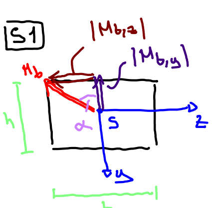
S1



1.) Projektion von M_b auf die Hauptachsen

$M_{b,y} = \cos(\alpha) M_b (-1)$

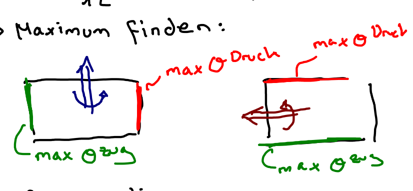
$M_{b,z} = \sin(\alpha) M_b (-1)$

2.) allgemeine Biegung

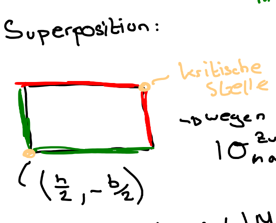
$\sigma_x(\cancel{x},y,z) = \cancel{\frac{N(x)}{A(x)}}^{\to 0} - \frac{M_z(x)}{I_z(\cancel{x})} \cdot y + \frac{M_y(x)}{I_y(\cancel{x})} \cdot z$

$I_z = \frac{b h^3}{12} \quad I_y = \frac{h b^3}{12}$

→ Maximum finden:



→ Superposition:



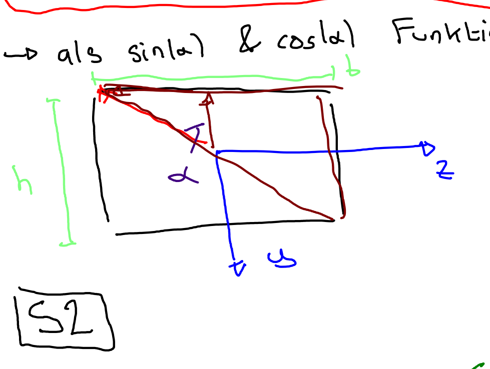
→ wegen Symmetrie: $|\sigma_{max}^{Zug}| = |\sigma_{max}^{Druck}|$

$\left(\frac{h}{2}, -\frac{b}{2}\right)$

$\sigma_x(y=h/2, z=-b/2) = \frac{\sin(\alpha) M_b \cdot 12 h}{b h^3 \cdot 2} + \frac{\cos(\alpha) M_b 12}{b^3 h}\left(+\frac{b}{2}\right)$

$$= \frac{6 M_b}{bh}\left(\frac{\sin(\alpha)}{h} + \frac{\cos(\alpha)}{b}\right)$$

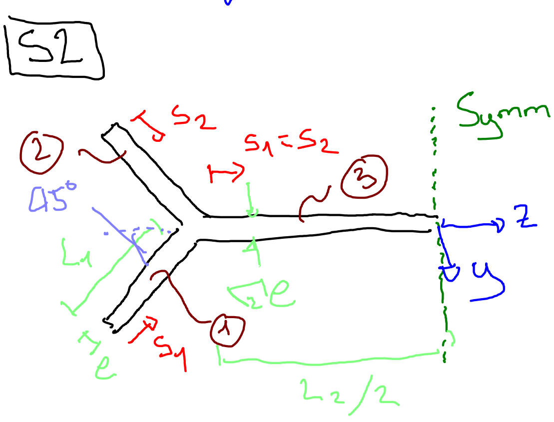
→ als $\sin(\alpha)$ & $\cos(\alpha)$ Funktion von b & h:

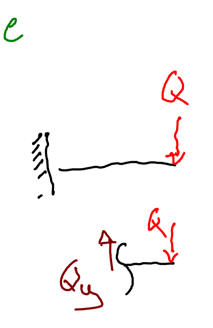


$\cos(\alpha) = \frac{h}{\sqrt{h^2+b^2}}$

$\sin(\alpha) = \frac{b}{\sqrt{h^2+b^2}}$

S2





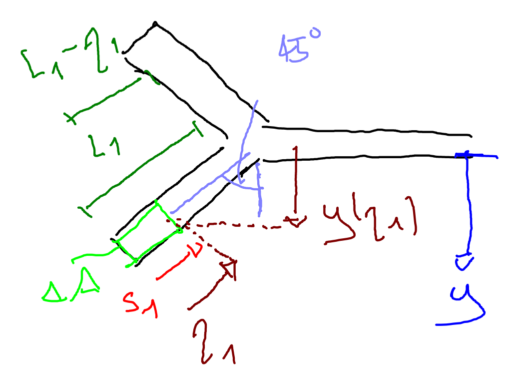
$Q_y = Q$ = konst

1.) Laufvariable s einführen

2.) Schubfluss im Abschnitt ①:

$\tau_{xs_1}(\cancel{x}, s_1) = -\frac{Q_y(\cancel{x})}{I_z(\cancel{x})} \frac{H_z(s_1)}{\cancel{e(s_1)}} \to e$

