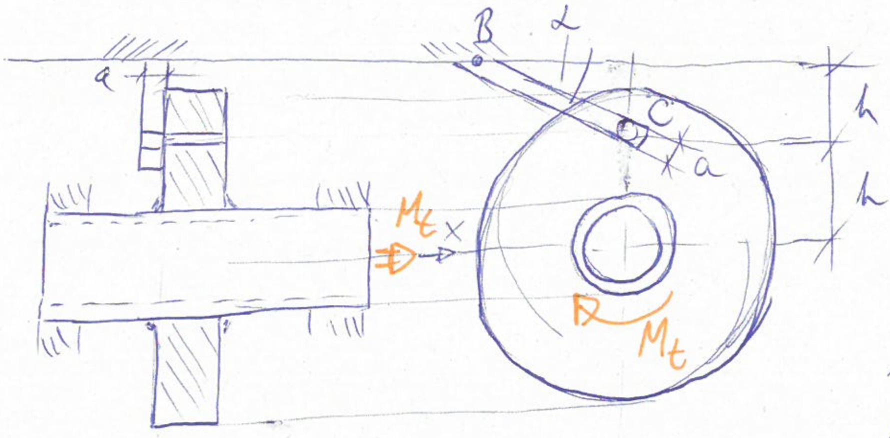
5.1



$\tau_{meg} = 50\,MPa$

$\sigma_{meg} = 100\,MPa$

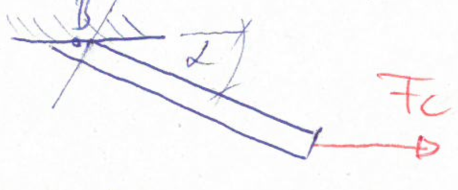
$M_t = 1\,kNm$

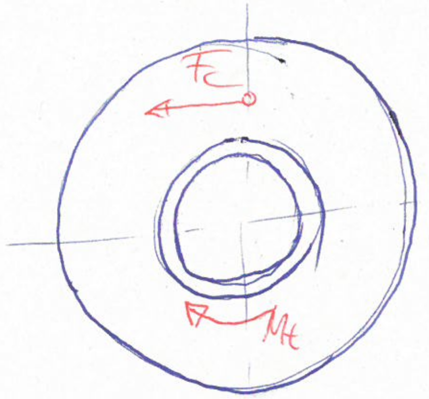
$v = 5\,mm$

$h = 0.2\,m$

$\alpha = 60°$

méretezés $d_k = ?$ középes átmérőre, $a = ?$ (húzás + hajlítás)





$F_C \cdot h - M_t = 0$

$F_C = \frac{M_t}{h} = 5000\,N$

B pontra redukálva F_C-t

$N_B = \cos\alpha \cdot F_C$

$M_{hB} = F_C \cdot h$

$V_B = \ldots$

'a' meghatározása hajlításra méretezünk, hajlítás + húzásra ellenőrzünk

$\sigma_x^B(z) = \frac{M_{hB}}{\frac{a \cdot a^3}{12}} \cdot z \qquad \sigma_x^{BMAX} = \frac{M_{hB}}{\frac{a \cdot a^3}{12}} \cdot \frac{a}{2} \le \sigma_{meg} \rightarrow a \ge 39.15\,mm \rightarrow a = 40\,mm$

ellenőrzés

$\sigma_x^B(z) = \frac{N_B}{a^2} + \frac{M_{hB}}{\frac{a \cdot a^3}{12}} z \rightarrow \sigma_x^B\left(\frac{a}{2}\right) = \sigma_x^{BMAX} = 93.75\,MPa < \sigma_{meg}$ ✓

