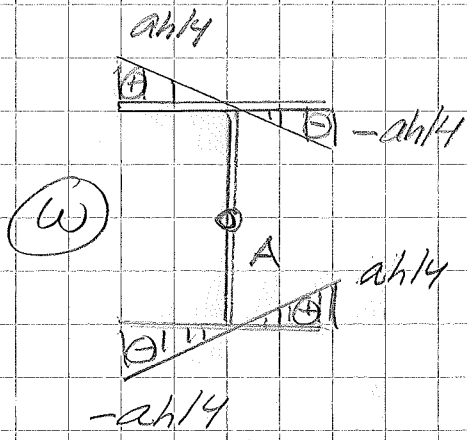
3. Määritä oheisen I-profiilin ohutseinäisen avoimen poikkileikkauksen pintakeskiö, vääntökeskiö, ω-kuvio sekä sektorineliömomentti (käyristymisjäyhyys) I_ω, kun ylälaipan ja uuman paksuus on t ja alalaipan paksuus on $2t$.



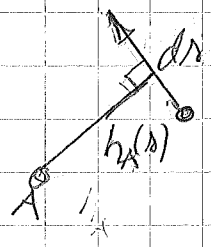
painokeskiö

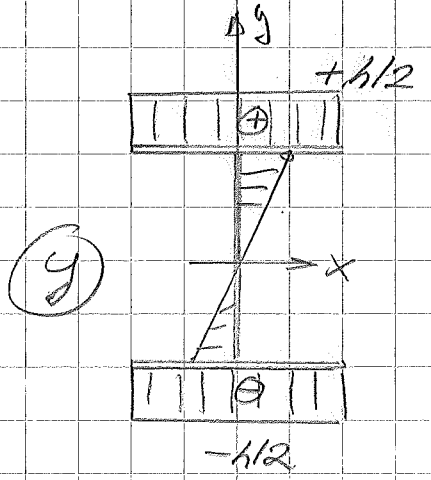
$$y = \frac{a t h + h t h/2}{2at + ht} = \frac{h(a + h/2)}{2(a + h/2)}$$

