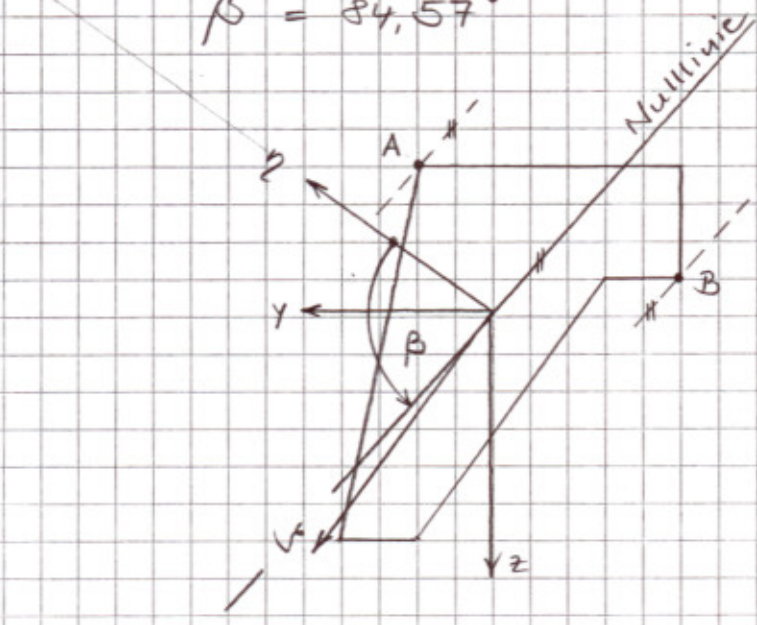
A1.1.12

1/ $\alpha = 30° + 35,82° = 65,82°$

$$\tan\beta = \frac{482\,cm^4}{102\,cm^4} \cdot \tan(65,82°) = 10,5245$$

$$\beta = 84,57°$$



2/ $y_A = 1,98\,cm$ $\quad y_B = -5,02\,cm$

$z_A = -3,95\,cm$ $\quad z_B = -0,95\,cm$

$$\eta_A = -3,95\,cm \cdot \sin(-35,82°) + 1,98\,cm \cdot \cos(-35,82°) = 3,92\,cm$$

$$\zeta_A = -3,95\,cm \cdot \cos(-35,82°) - 1,98\,cm \cdot \sin(-35,82°) = -2,04\,cm$$

$$\eta_B = -0,95\,cm \cdot \sin(-35,82°) - 5,02\,cm \cdot \cos(-35,82°) = -3,51\,cm$$

$$\zeta_B = -0,95\,cm \cdot \cos(-35,82°) + 5,02\,cm \cdot \sin(-35,82°) = -3,71\,cm$$

$$\sigma_b^A = \frac{M_b \cdot \cos 65,82°}{482\,cm^4} \cdot (-2,04\,cm) - \frac{M_b \cdot \sin 65,82°}{102\,cm^4} \cdot 3,92\,cm$$

$$\sigma_b^A = -0,0368\,\frac{1}{cm^3} \cdot M_b$$

$$\sigma_b^B = \frac{M_b \cdot \cos 65{,}82^\circ}{482\,cm^4} \cdot (-3{,}71\,cm) - \frac{M_b \cdot \sin 65{,}82^\circ}{102\,cm^4} \cdot (-3{,}51\,cm)$$

$$\sigma_b^B = 0{,}0282 \frac{1}{cm^3} \cdot M_b$$

$$zul\ M_b = \frac{zul\ \sigma}{0{,}0368 \frac{1}{cm^3}}$$

$$zul\ M_b = \frac{75 \frac{N}{mm^2}}{0{,}0368 \cdot 10^{-3} \cdot \frac{1}{mm^3}}$$