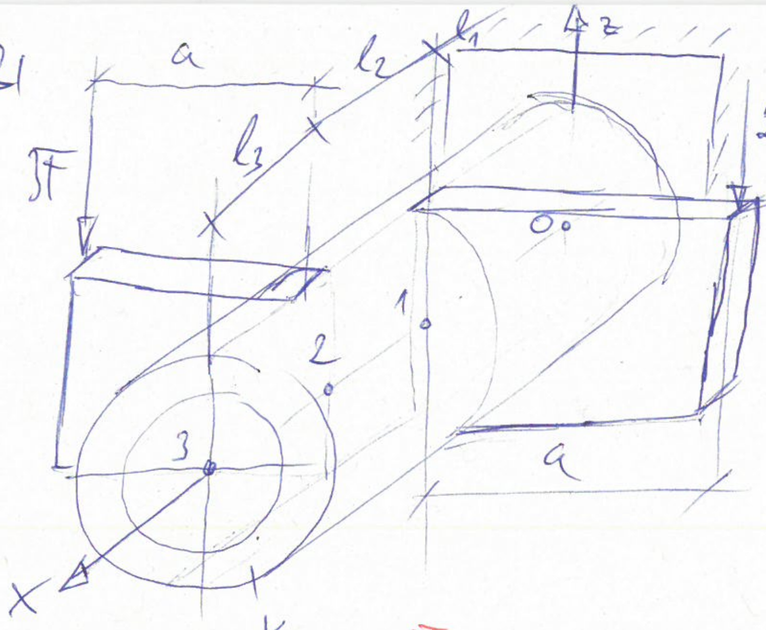
'd_k' meghatározása $I_p \approx \frac{d_k^3 \pi v}{4}$

$\tau_{xy} = \frac{M_t}{I_p} \cdot \frac{d_k}{2} \le \tau_{meg} \qquad d_k \ge 50.46\,mm \rightarrow \underline{d_k = 51\,mm} \qquad I_p = \frac{(d_k+v)^4 \pi}{32} - \frac{(d_k-v)^4 \pi}{32}$

51 mm-re nem felel meg az ellenőrzéskor $\tau_{xy}^{MAX} = \frac{M_t}{I_p} \cdot \frac{d_k+v}{2} = 54.42\,MPa > \tau_{meg}$ ✗

$\underline{d_k = 53\,mm}$ már megfelel a pontos összefüggéssel is!

5.21

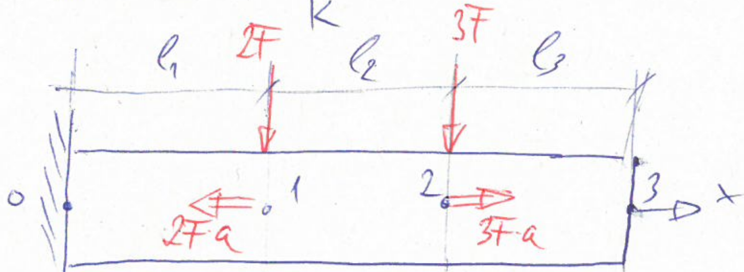


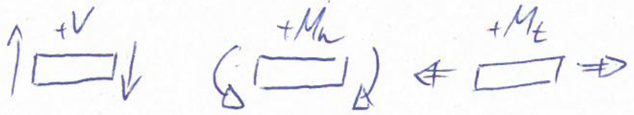
D = 100 mm, d = 80 mm, a = 0.75 m

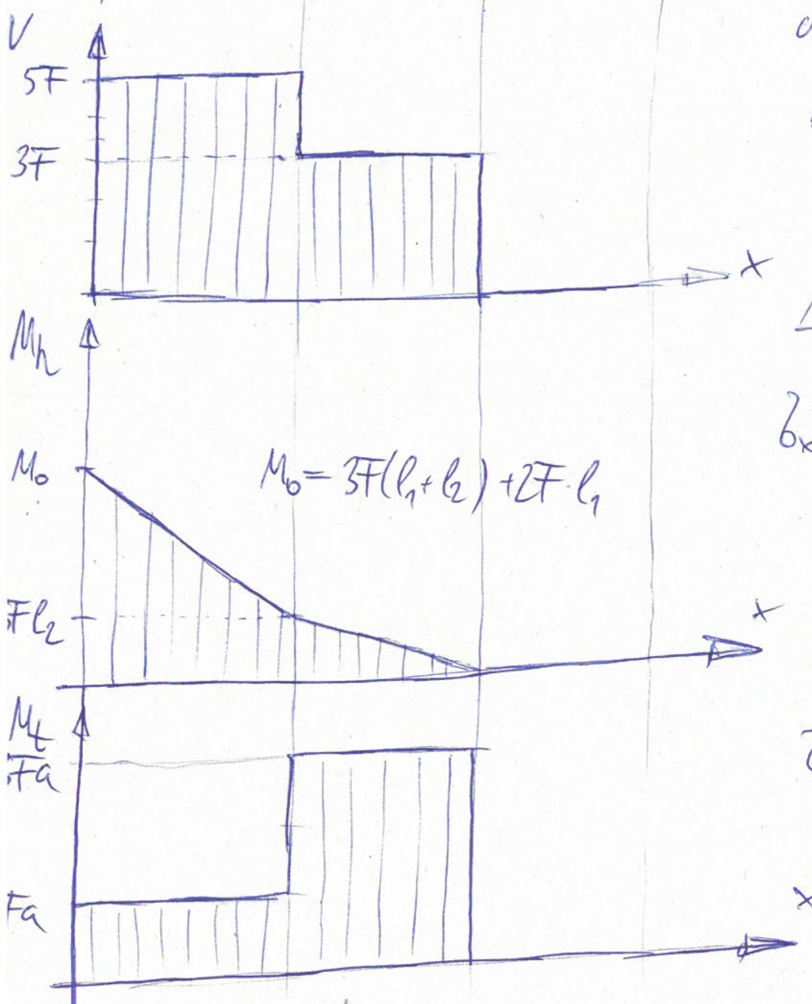
$l_1 = 1\,m$, $l_2 = 0.5\,m$, $l_3 = 0.6\,m$