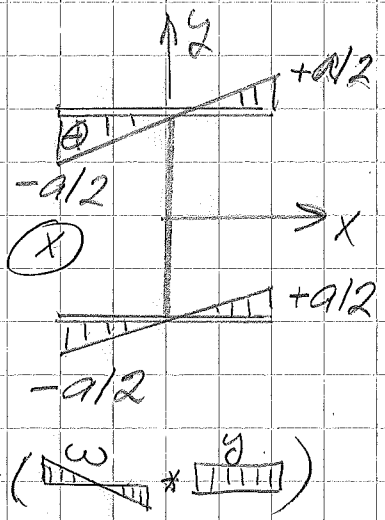
$$= h/2$$



$$\omega_A = \int_A h_A(s)\,ds$$

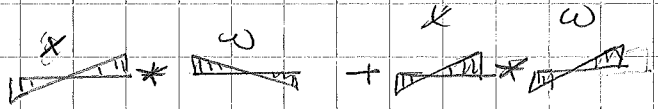






$$2 * \left(\omega * y \right)$$

$$I_{xw} = \int y(s)\,\omega_A(s)\,dA = 0$$

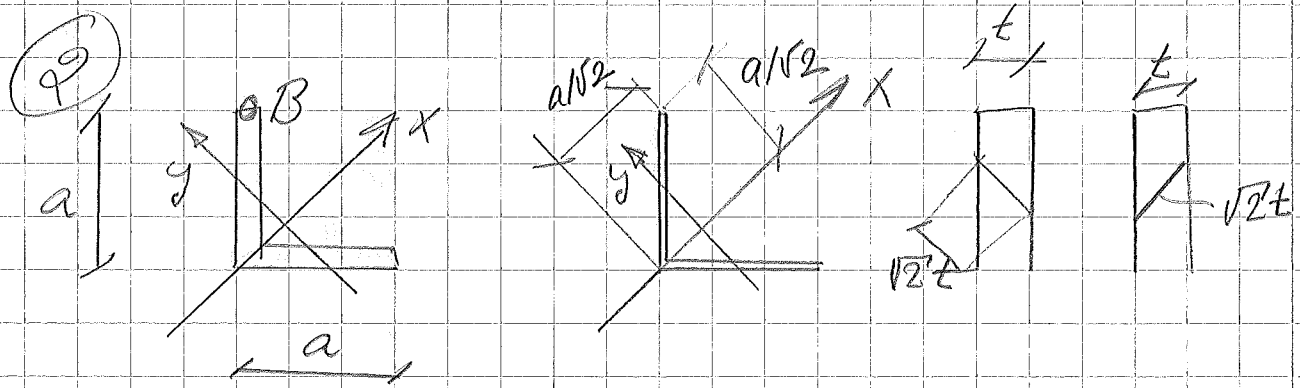


$$I_{yw} = \int x(s)\,\omega_A(s)\,dA = \quad k - k = 0$$

$$I_\omega = \int \omega^2\,dA = 4\,\frac{1}{3}\left(\frac{ah}{4}\right)^2 t\,\frac{a}{2} = \underline{\frac{1}{24}\,a^3 h^2 t}$$

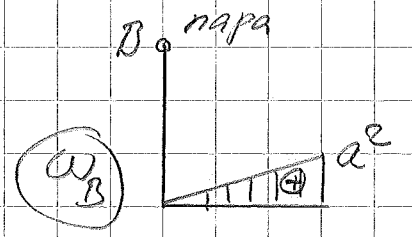
$$\int \left(\alpha * \alpha \right) = \frac{1}{3}\,\alpha^2 t$$

(9)



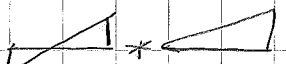
$$I_x = 2 * \frac{1}{3}\sqrt{2}t\left(\frac{a}{\sqrt{2}}\right)^3 = \frac{1}{3}ta^3$$

$$I_y = 2 * \frac{1}{12}\sqrt{2}t\left(\frac{a}{\sqrt{2}}\right)^3 = \frac{1}{12}ta^3$$

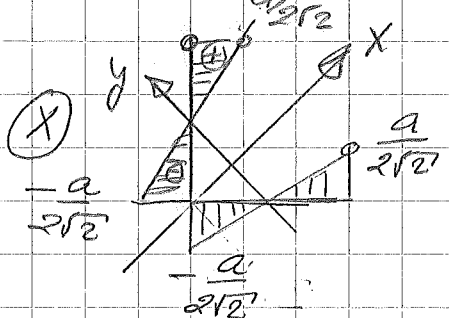


(ω_B)

$$y_A - y_B = \frac{-\int x\omega dA}{I_y}$$



(X)

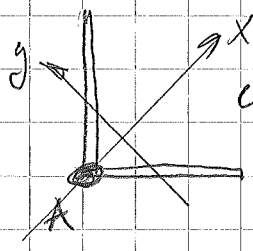


$$\int x\omega dA = \frac{1}{6}a\,a^2\left(-\frac{a}{2\sqrt{2}} + \frac{2a}{2\sqrt{2}}\right)t$$

$$= \frac{1}{12\sqrt{2}}a^4 t$$

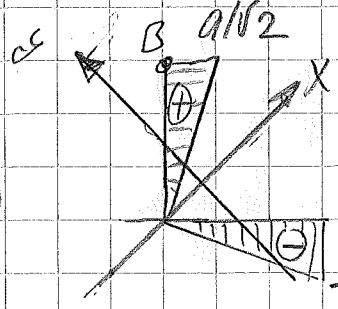
$$y_A - y_B = \frac{-\frac{1}{12\sqrt{2}}a^4 t}{\frac{1}{12}ta^3} = -\frac{a}{\sqrt{2}}$$

$$y_B = \frac{a}{\sqrt{2}} \qquad y_A = -\frac{a}{\sqrt{2}} + \frac{a}{\sqrt{2}} = 0$$



