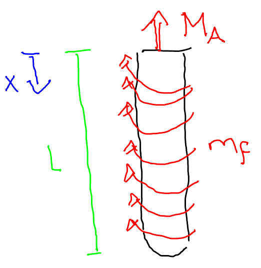
## S2




1.) $m_F = k \cdot x$

$\left[\frac{\text{Moment}}{\text{Länge}} = \frac{Nm}{m} = N\right]$

→ Gleichgewichtsbedingungen:

$\sum M: \; M^A = M^F$


$M^F = \int_0^L m_F \, dx$

$= \int_0^L k \cdot x \, dx = \left[k \frac{x^2}{2}\right]_0^L$

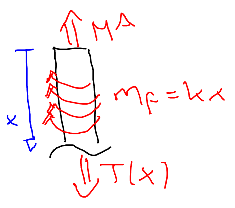
$= \frac{kL^2}{2} = M^A$

$\rightarrow \boxed{k = \frac{2M^A}{L^2}}$

2.) $\Theta_{max} = \Theta(x = L) = \int_0^L \frac{T(x)}{G\, I_T(x)} dx$

$I_T(x) = I_p^{Kreis} = \int_0^{2\pi}\int_0^R \rho^3 \, d\rho \, d\varphi$

$= 2\pi \left[\frac{\rho^4}{4}\right]_0^R = \frac{\pi R^4}{2}$




$\sum M^{\text{im Schnittufer}}$:

$T(x) = M^A - \int_0^x m_F \, dx$

$= M^A - \int_0^x kx \, dx$

$= M^A - k\frac{x^2}{2}$

$= M^A - \frac{\cancel{2}M^A}{L^2}\frac{x^2}{\cancel{2}}$

$= M^A\left(1 - \frac{x^2}{L^2}\right)$

$\Theta_{max} = \int_0^L \frac{M^A\left(1 - \frac{x^2}{L^2}\right)}{G\frac{\pi R^4}{2}} dx = \frac{2M^A}{\pi R^4 G}\int_0^L 1 - \frac{x^2}{L^2} dx$

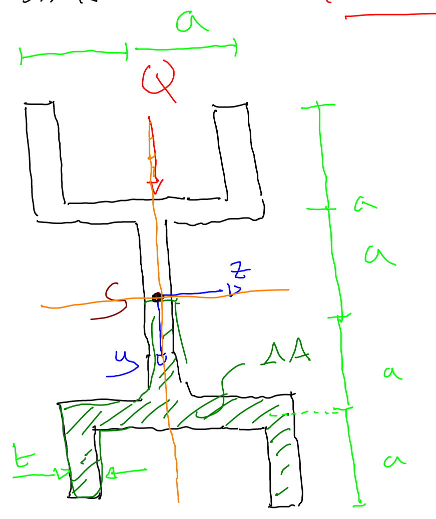
$= \frac{2M^A}{\pi R^4 G}\left[x - \frac{x^3}{3L^2}\right]_0^L = \frac{2M^A}{\pi R^4 G}\underbrace{\left(L - \frac{L^{\cancel{3}}}{3\cancel{L^2}}\right)}_{2/3\,L}$

$= \boxed{\frac{4M^A L}{3\pi R^4 G}} = \Theta_{max}$

3.) $\Theta_{max} \le \Theta_0$

$\frac{4M^A_{zul} L}{3\pi R^4 G} \le \Theta_0 \rightarrow \boxed{M^A_{zul} \le \frac{3\pi R^4 G \Theta_0}{4L}}$

## W1




Man bestimme den Betrag der Schubspannung $\tau_{xy}$ im Schwerpunkt der Figur auf Grund von $Q$.

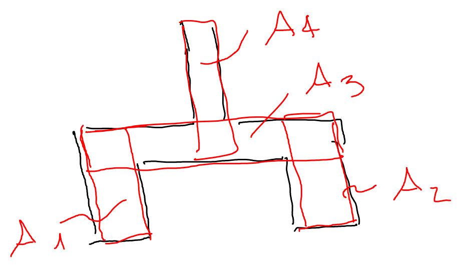
($I_z$ ist gegeben. Dicke ist konstant)

$\left|\tau_{xs}(x,s)\right| = \left|-\frac{Q_y}{I_z}\frac{H_z(s)}{t(s)}\right| \Rightarrow |\tau_{xy}(P)| = \frac{Q}{I_z}\frac{a^2 \cancel{t}\, 11/2}{\cancel{t}} = \boxed{\frac{Q}{I_z}\frac{11}{2}a^2}$

$H_z(P) = \underbrace{H_z^1 + H_z^2}_{} + H_z^3 + H_z^4 = 2 \cdot y_S^1 A_1 + y_S^3 \cdot A_3 + y_S^4 \cdot A_4$

$= 2 \cdot 3/2\, a \cdot a \cdot t + a \cdot 2a \cdot t + a/2 \cdot a \cdot t$

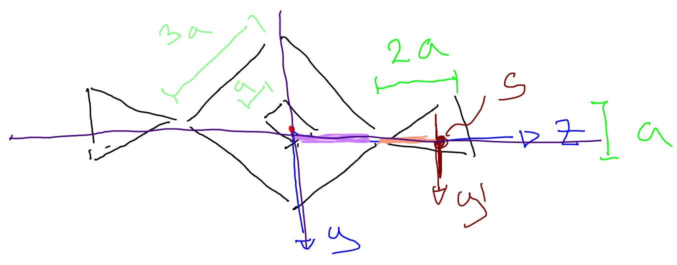
$= a^2 t\,(3 + 2 + 1/2) = a^2 t\; 11/2$




→ $C_{yz} = 0$

$I_y \,?\, I_z$

## W2




Man bestimme $I_y$.

