

## Task 1) Shoulder calculation

Only Bending:

Scale factor  $\downarrow$  Surface factor  $\downarrow$  fatigue strength of material

$$n = m \cdot K \cdot \sigma_{fu}$$

$$k_{fb} \cdot \sigma_{nom}$$

$$k_{fb} = 1 + q \left( \frac{1}{k_t} - 1 \right)$$

Diagram

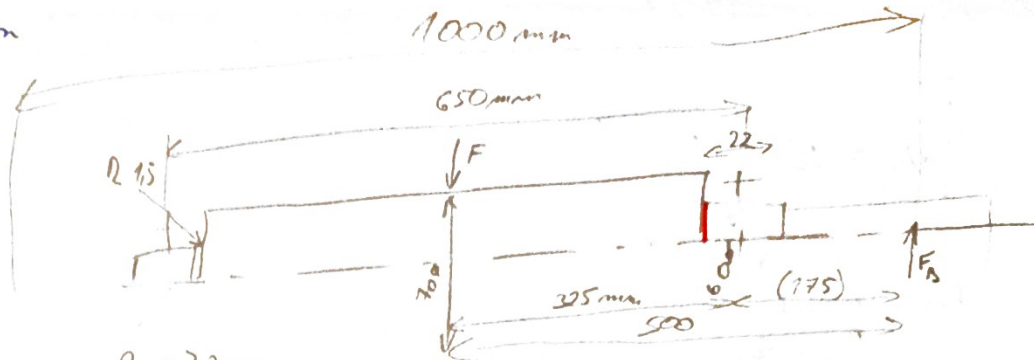
from tables:  $m = 0,77$

$$K = 0,84$$

$$\sigma_{fu} = 260 \text{ MPa}$$

$$k_B = 1 + q_B (2,3 - 1)$$

$$k_{fb} = 2,17$$



$$R_a = 3,2 \mu\text{m}$$

$$S_{355 32}$$

$$\sigma_{fu} = 260 \text{ MPa}$$

$$R_m = 490 \text{ MPa}$$

$$F = 8 \text{ kN}$$

$$F_B = 4 \text{ kN}$$

$$M_B = 4 \text{ kN} \cdot (175 + (11 - 1,5))$$

$$M_B = 738000 \text{ Nmm}$$

$$\sigma_{nom} = \frac{32 \cdot 738000}{\pi \cdot 60^3}$$

$$\sigma_{nom} = 34,8 \text{ MPa}$$

$$n = \frac{0,77 \cdot 0,84 \cdot 260}{2,17 \cdot 34,8} = \underline{\underline{2,2}}$$

## Task 2) Maximum reversed fatigue load T?

$$n = \frac{m \cdot K \cdot \sigma_{fu}}{\sigma_{ref}}$$

$$\sigma_{ref} = \sqrt{\sigma_a^2 + 3\tau_a^2}$$

from tables:

Bigger diam  $\rightarrow m = 0,78$

$$K = 0,83$$

$$R_m = 700 \text{ MPa}$$

$$\sigma_{fu} = 430 \text{ MPa}$$

$$k_{ft} = 1 + q(k_t - 1)$$

$$= 1 + q_B(1,95 - 1)$$

$$k_{ft} = 1,405$$

reversed fatigue

$$\tau_a = \tau_{max}$$

$$\tau_{max} = k_{ft} \cdot \tau_{nom}$$

$$\tau_{nom} = \frac{16 \cdot T}{\pi \cdot d^3}$$

$$\sigma_a = 0 \text{ MPa}$$

$$\tau_a = \tau_{max}$$

$$n = \frac{m \cdot K \cdot \sigma_{fu}}{\sqrt{3} \cdot \tau_{max}}$$

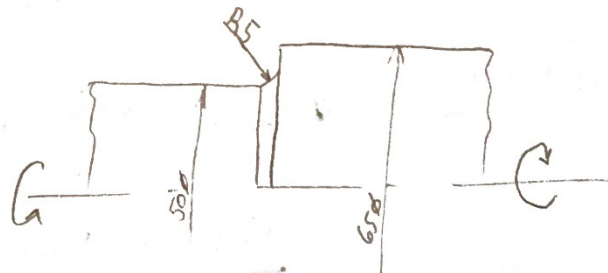
$$\tau_{nom} = \frac{m \cdot K \cdot \sigma_{fu}}{\sqrt{3} \cdot n \cdot k_{ft}}$$

