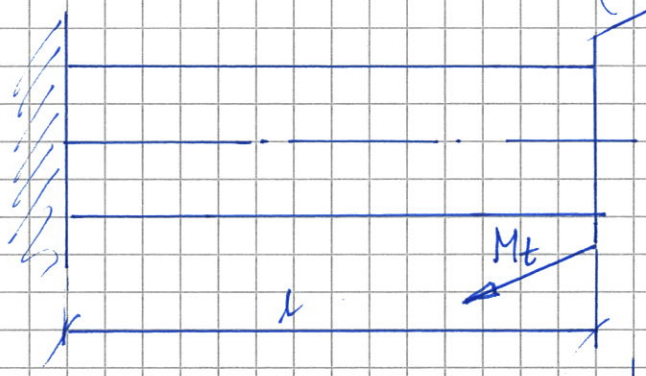
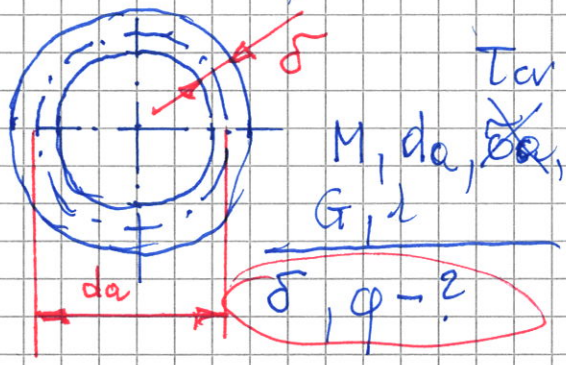
Torsion_2

Exe 1. / ćw. 1



Thin-walled pipe / tube
(rura cienkościenna)



(1) For thin-walled tubes

$$\tau_a = \frac{\tau_{max} + \tau_{min}}{2}$$

$$\tau_a = \frac{M_t \cdot r_a}{I_o}$$

d_a – average diameter (średnia średnica)

δ – thickness of the wall (grubość ścianki)

$r_a = \frac{d_a}{2}$ – average radius (średni promień)

τ_{cr} – allowable tension (naprężenie dopuszczalne / krytyczne)

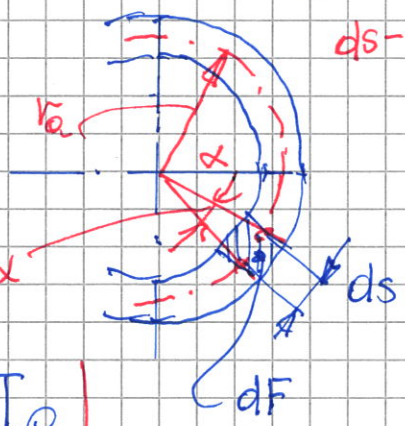
τ_a – average stress

(2) Moment of inertia

$$I_o = \int_F r_a^2 \cdot dF = \int_F r_a^2 \cdot \delta \cdot ds =$$

$$= \int_0^{2\pi} r_a^2 \delta \cdot r_a \cdot d\alpha =$$

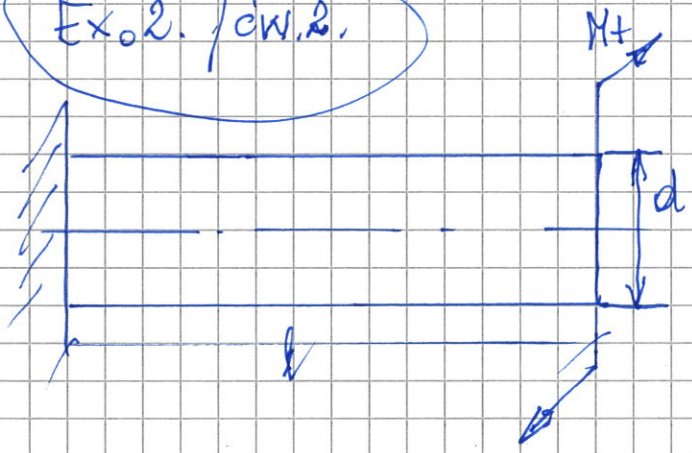
$$= \int_0^{2\pi} r_a^3 \cdot \delta \cdot d\alpha = \boxed{2\pi \delta r_a^3 = I_o}$$