$I_y^{totale} = I_y^Q - I_y^q + 2I_y^{D'} = \frac{81a^4}{12} - \frac{a^4}{12} + 2 \cdot 12{,}16a^4$

$\frac{9\sqrt{2}+8}{6}$

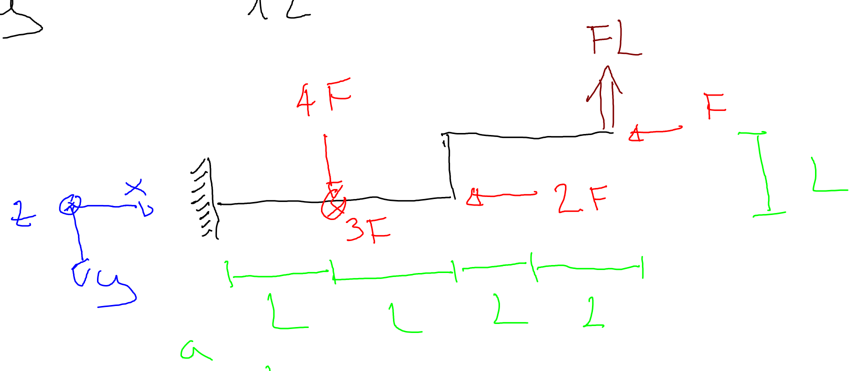
$\overbrace{\underbrace{\frac{\sqrt{2}\,3}{2} + \frac{4}{3}}}$

$I_{y'}^D = \frac{a(2a)^3}{36} - \frac{2}{9}a^4 \qquad I_y^D = I_{y'}^D + A \cdot d^2 = \frac{2}{9}a^4 + \frac{2a^2}{2}\cdot\left(\frac{3}{\sqrt{2}}a + \frac{2}{3}2a\right)^2$

$= a^4\left(\frac{2}{9} + \frac{(9\sqrt{2}+8)^2}{36}\right) \approx 12.16a^4$

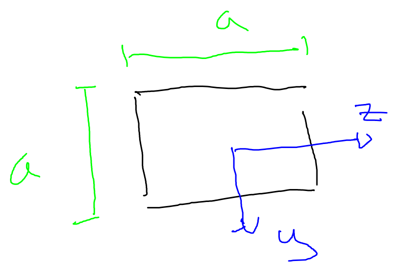
$I_y^{Total} = \frac{80a^4}{12} + 24{,}31a^4$

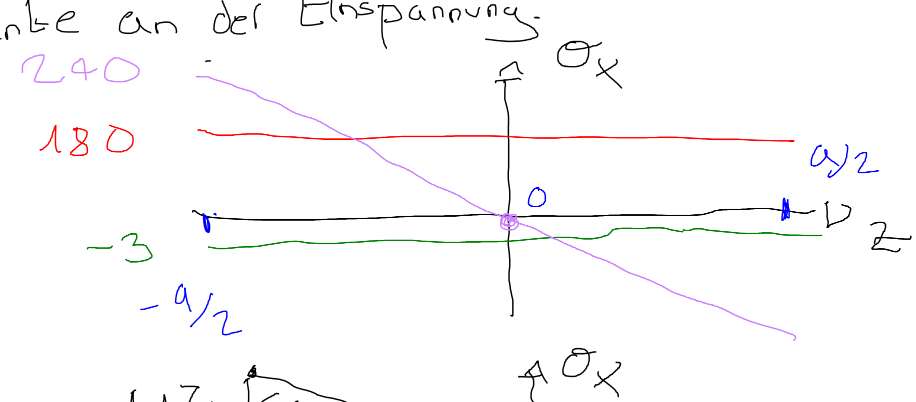
## W3

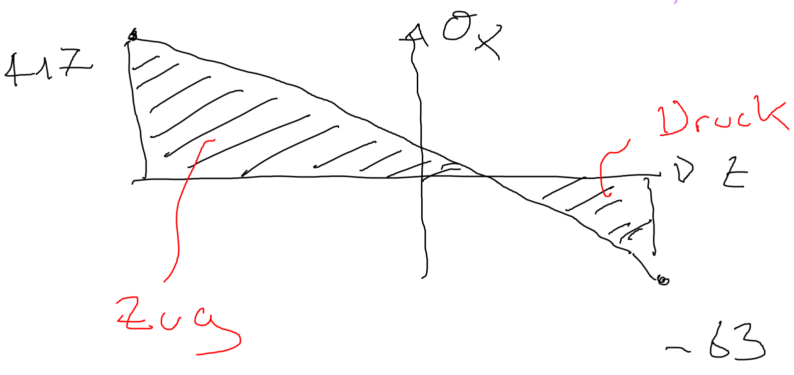



Man bestimme den Normalspannungsverlauf für die obere Kante an der Einspannung.

$L = 10a$




$\sigma_x(x,y,z) = \frac{N(x)}{A} - \frac{M_z(x)}{I_z}\cdot y + \frac{M_y(x)}{I_y}\cdot z$

$\boxed{\frac{N(x=0)}{A}} = -\frac{3F}{a^2} = -3\frac{F}{a^2}$

$\boxed{-\frac{M_z(x=0)}{I_z}(-a/2)} = \frac{12}{a^4}\frac{a}{2}\left(4FL - FL\right) = 18\frac{FL}{a^3} = 180\frac{F}{a^2}$

$\frac{M_y(x=0)}{I_y}\cdot z = \frac{12}{a^4}\left(-3FL - FL\right)z = -\frac{48}{a^4}FLz = -480\frac{F}{a^2}\cdot z$