$\omega_A \equiv 0 \rightarrow I_\omega = \int \omega_A^2 dA = 0$

2 jatkoa



(y)

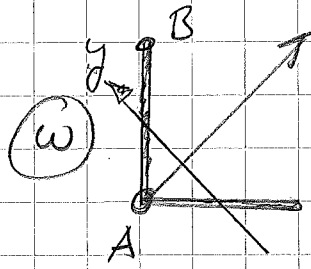
$$x_A - x_B = \frac{+\int y\omega_B\, dA}{I_x}$$

$$\int y\omega_B\, dA = \frac{1}{3}at\left(-\frac{a}{\sqrt{2}}\right)a^2 = -\frac{1}{3\sqrt{2}}a^4t$$

$$x_A - x_B = \frac{-\frac{1}{3\sqrt{2}}a^4t}{\frac{1}{3}a^3t} = -\frac{a}{\sqrt{2}} \qquad x_B = \frac{a}{2\sqrt{2}}$$

$$x_A = \frac{a}{2\sqrt{2}} - \frac{a}{\sqrt{2}} = -\frac{a}{2\sqrt{2}}$$

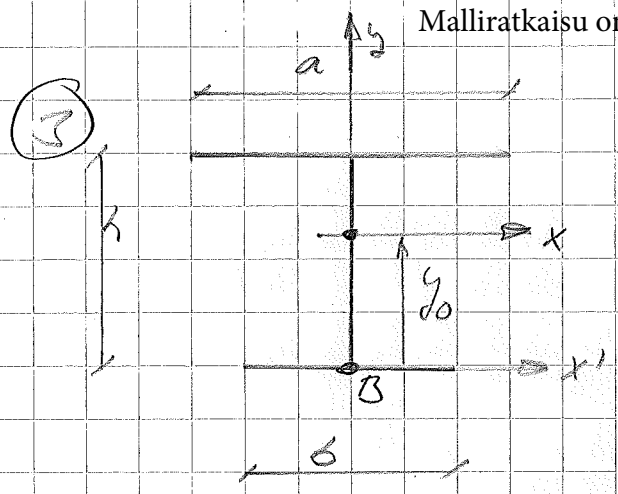
$$(x_A, y_A) = \left(-\frac{a}{2\sqrt{2}}, 0\right)$$



(ω)

