Webinar: Elastostatik
Thema: Torsion

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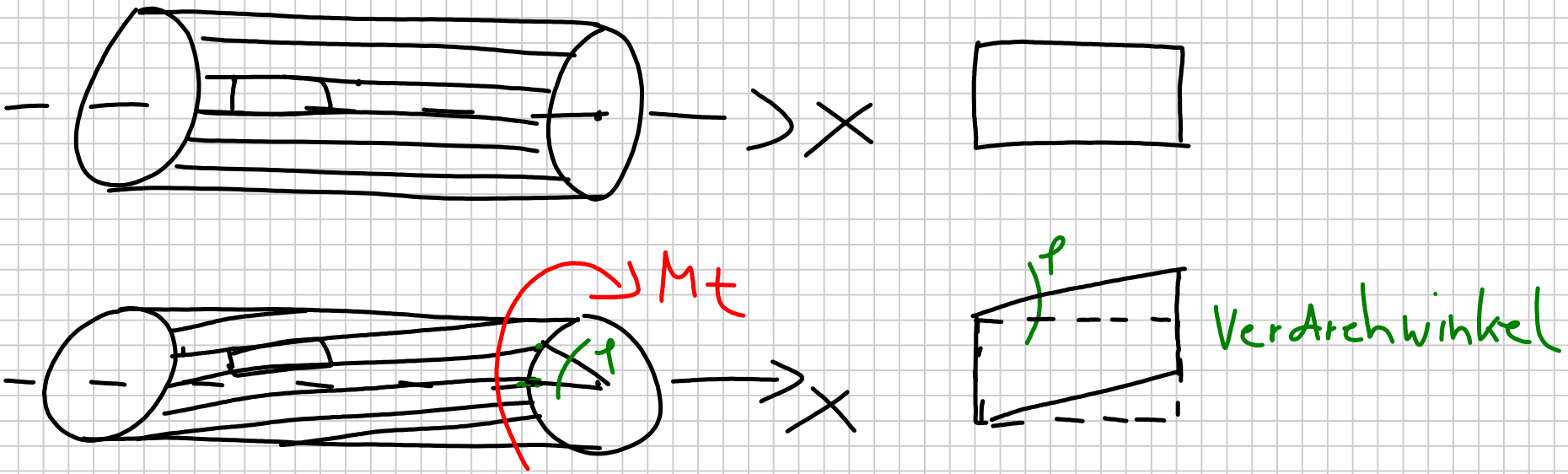
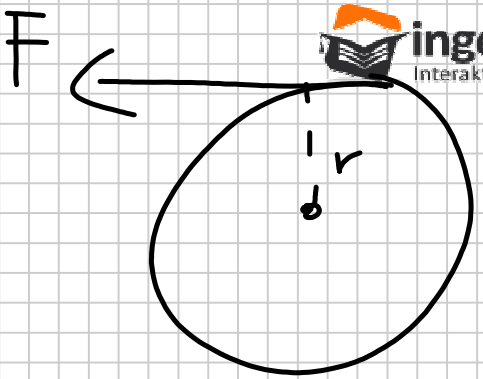
Note Title 25.10.2016