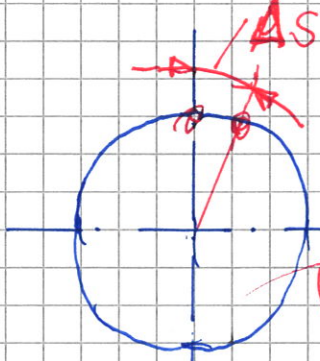


$$\tau_a \le \tau_{cr} \qquad \tau_{cr} \le \frac{M_t \cdot r_a}{I_o} = \frac{M_t \cdot r_a}{2\pi \delta r_a^3} = \frac{M_t}{2\pi \delta \cdot r_a^2}$$

$$\boxed{\delta \ge \frac{M_t}{2\pi \tau_{cr} \cdot r_a^2}} \qquad \boxed{\varphi = \frac{M_T \cdot l}{G \cdot I_o} = \frac{M_t \cdot l}{G \cdot 2\pi \delta r_a^3} = \frac{M_t \cdot l}{2\pi G \delta r_a^3}}$$

Ex. 2. / cw. 2.





$M_t, l, \Delta S, E, d$

$\nu = ?$

ν - Poisson's ratio (współczynnik Poissona)

① Rotation / deformation angle (kąt obrotu)

$$\varphi = \frac{\frac{\Delta S}{2}}{\frac{d}{2}} = \frac{2 \cdot \Delta S}{d}$$

$$\varphi = \frac{M_T \cdot l}{G I_0} \Rightarrow G = \frac{M_T \cdot l}{\varphi \cdot I_0}$$

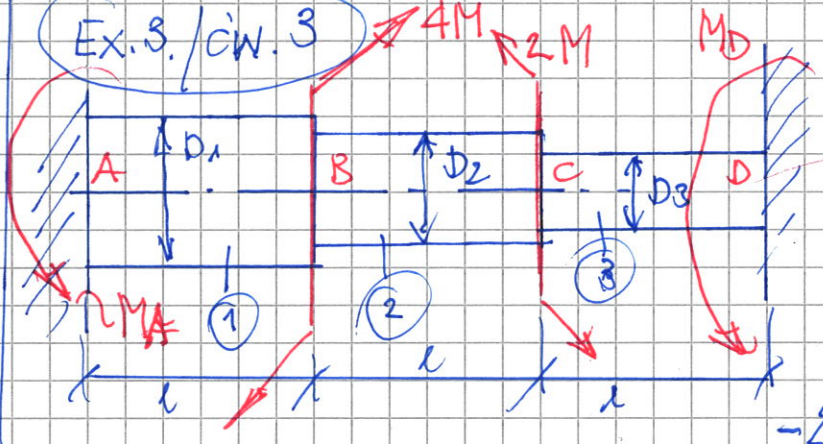
② Poisson's ratio - ν

$$G = \frac{E}{2(1+\nu)} \Rightarrow \boxed{\frac{E}{2G} - 1 = \nu}$$

$$\nu = \frac{E \varphi \cdot I_0}{2 M_T \cdot l} - 1 = \frac{E \cdot 2 \Delta S}{2 M_T \cdot l \cdot d} - 1$$

$$\boxed{\nu = \frac{E \cdot \Delta S}{M_T \cdot l \cdot d} - 1}$$

Ex. 3. / cw. 3



$D_1 = 3D, D_2 = 2D, D_3 = D$

l, G, M

$\tau_1, \tau_2, \tau_3 = ?$

as homework !