$F = 500\,N$, $G = 8\cdot 10^4\,MPa$

legnagyobb nyíró, hajlító, csavaró igénybevételek?
ezekből a maximális feszültségek
szabad vég elcsavarodása?







$M_0 = 3F(l_1+l_2) + 2F\cdot l_1$

nyírás csőre $\tau_{xz}^{MAX} = 2\cdot\frac{V^{MAX}}{A}$ $\quad A = \frac{(D^2-d^2)\pi}{4}$

$\tau_{xz}^{MAX} = 2\cdot\frac{5F}{A} = 1.77\,MPa$

hajlítás (Navier) $I_y = \frac{(D^4-d^4)\pi}{64}$

$\sigma_x^{MAX} = \frac{M_0}{I_y}\cdot\frac{D}{2} = 56.07\,MPa$

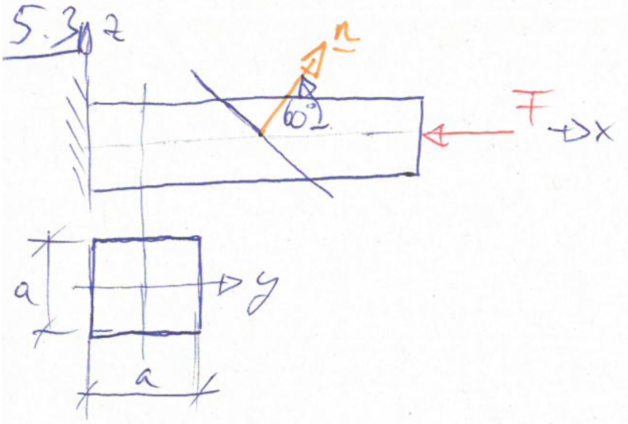
csavarás $I_p = \frac{(D^4-d^4)\pi}{32}$

$\tau_{xt}^{MAX} = \frac{3Fa}{I_p}\cdot\frac{D}{2} = 9.705\,MPa$

$\frac{\Delta\varphi}{\Delta x} \approx \frac{M_t}{I_pG}$

$$\varphi_3 = \int_0^{l_1+l_2+l_3}\frac{M_t}{I_pG}dx = \frac{Fa}{I_pG}\int_0^{l_1}1dx + \frac{3Fa}{I_pG}\int_{l_1}^{l_1+l_2}1dx + 0\int_{l_1+l_2}^{l_1+l_2+l_3}1dx = \underline{0.116^\circ}$$