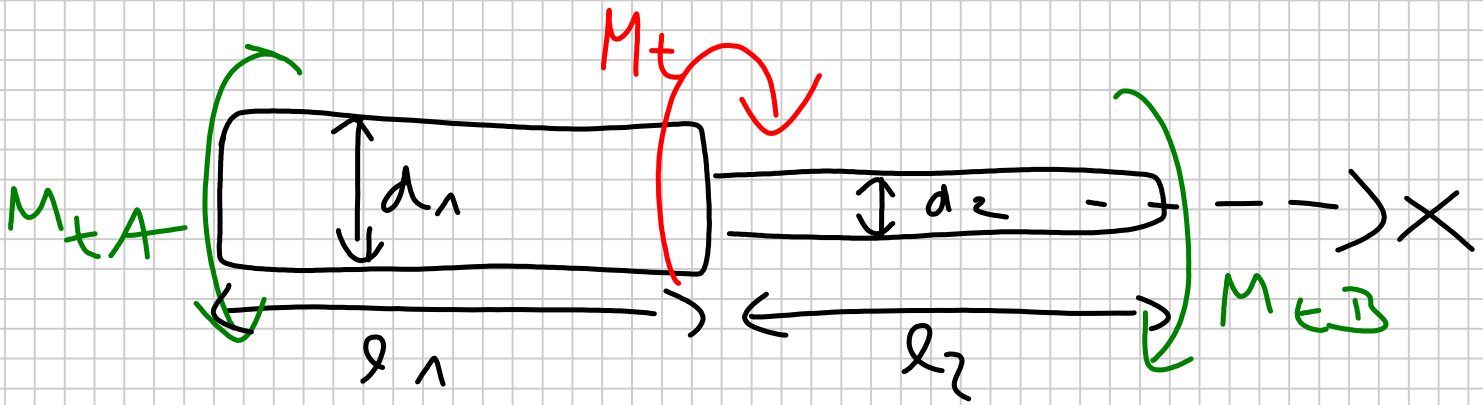


Torsionsmoment:

$M_t = F \cdot r$ $\quad r = 9\,cm$



$M_t = 10\,kN \cdot 9\,cm = \underline{90\,kN \cdot cm}$



$\circlearrowleft: \; -M_t + M_{tA} + M_{tB} = 0$ Gleichgewicht

$$M_t = M_{tA} + M_{tB}$$

$$\Delta\varphi = \frac{M_t \cdot l}{G \cdot I_p}$$ Verdrehwinkel

$$\Delta\varphi_C = \frac{M_{tA} \cdot l_1}{G \cdot I_{p1}} \qquad \Delta\varphi_C = \frac{M_{tB} \cdot l_2}{G \cdot I_{p2}}$$

$$\frac{M_{tA} \cdot l_1}{G \cdot I_{p1}} = \frac{M_{tB} \cdot l_2}{G \cdot I_{p2}}$$

$$M_{tB} = M_{tA} \cdot \frac{\cancel{G} \cdot I_{p2} \cdot l_1}{\cancel{G} \cdot I_{p1} \cdot l_2}$$

$$\boxed{M_{tB} = M_{tA} \cdot \frac{I_{p2} \cdot l_1}{I_{p1} \cdot l_2}}$$

$$M_t = M_{tA} + M_{tB}$$

$$M_t = M_{tA} + M_{tA} \cdot \frac{I_{p2} \cdot l_1}{I_{p1} \cdot l_2}$$

$$M_t = M_{tA} \cdot \left(1 + \frac{I_{p2} \cdot l_1}{I_{p1} \cdot l_2}\right)$$

$$M_{tA} = \frac{M_t}{1 + \frac{I_{p2} \cdot l_1}{I_{p1} \cdot l_2}}$$

$$I_p = \frac{\pi \cdot r^4}{2}$$

$$I_{p1} = \frac{\pi \cdot r_1^4}{2} \qquad I_{p2} = \frac{\pi \cdot r_2^4}{2}$$

$$I_{p1} = \frac{\pi \cdot (4\,cm)^4}{2} = 402{,}12\,cm$$

$$I_{p2} = \frac{\pi \cdot (3\,cm)^4}{2} = 127{,}23\,cm$$

$$M_{tA} = \frac{90\,kN \cdot cm}{1 + \frac{127{,}23\,cm \cdot 40\,cm}{402{,}12\,cm \cdot 30\,cm}}$$

$$\boxed{M_{tA} = 63{,}3\,kNcm}$$

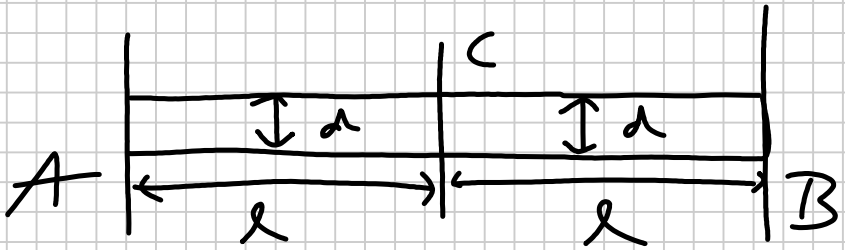
$$M_t = M_{tA} + M_{tB}$$

$$M_{tB} = M_t - M_{tA}$$

$$M_{tB} = 90\,kN \cdot cm - 63{,}3\,kN \cdot cm$$

$M_{tB} = 26{,}7\ kN\,cm$

Exkurs: Welle mit konstantem Durchmesser d
Abstände vom Lager A und Lager B
zur Stelle C identisch