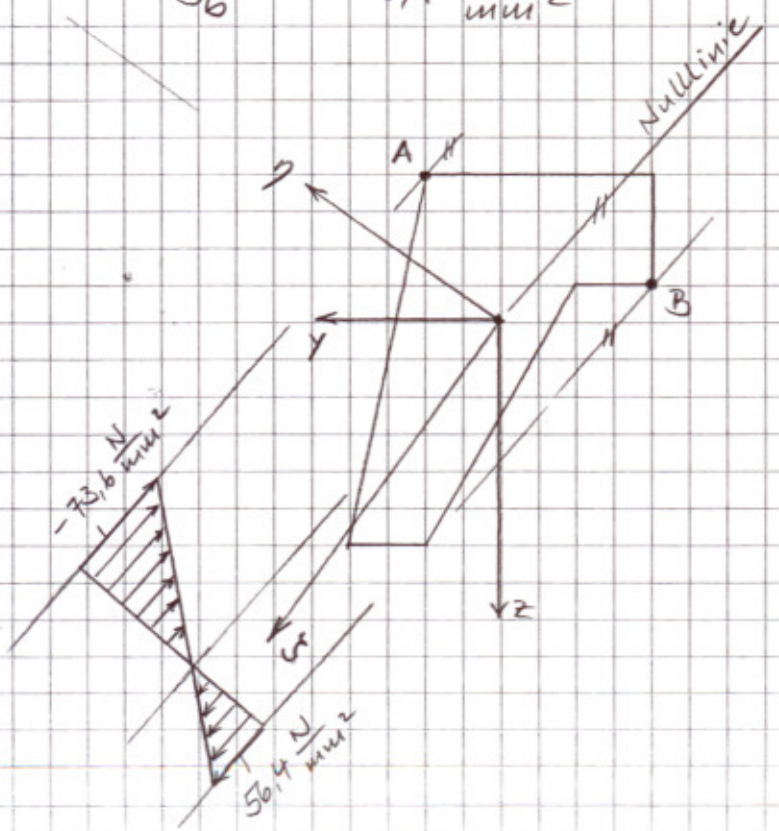
$$zul\ M_b = 2038043\ N \cdot mm = 2{,}038\ kN \cdot m$$

zu 4) $\sigma_b^A = -0{,}0368 \cdot \frac{1}{cm^3} \cdot 200\,kN \cdot cm = -7{,}36 \frac{kN}{cm^2}$

$$\sigma_b^A = -73{,}6 \frac{N}{mm^2}$$

$$\sigma_b^B = 0{,}0282 \frac{1}{cm^3} \cdot 200\,kN \cdot cm = 5{,}64 \frac{kN}{cm^2}$$

$$\sigma_b^B = 56{,}4 \frac{N}{mm^2}$$



Aufgabe 2

zu 1) **Schnitt 1**

$$S_{y1} = 12\,cm \cdot 0{,}5\,cm \cdot 2{,}16\,cm = 12{,}96\,cm^3$$

$$\tau_{Q1} = \frac{40\,kN \cdot 12{,}96\,cm^3}{305\,cm^4 \cdot 0{,}5\,cm} = 3{,}399\,\frac{kN}{cm^2} = 33{,}99\,\frac{N}{mm^2}$$

Schnitt 2

$$S_{y2} = 4\,cm \cdot 0{,}4\,cm \cdot 4{,}04\,cm = 6{,}46\,cm^3$$

$$\tau_{Q2} = \frac{40\,kN \cdot 6{,}46\,cm^3}{305\,cm^4 \cdot 0{,}4\,cm} = 2{,}118\,\frac{kN}{cm^2} = 21{,}18\,\frac{N}{mm^2}$$

Schnitt 3

$$S_{y3} = 12{,}96\,cm^3 - 6{,}46\,cm^3 = 6{,}50\,cm^3$$

$$\tau_{Q3} = \frac{40\,kN \cdot 6{,}50\,cm^3}{305\,cm^4 \cdot 0{,}4\,cm} = 2{,}131\,\frac{kN}{cm^2} = 21{,}31\,\frac{N}{mm^2}$$

