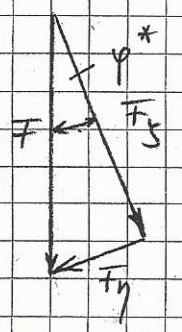
A1/1

1)



$$F_\eta = F \cdot \sin\varphi^*$$

$$F_\zeta = F \cdot \cos\varphi^*$$

$$f_\eta = \frac{F \cdot \sin 21{,}72° \cdot (2000\,mm)^2 \cdot (4 \cdot 2000\,mm + 3 \cdot 4000\,mm)}{12 \cdot 2{,}1 \cdot 10^5 \frac{N}{mm^2} \cdot 97{,}29 \cdot 10^4\,mm^4}$$

$$f_\eta = 0{,}01208 \frac{mm}{N} \cdot F$$

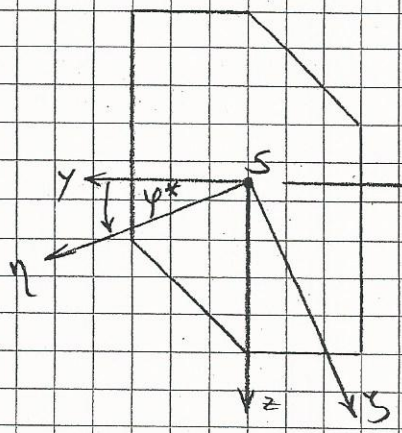
$$f_\zeta = \frac{F \cdot \cos 21{,}72° \cdot (2000\,mm)^2 \cdot (4 \cdot 2000\,mm + 3 \cdot 4000\,mm)}{12 \cdot 2{,}1 \cdot 10^5 \frac{N}{mm^2} \cdot 273{,}96 \cdot 10^4\,mm^4}$$

$$f_\zeta = 0{,}01077 \frac{mm}{N} \cdot F$$

$$f_{ges} = F \cdot \sqrt{\left(0{,}01208 \frac{mm}{N}\right)^2 + \left(0{,}01077 \cdot \frac{mm}{N}\right)^2} = 10\,mm$$

$$F = \frac{10\,mm}{0{,}01618 \frac{mm}{N}} = 618{,}05\,N$$

2) $M_B = -600N \cdot 2m = -1200\,N \cdot m = -1{,}2\,kN \cdot m$



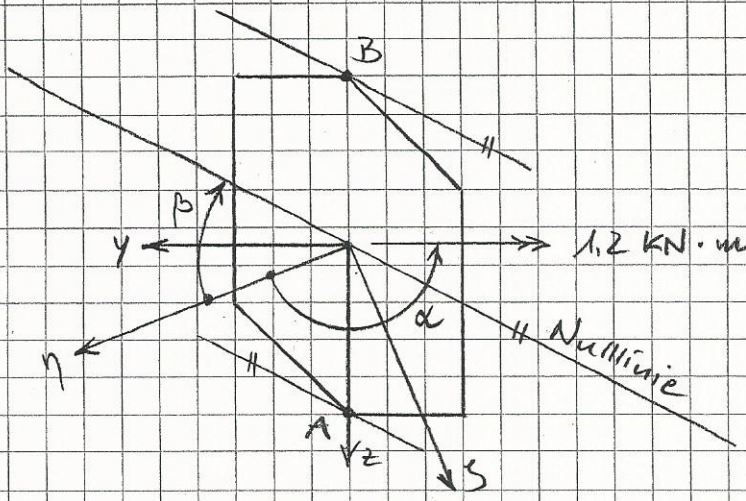
$M_B = 1{,}2\,kN \cdot m$

$\alpha = 180° - \varphi^* = 158{,}28°$

Spannungsnulllinie

$$\tan\beta = \frac{273{,}96\ cm^4}{97{,}29\ cm^4} \cdot \tan 158{,}28° = -1{,}1217$$

$$\beta = -48{,}28°$$



$$M_{by} = 1{,}2\ kN\cdot m \cdot \cos 158{,}28° = -1{,}115\ kN\cdot m$$

$$M_{bz} = 1{,}2\ kN\cdot m \cdot \sin 158{,}28° = 0{,}444\ kN\cdot m$$

$$\eta_A = 4{,}5\ cm \cdot \sin 21{,}72° + 0 \cdot \cos 21{,}72° = 1{,}665\ cm$$

$$\zeta_A = 4{,}5\ cm \cdot \cos 21{,}72° + 0 \cdot \sin 21{,}72° = 4{,}181\ cm$$