$H_z(s_1) = \int_0^{s_1} y(\eta) e(\eta) \, d\eta$



$= \int_0^{s_1} (L_1 - \eta_1) \cos(45°) e \, d\eta_1$

$= \frac{\sqrt{2}}{2} e \left[L_1 \eta_1 - \frac{\eta_1^2}{2}\right]_{\eta_1=0}^{\eta_1=s_1}$

$= \frac{\sqrt{2}}{2} e \left(L_1 s_1 - \frac{s_1^2}{2}\right)$ $\quad q := \frac{Q_y}{I_z}$

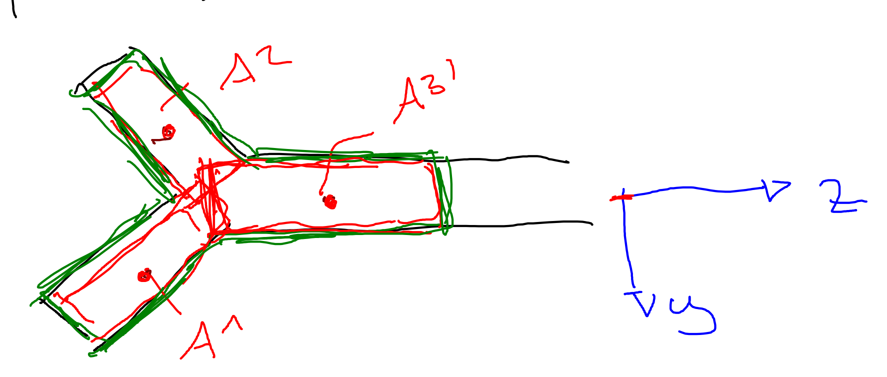
$$\tau_{xs_1}(s_1) = -q \frac{\sqrt{2}}{2}\left(L_1 s_1 - \frac{s_1^2}{2}\right) \quad s_1 \in [0, L_1]$$

2.) Schubfluss im Abschnitt ②:

$\tau_{xs_1} \hat{=} -\tau_{xs_2}$

$$\tau_{xs_2}(s_2) = q \frac{\sqrt{2}}{2}\left(L_1 s_2 - \frac{s_2^2}{2}\right) \quad s_2 \in [0, L_1]$$

3.) Schubfluss im Abschnitt ③:



→ Additivität:

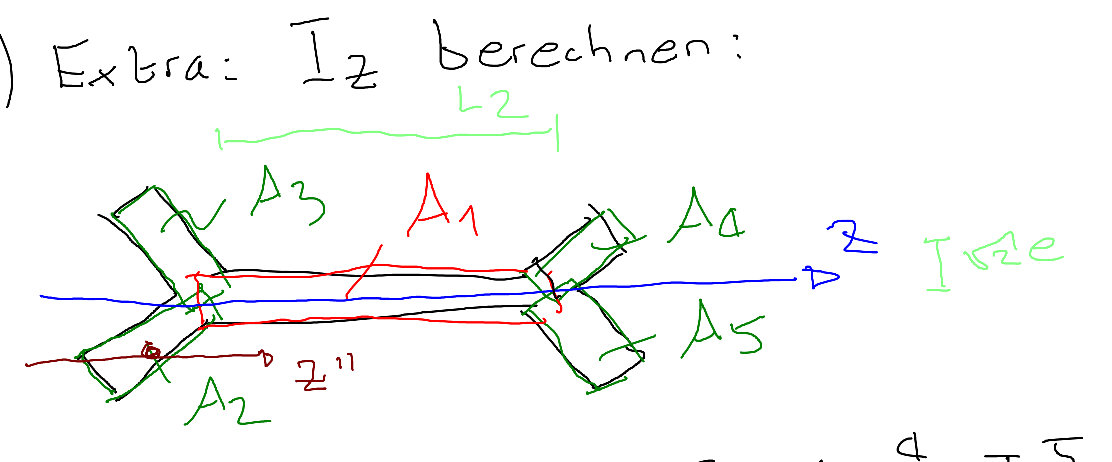
$H_z^3 = H_z^1 + H_z^2 + H_z^{3'}$

$= y_{s,1} \cdot \Delta A_1 + y_{s,2} \Delta A_2 + \cancel{y_{s,3'}}^{\to 0} \Delta A_{3'}$

$\overset{\Delta A_1 = \Delta A_2}{=} \Delta A_1 (\cancel{y_{s,1} + y_{s,2}})^{\to 0} = 0$ $\quad y_{s,1} = -y_{s,2}$

$$\tau_{xs_1}(s_1 > L_1) = 0$$

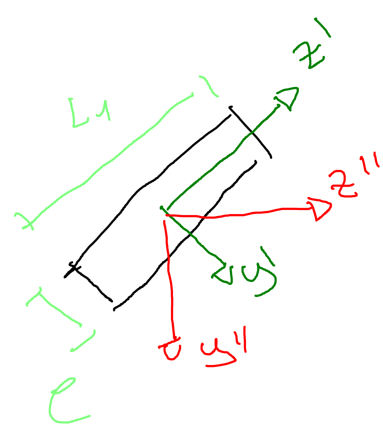
6.) Extra: I_z berechnen:



$I_z^{gesamt} = I_z^1 + \underbrace{I_z^2 + I_z^3 + I_z^4 + I_z^5}_{= I_z^2 \cdot 4}$

$= \cancel{I_z^1}^{\to 0} + 4 \cdot I_z^2$

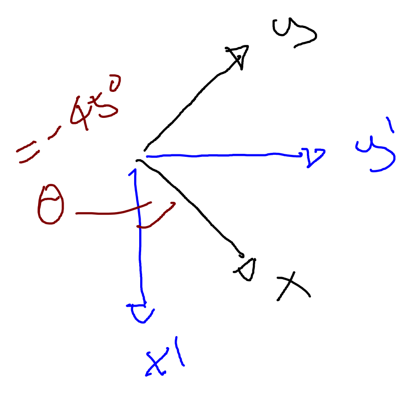
$I_z^1 = \frac{L_2 (\sqrt{2} e)^3}{12} = \frac{L_2 \cdot \sqrt{2} \cdot 2 \cancel{e^3}}{12} \approx 0$ (e≪h)



$I_{z'} = \frac{L_1 \cdot \cancel{e^3}^{\to \approx 0}}{12} \approx 0$

$I_{y'} = \frac{L_1^3 \cdot e}{12}$

$C_{yz} = 0$



$I_{z'} \hat{=} \sigma_y$

$I_{y'} \hat{=} \sigma_x$

$I_{z''} = I_{y'} \sin^2(\theta)$

$+ \cancel{I_{z'} \cos^2(\theta)}^{\to 0}$

$- \cancel{2 C_{yz} \sin(\theta) \cos(\theta)}^{\to 0}$

$I_{z''} = \frac{e L_1^3}{12}\left(\frac{\sqrt{2}}{2}\right)^2 = \frac{e L_1^3}{24}$

$I_z = I_{z''} + A \cdot d^2 = \frac{e L_1^3}{24} + e L_1 \left(\frac{L_1}{2}\frac{\sqrt{2}}{2}\right)^2$

$= e L_1^3 \left(\frac{1}{24} + \frac{1}{8}\right) = \frac{e L_1^3}{6}$

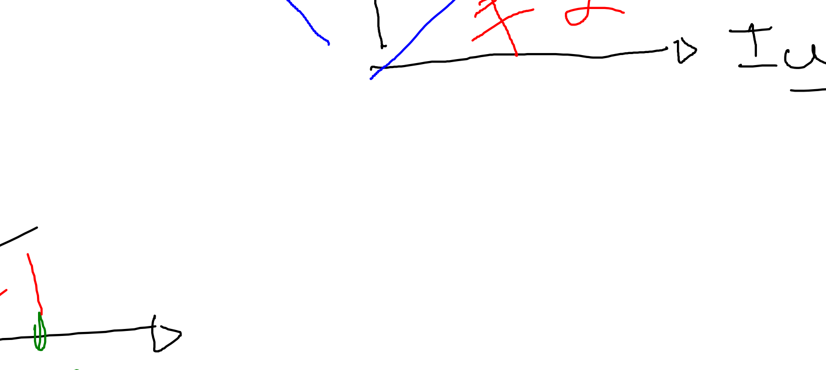
$$I_z^{gesamt} = \frac{2}{3} e L_1^3$$

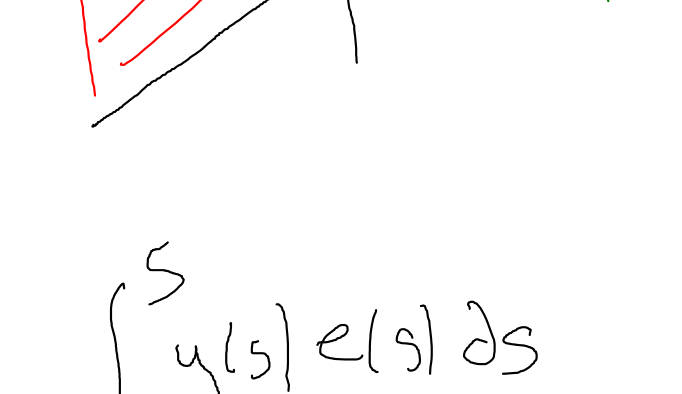
staerkr

$I_{y'} = I_y \cos^2(\alpha) + I_z \sin^2(\alpha) + 2 C_{yz} \sin(\alpha) \cos(\alpha)$

$I_{z'} = I_y \sin^2(\alpha) + I_z \cos^2(\alpha) - 2 C_{yz} \sin(\alpha) \cos(\alpha)$

$C_{yz'} =$





$\int_0^s y(s) e(s) \, ds$