$$M_{tA} = M_{tB} = \frac{M_t}{2}$$

Verdrehw

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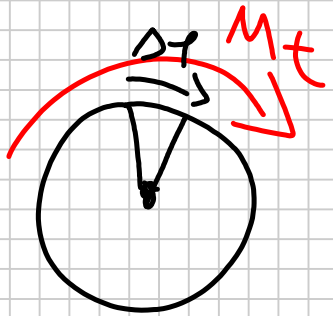
Verdrehwinkel:

$$\Delta\varphi = \frac{M_{tA} \cdot l_1}{G \cdot I_{p1}}$$



$$\Delta\varphi = \frac{63{,}3\,kNcm \cdot 40cm}{8{,}1 \cdot 10^3 \frac{kN}{cm^2} \cdot 402{,}12cm}$$

$$\Delta\varphi = 0{,}00078\,Rad$$

$$1\,rad = \frac{180°}{\pi}$$

$$0{,}00078\,rad = 0{,}00078 \cdot \frac{180°}{\pi}$$

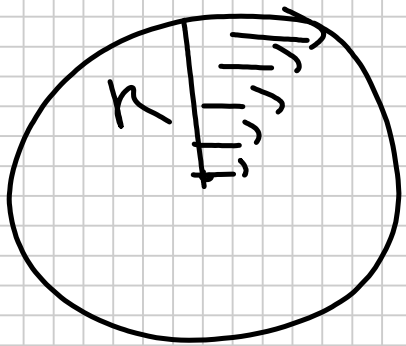
$$0{,}00078\,rad = \underline{\underline{0{,}04°}}$$

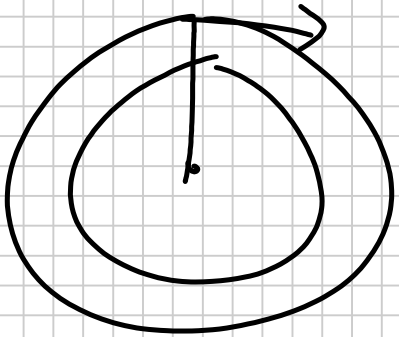
Verdrillung

$$\upsilon = \frac{\varphi}{\ell}$$

$$\upsilon_1 = \frac{\varphi_C}{\ell_1} = \frac{0{,}04°}{40\,cm} = 0{,}001°/cm$$

$$\upsilon_2 = \frac{\varphi_C}{\ell_2} = \frac{0{,}04°}{30\,cm} = 0{,}0013°/cm$$





$$\tau_{max} = \frac{M_t}{W_t} \qquad W_t = \frac{I_p}{R}$$

$$W_{t,1} = \frac{I_{p,1}}{r_1} \qquad W_{t,2} = \frac{I_{p,2}}{r_2}$$

$$I_{p1} = \frac{\pi \cdot r_1^4}{2} \qquad I_{p2} = \frac{\pi \cdot r_2^4}{2}$$

$$W_{t1} = \frac{\frac{\pi \cdot r_1^4}{2}}{r_1} = \frac{\pi \cdot r_1^4}{2 r_1} = \frac{\pi \cdot r_1^3}{2}$$

$$W_{t2} = \frac{\pi \cdot r_2^3}{2}$$

$$W_{t1} = \frac{\pi \cdot 4\,cm^3}{2} = 100{,}53\,cm^3$$

$$W_{t2} = \frac{\pi \cdot 3\,cm^3}{2} = 42{,}41\,cm^3$$

$$\tau_{max1} = \frac{63{,}3\,kN \cdot cm}{100{,}53\,cm^3} = 0{,}629\,7\,\frac{kN}{cm^2}$$

$$\tau_{max2} = \frac{26{,}7\,kN \cdot cm}{42{,}41\,cm^3} = 0{,}629\,6\,\frac{kN}{cm^2}$$