Schnitt 4

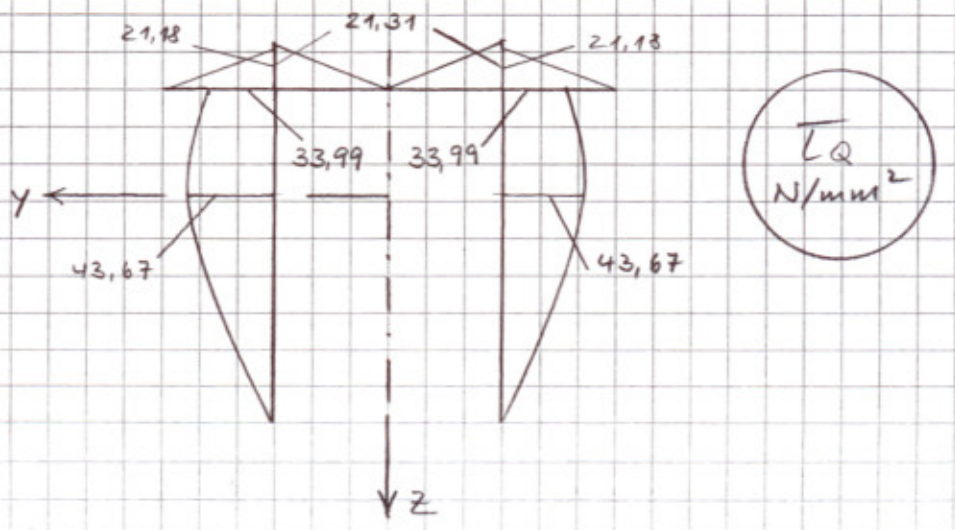
$$S_{y4} = 12{,}96\,cm^3 - 8\,cm \cdot 0{,}4\,cm \cdot 4{,}04\,cm = 0{,}032\,cm^3 \approx 0$$

$$\tau_{Q4} = 0$$

zu 2) $$S_{y\,max} = 0{,}5\,cm \cdot 8{,}16\,cm \cdot \frac{8{,}16\,cm}{2} = 16{,}65\,cm^3 \quad (z = 0)$$

$$\tau_{Q\,max} = \frac{40\,kN \cdot 16{,}65\,cm^3}{305\,cm^4 \cdot 0{,}5\,cm} = 4{,}367\,\frac{kN}{cm^2} = 43{,}67\,\frac{N}{mm^2}$$

zu 3)



zu 4) $I_T = \frac{1}{3} \cdot (5\,mm)^3 \cdot 2 \cdot 120\,mm + \frac{1}{3} \cdot (4\,mm)^3 \cdot 160\,mm$

$I_T = 13413\,mm^4$

Stege:

$\tau_T = \frac{100 \cdot 10^3\,N \cdot mm}{13413\,mm^4} \cdot 5\,mm = 37{,}27\,\frac{N}{mm^2}$

Gurt:

$\tau_T = 37{,}37\,\frac{N}{mm^2} \cdot \frac{4\,mm}{5\,mm} = 29{,}90\,\frac{N}{mm^2}$

zu 5) $\Delta\varphi = \frac{M_T}{G \cdot I_T} \cdot l$

$\Delta\varphi = \frac{100 \cdot 10^3\,N \cdot mm \cdot 2000\,mm}{8{,}1 \cdot 10^4\,\frac{N}{mm^2} \cdot 13413\,mm^4} = 0{,}1841$

$\Delta\varphi = 0{,}1841 \cdot \frac{180^\circ}{\pi} = 10{,}55^\circ$

A3,12

Aufgabe 3

$$\frac{k_1}{k_2} = \sqrt{\frac{F}{E \cdot I_1} \cdot \frac{E \cdot I_2}{F}} = \sqrt{\frac{I_2}{I_1}} = \sqrt{\frac{\alpha^4}{12} \cdot \frac{12}{1{,}54 \cdot \alpha^4}} = \frac{1}{2{,}25}$$

$$k_2 = 2{,}25 \cdot k_1$$

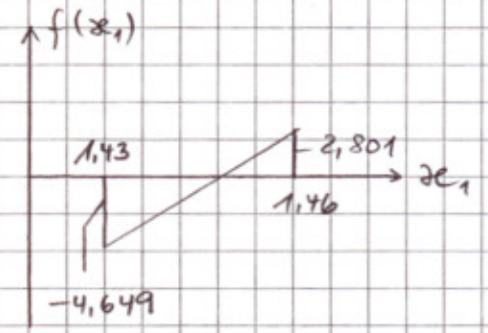
$$\alpha_2 = k_2 \cdot \ell_2 = 2{,}25 \cdot k_1 \cdot \frac{1}{2} \cdot \ell_1 = 1{,}125 \cdot k_1 \cdot \ell_1$$

$$\alpha_2 = 1{,}125 \cdot \alpha_1$$

$$f(\alpha_1) = \tan(\alpha_1) + \frac{1}{2{,}25} \cdot \tan(1{,}125 \cdot \alpha_1) = 0$$

$$f(1{,}43) = -4{,}649$$

$$f(1{,}46) = 2{,}801$$

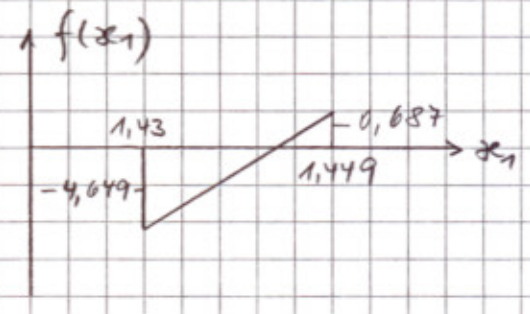


$$\frac{\Delta\alpha_1}{4{,}649} = \frac{0{,}03}{7{,}45}$$

$$\Delta\alpha_1 = 0{,}019$$

$$\alpha_{1\,neu} = 1{,}43 + 0{,}019 = 1{,}449$$

$$f(1{,}449) = 0{,}687$$



$$\frac{\Delta\alpha_1}{4{,}649} = \frac{0{,}019}{5{,}336}$$

$$\Delta\alpha_1 = 0{,}016$$

$$\alpha_{1\,neu} = 1{,}446$$

$$f(1{,}446) = 0{,}037 \approx 0$$

A3,2,2

$$\lambda_1 = k_1 \cdot l_1 = \sqrt{\frac{F_k}{E \cdot I_1}} \cdot l_1 = 1{,}446$$

$$\sqrt{\frac{4 \cdot F}{E \cdot I_1}} \cdot l_1 = 1{,}446$$

$$\frac{4 \cdot F \cdot 12}{E \cdot 1{,}5^4 \cdot a^4} \cdot l_1^2 = 1{,}446^2$$

$$a = \sqrt[4]{\frac{4 \cdot F \cdot 12 \cdot l_1^2}{E \cdot 1{,}5^4 \cdot 1{,}446^2}}$$

$$a = \sqrt[4]{\frac{4 \cdot 50000\,N \cdot 12 \cdot (2000\,mm)^2}{2{,}1 \cdot 10^5 \frac{N}{mm^2} \cdot 1{,}5^4 \cdot 1{,}446^2}}$$

$$a = 45{,}58\ mm$$

zu 2) $$\sigma_k = \frac{4 \cdot F}{a^2} = \frac{4 \cdot 50000\,N}{(45{,}58\,mm)^2}$$

$$\sigma_k = 96{,}27 \frac{N}{mm^2} < 188 \frac{N}{mm^2} = \sigma_{dP}$$