5.3



σ_n, τ_{nt} ? $\quad F = 50\,kN, \; a = 25\,mm$

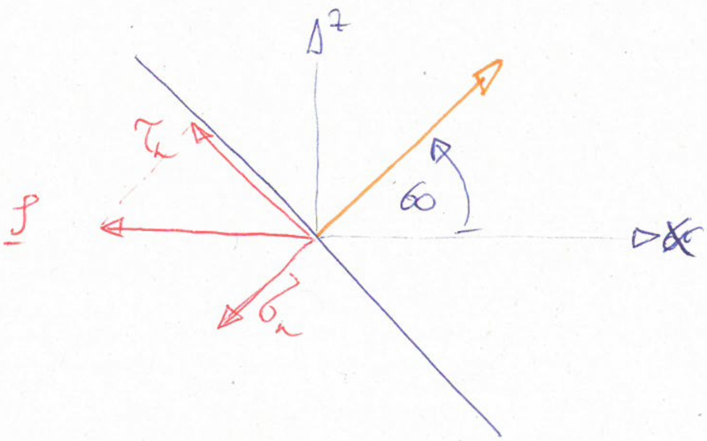
$$\underline{n} = \begin{bmatrix} \cos 60^\circ \\ 0 \\ \sin 60^\circ \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 1 \\ 0 \\ \sqrt{3} \end{bmatrix}$$

$$\underline{\underline{\sigma}} = \begin{bmatrix} \sigma_x & \tau_{yx} & \tau_{zx} \\ \tau_{xy} & \sigma_y & \tau_{zy} \\ \tau_{xz} & \tau_{yz} & \sigma_x \end{bmatrix} = \begin{bmatrix} -F/a^2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$ pontban és irányhoz kötve!

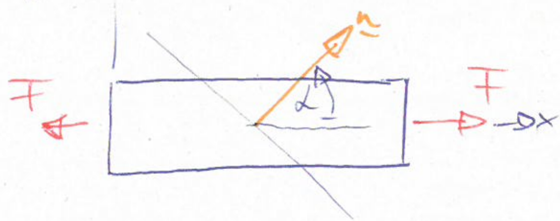
$$\underline{\rho}_n = \underline{\underline{\sigma}} \cdot \underline{n} = \begin{bmatrix} -F/a^2 \cos 60^\circ \\ 0 \\ 0 \end{bmatrix}$$ feszültségvektor

$$\sigma_n = \underline{n}^T \cdot \underline{\underline{\sigma}} \cdot \underline{n} = \underline{n}^T \cdot \underline{\rho}_n = -F/a^2 \cdot (\cos 60^\circ)^2 = -20\,MPa$$

$$\tau_n = |\underline{\rho}_n - \underline{n} \cdot \sigma_n| = \left\| \begin{bmatrix} -F \dfrac{\cos 60^\circ \cdot (\sin 60^\circ)^2}{a^2} \\ 0 \\ F \dfrac{(\cos 60^\circ)^2 \sin 60^\circ}{a} \end{bmatrix} \right\| = 34.6\,MPa$$



5.4. DZ



$a = 50\,mm$ $\quad F = 500\,kN$

$b = 75\,mm$

$\tau_{max} = ?$ $\quad \alpha = ?$

$$\underline{\underline{\sigma}} = \begin{bmatrix} F/a \cdot b & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \qquad \underline{n} = \begin{bmatrix} \cos\alpha \\ \sin\alpha \\ 0 \end{bmatrix}$$

$$\underline{\rho}_n = \underline{\underline{\sigma}} \cdot \underline{n} = \begin{bmatrix} \cos\alpha \cdot \frac{F}{a \cdot b} \\ 0 \\ 0 \end{bmatrix} \qquad \tau_n = \left(\underline{n}^{+90^\circ}\right)^T \cdot \underline{\rho}_n = \begin{bmatrix} \sin\alpha & -\cos\alpha & 0 \end{bmatrix} \begin{bmatrix} \cos\alpha \frac{F}{a \cdot b} \\ 0 \\ 0 \end{bmatrix}$$

$$\tau_n(\alpha) = \frac{F}{a \cdot b} \cos(\alpha) \cdot \sin(\alpha) = \frac{F}{2a \cdot b} \sin(2\alpha)$$

$$\frac{d\tau_n(\alpha)}{d\alpha} = \frac{F}{a \cdot b} \cos(2\alpha) \overset{?}{=} 0 \qquad \cos 2\alpha = 0 \qquad 2\alpha = \frac{\pi}{2} + k\pi \qquad k \in \mathbb{Z}$$

$$\alpha = \frac{\pi}{4} + k\frac{\pi}{2} \qquad k \in [0, 1, 2, 3]$$

k	τ_n [MPa]
0	$66.\dot{6}$
1	$-66.\dot{6}$
2	$66.\dot{6}$
3	$-66.\dot{6}$