$$T = \frac{\pi \cdot m \cdot K \cdot \sigma_{fu} \cdot d^3}{16 \sqrt{3} \cdot n \cdot k_{ft}}$$

$$T = \frac{\pi \cdot 0,78 \cdot 0,83 \cdot 430 \cdot 0,05^3}{16 \cdot \sqrt{3} \cdot 2,5 \cdot 1,405}$$

$$T = \underline{\underline{0,001123 \text{ Nm}}}$$

~~Somehow missed  $\cdot 10^0$~~



$$R_a = 1,6 \mu\text{m}$$

$$250 \text{ MPa}$$

Task 3) What is the maximum reversed fatigue load  $M$ ?

$$m = \frac{m \cdot K \cdot \sigma_{TW}}{\sigma_{ref}}$$

From tables:

$$R_m = 900 \text{ MPa or } 1100 \text{ MPa}$$

$$\sigma_{TW} = 520 \text{ MPa}$$

$$K_{ft} = 0,75$$

$$m = 0,8$$

$$n = 2,1$$

$$D_d = 1,375$$

$$y_d = 0,075$$

$$k_{fb} = 1 + 0,9 \left( \frac{2,1}{1,9} - 1 \right)$$

$$k_{fb} = 1,81$$

$$[42 \text{ CrV70 S4}]$$

$$R_a = 3,2 \mu\text{m}$$

$$m = 2,1$$

$$T = 800 \text{ Nm}$$

$$k_{ft} = 1 + 0,9 (1,55 - 1)$$

$$k_{ft} = 1,495$$

$$\tau_{nom} = \frac{16 T}{\pi d^3} = \frac{16 \cdot 800}{\pi \cdot 0,04^3}$$

$$\tau_{nom} = 63,66 \text{ MPa}$$

$$\tau_{max} = k_{ft} \cdot \tau_{nom}$$

$$\tau_{max} = 1,495 \cdot 63,66$$

$$\tau_{max} = 95,17 \text{ MPa}$$

↓

Pulsating

$$\tau_a = \frac{\tau_{max}}{2}$$

$$\tau_a = 47,59 \text{ MPa}$$

$$\sigma_{ref} = \sqrt{\sigma_a^2 + 3\tau_a^2}$$

revers:

$$\sigma_a = \sigma_{max}$$

$$\sigma_{max} = k_{fb} \cdot \sigma_{nom}$$

$$= k_{fb} \cdot \frac{32 M}{\pi d^3}$$

all together:

$$\sigma_{ref} = \frac{m \cdot K \cdot \sigma_{TW}}{n} = \frac{0,8 \cdot 0,75 \cdot 520 \cdot 10^6}{2,1}$$

$$\sigma_{ref} = 148,6 \text{ MPa}$$

$$\sqrt{\sigma_{ref}^2 - 3\tau_a^2} = \frac{32 M}{\pi d^3} \cdot k_{fb}$$

irrelevant

$$M = \frac{\pi \cdot 0,04^3 \sqrt{(148,6 \text{ MPa})^2 - 3 \cdot (47,59)^2}}{32 \cdot 1,81}$$

$$\cancel{43723}$$

$$M = \frac{25781 \text{ Nm}}{429}$$

$$\sigma_{ref} = \sqrt{\sigma_a^2 + 3\tau_a^2} \Rightarrow \sigma_{ref}^2 - 3\tau_a^2 = \sigma_a^2 \Rightarrow \sigma_a = \sqrt{\sigma_{ref}^2 - 3\tau_a^2}$$

$$k_{fb} \cdot \sigma_{nom} = \sqrt{\sigma_{ref}^2 - 3\tau_a^2} \Rightarrow \sigma_{nom} = \frac{\sqrt{\dots}}{k_{fb}}$$

$$\frac{32 M}{\pi d^3} = \frac{\sqrt{\dots}}{k_{fb}}$$

$$M = \frac{\pi d^3 \sqrt{\dots}}{32 \cdot k_{fb}}$$