$$\eta_B = -1{,}665\ cm$$

$$\zeta_B = -4{,}181\ cm$$

$$\sigma_b^A = -\frac{-1{,}115 \cdot 100\ kN\cdot cm}{273{,}96\ cm^4} \cdot 4{,}181\ cm$$

$$-\frac{0{,}444 \cdot 100\ kN\cdot cm}{97{,}29\ cm^4} \cdot 1{,}665\ cm$$

$$\sigma_b^A = -2{,}461\ \frac{kN}{cm^2} = -24{,}61\ \frac{N}{mm^2}\ ;\quad \sigma_b^B = 24{,}61\ \frac{N}{mm^2}$$

1) $S_{y1} = 4\,mm \cdot 60\,mm \cdot 68,15\,mm = 16356\,mm^3$

$S_{y2} = 16356\,mm^3$

$S_{y3} = 16356\,mm^3 + 5\,mm \cdot 110\,mm \cdot 11,15\,mm = 22488,5\,mm^3$

$S_{y4} = 22488,5\,mm^3$

$S_{y5} = 22488,5\,mm^3 + 6\,mm \cdot 80\,mm \cdot (-46,85\,mm) = 0,5\,mm^3 \sim 0$

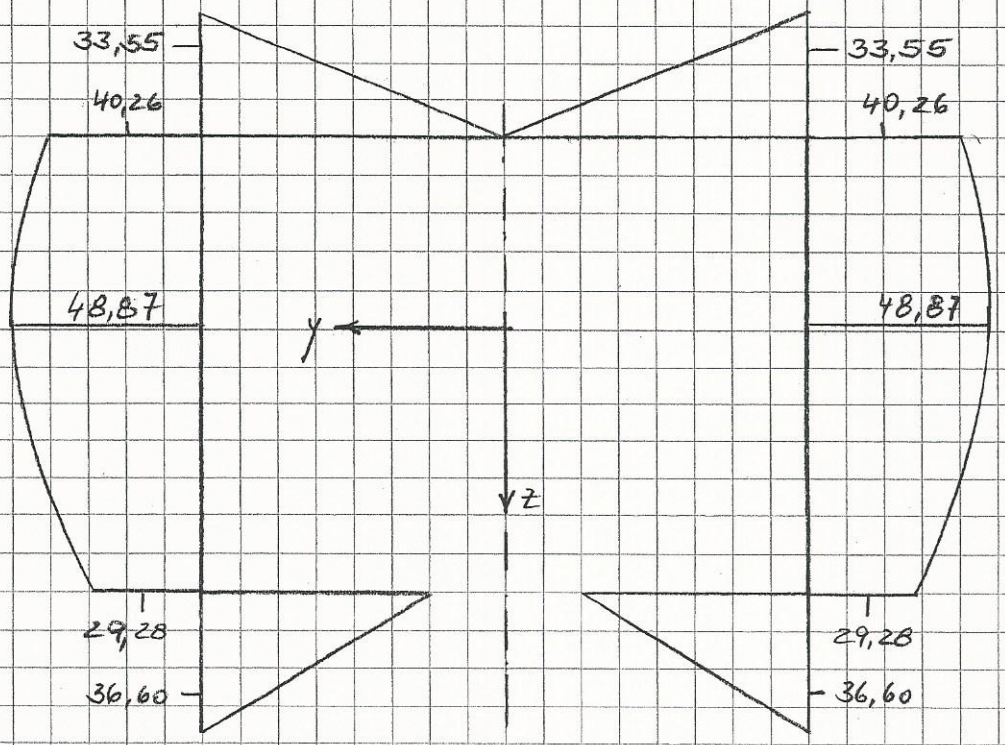
Schnitt	S_y in mm^3	t in mm	τ in N/mm^2
1	16356	4	36,60
2	16356	5	29,28
3	22488,5	5	40,26
4	22488,5	6	33,55
5	0	6	0

2) $S_{ymax} = 16356\,mm^3 + 5\,mm \cdot 66,15\,mm \cdot \frac{66,15\,mm}{2}$

$S_{ymax} = 27296\,mm^3$

$\tau_{max} = \frac{50000\,N \cdot 27296\,mm^3}{558,59 \cdot 10^4\,mm^4 \cdot 5\,mm} = 48,87\,\frac{N}{mm^2}$

tritt auf in der Faser z = 0



$\tilde{\tau}$
N/mm²

A3/1

1/ $I_2 = \frac{108\ cm^4}{341\ cm^4} \cdot I_1 = 0{,}3167 \cdot I_1$; $l_2 = \frac{1}{2} \cdot l_1$

$$\varkappa_2 = K_2 \cdot l_2 = \sqrt{\frac{F}{E \cdot I_2}} \cdot l_2$$

$$\varkappa_2 = \sqrt{\frac{F}{E \cdot 0{,}3167 \cdot I_1}} \cdot \frac{1}{2} \cdot l_1$$

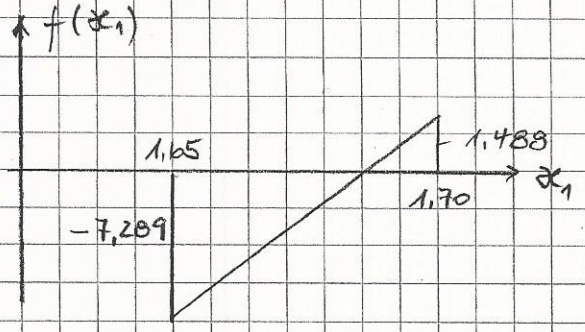
$$\varkappa_2 = \frac{1}{2} \cdot \frac{1}{\sqrt{0{,}3167}} \cdot \sqrt{\frac{F}{E \cdot I_1}} \cdot l_1 = 0{,}888 \cdot \varkappa_1$$

$$K_2 = \frac{1}{\sqrt{0{,}3167}} \cdot K_1 \; ; \; \frac{K_1}{K_2} = 0{,}5628$$

Knickbedingung: $f(\varkappa_1) = \tan \varkappa_1 + 0{,}5628 \cdot \tan(0{,}888 \cdot \varkappa_1) = 0$

$f(1{,}65) = -7{,}289$

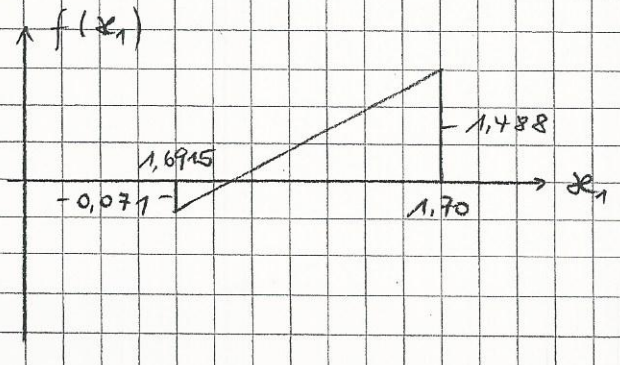
$f(1{,}70) = 1{,}488$



$$\frac{\Delta \varkappa_1}{7{,}289} = \frac{0{,}05}{7{,}289 + 1{,}488} \; ; \; \Delta \varkappa_1 = 0{,}0415$$

$\varkappa_{1Neu} = 1{,}65 + 0{,}0415 = 1{,}6915$

$f(\varkappa_{1Neu}) = -0{,}071$



$$\frac{\Delta \varkappa_1}{0,071} = \frac{1,70 - 1,6915}{1,488 + 0,071}$$

$$\Delta \varkappa_1 = 0,0004$$

$$\varkappa_{1\,neu} = 1,6915 + 0,0004 = 1,6919$$

$$\varkappa_1 = \sqrt{\frac{F_k}{E \cdot I_1}} \cdot l_1 = 1,6919$$

$$\frac{F_k}{E \cdot I_1} \cdot l_1^2 = 1,6919^2$$

$$F_k = \frac{E \cdot I_1 \cdot 1,6919^2}{l_1^2}$$

$$F_k = \frac{2,1 \cdot 10^5 \frac{N}{mm^2} \cdot 341 \cdot 10^4 mm^4 \cdot 1,6919^2}{(2000 mm)^2}$$

$$F_k = 512464 N$$

$$zu\ F = \frac{1}{4} \cdot 512464 = 128116 N$$

2) $$\sigma_k = \frac{512464 N}{60 mm \cdot 60 mm} = 142,35 \frac{N}{mm^2} < 188 \frac{N}{mm^2} = \sigma_{dp}$$