$$\omega_A = 0 \Rightarrow I_\omega = \int \omega_x^2\, dA = 0$$

Malliratkaisu on annettu tehtävään, jossa alalaipan paksuus on t

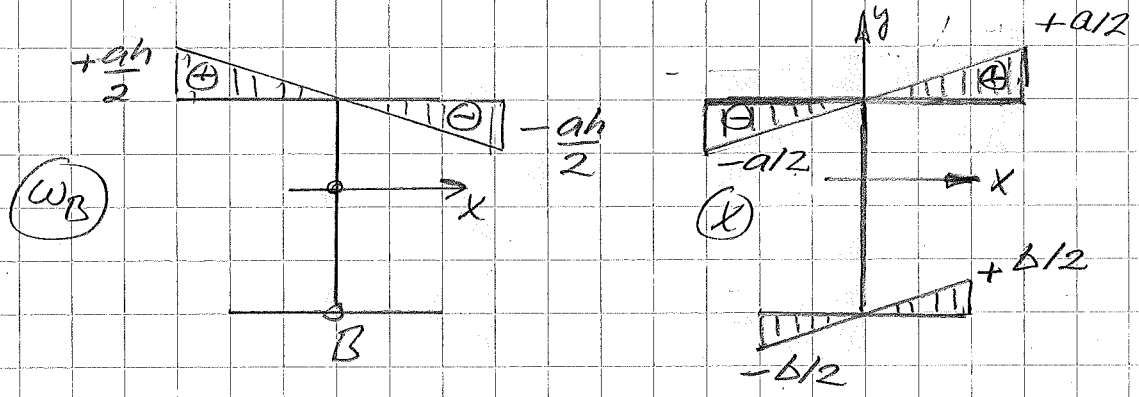


Pintakeskiö

$$y_0 = \frac{bt \cdot h/2 + at \cdot h}{bt + at + bt}$$

$$= \frac{0{,}5h^2 + ah}{b + a + b}$$

Valitaan mielivaltainen B navaksi



$$y_A - y_B = \frac{-\int x \omega_B \, dA}{I_y}$$

$$-\int x \omega_B \, dA = -t \cdot 2 \left(\frac{1}{3} \frac{a}{2} \left(-\frac{ah}{2} \right) \frac{a}{2} \right) = \frac{1}{12} t a^3 h$$

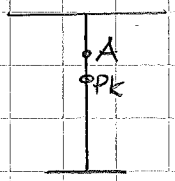
$$\int_0^L \bar{m} M \, dx = \frac{1}{3} L \bar{m} M$$

$$I_y = \frac{1}{12}(ta^3 + tb^3)$$

$$y_A - y_B = \frac{\frac{1}{12} t a^3 h}{\frac{1}{12}(ta^3 + tb^3)} = \frac{a^3 h}{a^3 + b^3}$$

Esim jos $a = h$ $b = a/2$

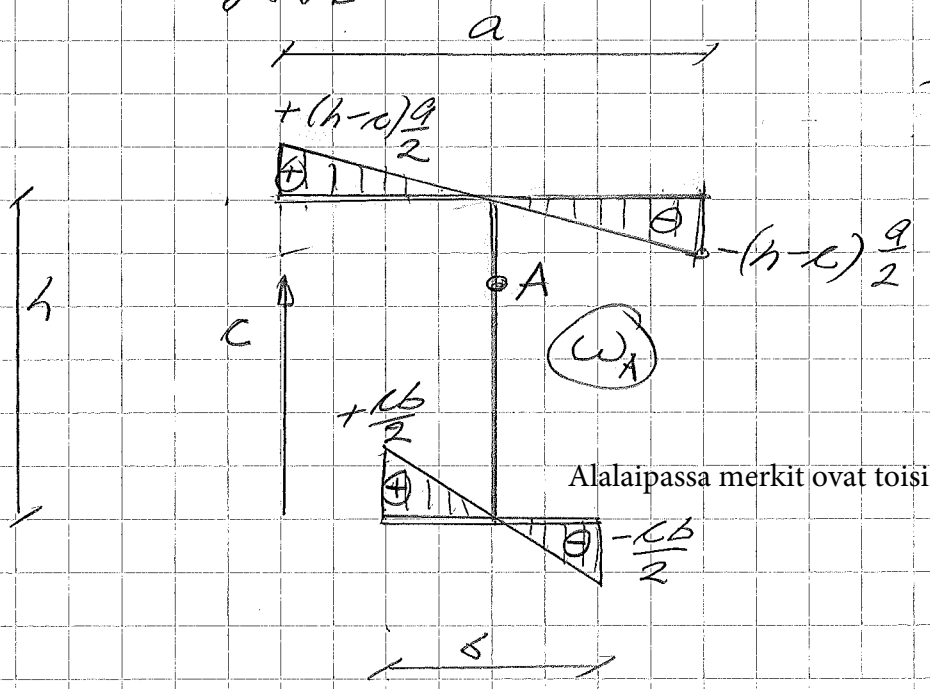
$\Rightarrow y_0 = 0{,}6h$ $y_A - y_B = 0{,}889h$



A on vääntökeskiö

merkitään $c = y_A - y_B$

3 jatkuva



Alalaipassa merkit ovat toisinpäin

huom. $S_\omega = \int \omega_x \, dA = 0 \Rightarrow$ ok

Merkkisääntö: Jos pinta-alaviuhka on vastapäivään, niin merkki on positiivinen.
Jos pinta-alaviuhka on myötäpäivään, niin merkki on negatiivinen