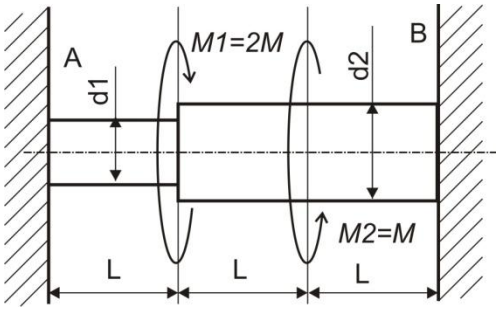
ZADATAK 2.

Štap promenljivog kružnog poprečnog preseka uklješten je na oba kraja i opterećen spregovima uvijanja. Odrediti:

- *Veličine momenata uvijanja u uklještenjima kao i odgovarajuće dijagrame*
- *Dimenzionisati štap na osnovu dozvoljenog ugla uvijanja i dozvoljenog napona*
- *Nacrtati dijagrame napona smicanja i ugla uvijanja po dužini štapa.*

$\theta_{doz} = \frac{\pi}{720} rad;\ \tau_{doz} = 80\ MPa; G = 8 \cdot 10^4\ MPa;\ \psi = 0.75;\ M_1 = 2M_2 = M = 1kNm; L = 1m$



a) Veličine momenata uklještenja

Uslovi ravnoteže

1. $\sum M_t = M_A - 2M + M + M_B = 0$
2. $\sum \theta_i = 0$

$I_{01} = \frac{d^4\pi}{32}$

$I_{02} = \frac{\left(\frac{4}{3}d\right)^4\pi}{32} = \frac{256}{81} \cdot \frac{d^4\pi}{32} = \frac{256}{81} \cdot I_{01}$

$M_A - 2M + M + M_B = 0 \rightarrow M_B = M - M_A$

$\frac{M_A \cdot L}{G \cdot I_{01}} + \frac{(M_A - 2M) \cdot L}{G \cdot I_{02}} + \frac{(M_A - 2M + M) \cdot L}{G \cdot I_{02}} = 0$

$\frac{M_A \cdot L}{G \cdot I_{01}} + \frac{(M_A - 2M) \cdot L}{G \cdot \frac{256}{81} \cdot I_{01}} + \frac{(M_A - 2M + M) \cdot L}{\frac{256}{81} \cdot I_{01}} = 0 \quad \left| \frac{1}{L} \cdot G \cdot \frac{256}{81} \cdot I_{01} \cdot \right.$

$\frac{256}{81} \cdot M_A + (M_A - 2M) + (M_A - 2M + M) = 0$

$\frac{418}{81} \cdot M_A - 3M = 0$

$M_A = \frac{81}{418} 3M = 0.58133\ \cdot M = 058133 \cdot 1\ kNm$

$M_A = 581\ Nm$

$M_B = M - M_A = 1000 - 581 = 419\ Nm$

b) Prečnik preko dozvoljenog ugla uvijanja

$$\theta = \frac{M_t L}{G \cdot I_0} \leq \theta_{doz}$$

$$\theta = \frac{M_A \cdot L}{G \cdot I_{01}} \leq \frac{\pi}{720} \rightarrow I_{01} = \frac{{d_1}^4 \pi}{32} = \frac{720\ M_A \cdot L}{\pi \cdot G} \rightarrow d_1 = \sqrt[4]{\frac{720 \cdot M_A \cdot 32 \cdot L}{\pi \cdot G \cdot \pi}} = \sqrt[4]{\frac{720 \cdot 581 \cdot 32 \cdot 1}{\pi^2 \cdot 8 \cdot 10^{10}}} = 0.06417\ m$$

$$d = 0.06417 usvojeno\ d = 65\ mm$$

$$d_2 = \frac{65}{0.75} = 87\ mm$$

$$I_{01} = \frac{d^4 \pi}{32} = \frac{0.065^4 \pi}{32} = 0.000001752\ m^4$$

$$I_{02} = \frac{d_2^4 \cdot \pi}{32} = \frac{0.087^4 \pi}{32} = 0.000005624\ m^4$$

c) Prečnik preko dozvoljenog napona

$$\tau = \frac{M_{max}}{W_{01}} \leq \tau_{doz} \rightarrow W_{01} \geq \frac{M_{max}}{\tau_{doz}} = \frac{2000}{80 \cdot 10^6} = 0{,}000025\ m^3$$

$$W_{01} = \frac{d^3 \pi}{16} \rightarrow d = \sqrt[3]{\frac{16\ W_{01}}{\pi}} = \sqrt[3]{\frac{16 \cdot 0.000025}{\pi}} = 0.0503\ m$$

Iz pokazanog se zaključuje da su merodavne vrednosti za dimenzionisanje vrednosti dobijene preko dozvoljenog ugla uvijanja pa su prečnici

$$d = 0.05033\ usvojeno\ d = 65\ mm$$

$$d_2 = \frac{65}{0.75} = 87\ mm$$

d) Karakteristične vrednosti uglova uvijanja

$$\theta_{doz} = \frac{\pi}{720} = 0.00436\ rad = 0.2498°$$

$$\theta_1 = \frac{M_A \cdot L}{G \cdot I_{01}} = \frac{581 \cdot 1}{8 \cdot 10^{10} \cdot 0.000004021} = 0.00414\ rad = 0.2372°$$

$$\theta_2 = \frac{(M_A - 2M) \cdot L}{G \cdot I_{02}} = \frac{(581 - 2000) \cdot 1}{8 \cdot 10^{10} \cdot 0.000005624} = 0.0032017 rad = 0.18344°$$

$$\theta_3 = \frac{(M_A - M) \cdot L}{G \cdot I_{02}} = \frac{(581 - 1000) \cdot 1}{8 \cdot 10^{10}\ 0.000005624} = 0.00094336\ rad = 0.05405°$$

Karakteristične vrednosti tangencijalnog napona

$$W_{01} = \frac{d^3 \pi}{16} = \frac{0.065^3 \pi}{16} = 0.000053922\ m^3$$

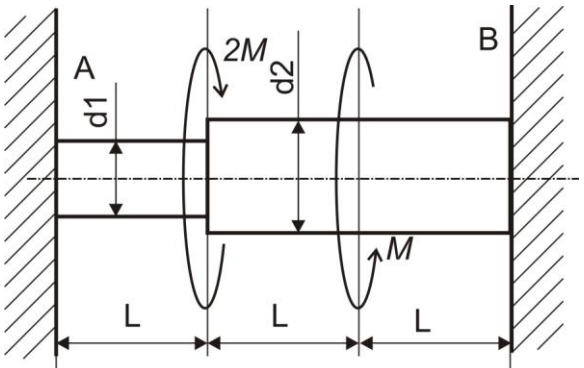
$$W_{02} = \frac{d_2^3 \cdot \pi}{16} = \frac{0.087^3 \pi}{16} = 0.000129296\ m^4$$

$$\tau_1 = \frac{M_A}{W_{01}} = \frac{581}{0.000053922} = 10774823\ Pa = 11\ MPa$$

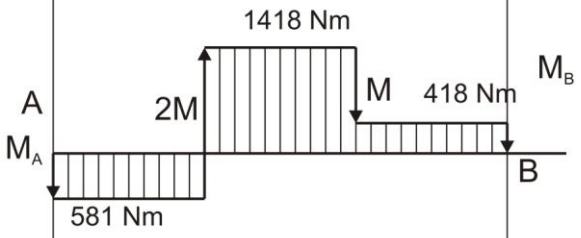
$$\tau_2 = \frac{M_2}{W_{02}} = \frac{1418}{0.000129296} = 10967018 Pa = 11\ MPa$$

$$\tau_2 = \frac{M_B}{W_{02}} = \frac{418}{0.000129296} = 3232891\ Pa = 3.2\ MPa$$

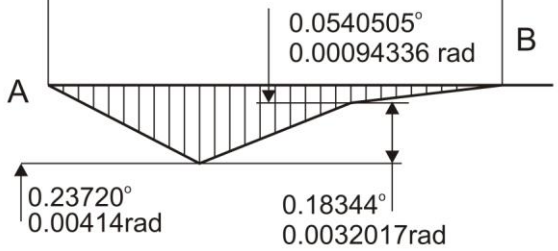
$$\tau_{max} = \frac{M_{max}}{W_{01}} = \frac{2000}{0.000053922} = 3708373Pa = 37\ MPa$$



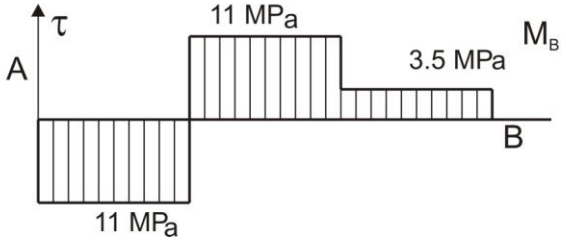
dijagram momemta uvijanja



dijagram ugla uvijanja



dijagram napona uvijanja



Ime i prezime	Broj indeksa	Datum:	Pregledao: