

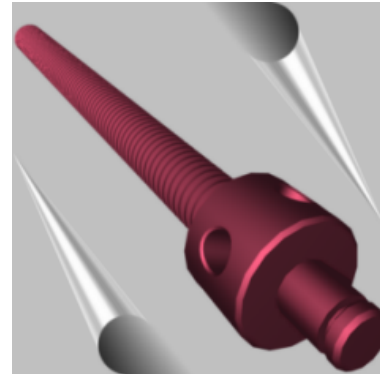
PRORACUN RUCNE DIZALICE SA NAVOJNIM VRETENOM

Polazni podaci

maksimalno opterecenje $F_a := 36000 \cdot \text{N}$

visina dizanja $h := 440 \cdot \text{mm}$

Rucna sila $F_r := 350 \cdot \text{N}$



Navojno vreteno

opterecenno je na pritisak i uvijanje, a krajnjem gornjem poloazaju kritican je i napon izvijanja

Materijal navojnog vretena **C. 0545** sa $ReH := 290 \cdot \frac{\text{N}}{\text{mm}^2}$

Precnik vretena

odredjuje se na osnovu povrinskog pritiska

koeficijent srednje klase izrade navoja $\xi_1 := 0.8$

koeficijent popravke $\xi_2 := 0.8$

stepen sigurnosti $S := 4$

dozvoljeni napon na zatezanje $\sigma_{zd} := \frac{ReH}{S}$ $\sigma_{zd} = 72.5 \cdot \frac{\text{N}}{\text{mm}^2}$

dozvoljeni napon na povrinski pritisak $\sigma_{pd}(0) := 1.2 \cdot \sigma_{zd}$ $\sigma_{pd}(0) = 87 \cdot \frac{\text{N}}{\text{mm}^2}$

dozvoljeni napon na povrinski pritisak $\sigma_{pd} := \xi_1 \cdot \xi_2 \cdot \sigma_{pd}(0)$ $\sigma_{pd} = 55.7 \cdot \frac{\text{N}}{\text{mm}^2}$

Povrsina poprecnog preseka jezgra navoja $A_1 := \frac{F_a}{\sigma_{pd}}$ $A_1 = 646.6 \text{mm}^2$

na osnovu površine A1 iz tablice biram za trapezni navoj precnik d.

Dimenzije navojnog vretena

iz **tablice** usvajam $A_1 := 830 \cdot \text{mm}^2$ **Tr 40x7** $d := 40 \cdot \text{mm}$

$P := 7 \cdot \text{mm}$

$d_1 := 32.5 \cdot \text{mm}$

$H_1 := 3 \cdot \text{mm}$

$d_2 := 36.5 \cdot \text{mm}$

$D_1 := 34 \cdot \text{mm}$

d	A1	A2	A3	A4	A5
40	32.500	0.250	0.750	3.250	0.250
44	36.500	0.250	0.750	3.750	0.250
48	40.500	0.250	0.750	4.250	0.250

Provera samokocivosti navoja

ugao profila navoja $\alpha := 30 \cdot \text{deg}$ za trapezni navoj

$\mu := 0.125$ koef. trenja za normalnu obradu navoja

$\rho_v := \text{atan} \left(\frac{\mu}{\cos \left(\frac{\alpha}{2} \right)} \right)$ $\rho_v = 0.13$ $\rho_v = 7.37 \text{deg}$ ugao trenja navoja

$$\phi := \operatorname{atan}\left(\frac{P}{d_2 \cdot \pi}\right) \quad \phi = 0.06 \quad \phi = 3.49 \text{ deg}$$

posto je $p_v > \phi$ **navoj je samokociv**

Provera slozenog napona

$$\sigma := \frac{F_a}{A_1} \quad \sigma = 4.3 \times 10^1 \frac{\text{N}}{\text{mm}^2} \quad \text{normalni napon u vretenu}$$

$$W_0 := \frac{d_1^3 \cdot \pi}{16} \quad W_0 = 6740.3 \text{ mm}^3 \quad \text{polarni otporni moment preseka vretena}$$

$$T := F_a \cdot \frac{d_2}{2} \cdot \tan(\phi + p_v) \quad T = 126.1 \text{ N}\cdot\text{m} \quad \text{moment uvijanja vretena}$$

$$\tau := \frac{T}{W_0} \quad \tau = 1.9 \times 10^1 \frac{\text{N}}{\text{mm}^2} \quad \text{napon uvijanja u vretenu}$$

idealni (svedeni) napon u navojnom vretenu

$$\sigma_i := \sqrt{\sigma^2 + 3 \cdot \tau^2} \quad \sigma_i = 5.4 \times 10^1 \frac{\text{N}}{\text{mm}^2}$$

stepen sigurnosti navojnog vretena

$$S := \frac{R_{eH}}{\sigma_i} \quad S = 5.4 \quad S > S_d \quad \text{sto odgovara} \quad S_d := 4$$

Navrtka

Materijal navrtke **P. Cu Sn 12** sa

$$R_m := 240 \cdot \frac{\text{N}}{\text{mm}^2}$$

$$R_{eH} := 130 \cdot \frac{\text{N}}{\text{mm}^2}$$

dozvoljeni povrinski pritisak za bronzu po celiku

$$p_d := 15 \cdot \frac{\text{N}}{\text{mm}^2}$$

$p_d = 11$ do 17.5 N/mm^2

Visina navrtke

$$m := 1.5 \cdot d \quad m = 60 \text{ mm}$$

Provera navojaka na pritisak

$$\text{broj navojaka} \quad z := \frac{m}{p} \quad z = 8.6$$

$$A := \left(d^2 - D_1^2\right) \cdot \frac{\pi}{4} \quad A = 348.7 \text{ mm}^2$$

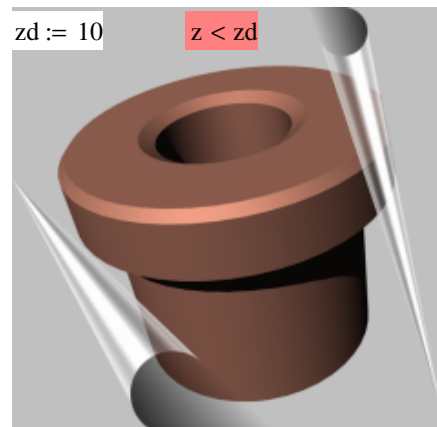
$$p := \frac{F_a}{z \cdot A} \quad p = 12 \frac{\text{N}}{\text{mm}^2} \quad p < p_d$$

Precnik tela navrtke

$$D_n := m \quad D_n = 60 \text{ mm}$$

Visina venca navrtke

$$h_2 := 0.25 \cdot m \quad h_2 = 15 \text{ mm}$$



Provera na smicanje

$$\tau_s := \frac{F_a}{D_n \cdot \pi \cdot h_2}$$

$$\tau_s = 12.7 \frac{N}{\text{mm}^2}$$

$$\tau_{sd} := 40 \cdot \frac{N}{\text{mm}^2}$$

Precnik venca navrtke

$$D_2 := 1.25 \cdot D_n$$

$$D_2 = 75 \text{ mm}$$

$$\tau_s < \tau_{sd}$$

Glava vretena**Precnik glave vretena**

$$D_3 := 1.8 \cdot d$$

$$D_3 = 72 \text{ mm}$$

Precnik vretena u nosacu tereta

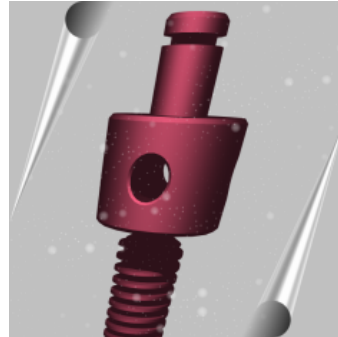
$$d_3 := 0.8 \cdot d$$

$$d_3 = 32 \text{ mm}$$

usvojeno

$$d_3 := 30 \cdot \text{mm}$$

zbog lezaja

**Visina glave vretena**

$$h_3 := 1.25 \cdot d$$

$$h_3 = 50 \text{ mm}$$

Zleb za izlaz alata

$$d_a := d_1$$

$$d_a = 32.5 \text{ mm}$$

$$b := 1.5 \cdot P$$

$$b = 10.5 \text{ mm}$$

Provera napona izvijanja

$$E := 206 \cdot 10^3 \cdot \frac{N}{\text{mm}^2}$$

modul elasticnosti celika

$$\text{ReH} := 290 \cdot \frac{N}{\text{mm}^2}$$

$$A := 335 \cdot \frac{N}{\text{mm}^2}$$

$$B := 0.62 \cdot \frac{N}{\text{mm}^2}$$

$$\lambda_0 := \frac{A - \text{ReH}}{B}$$

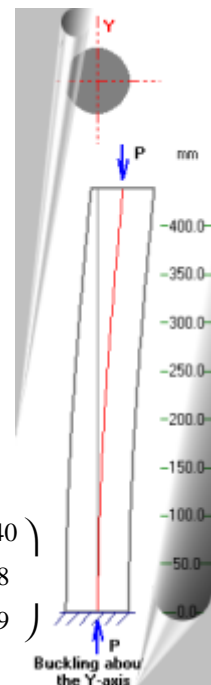
$$\lambda_0 = 73$$

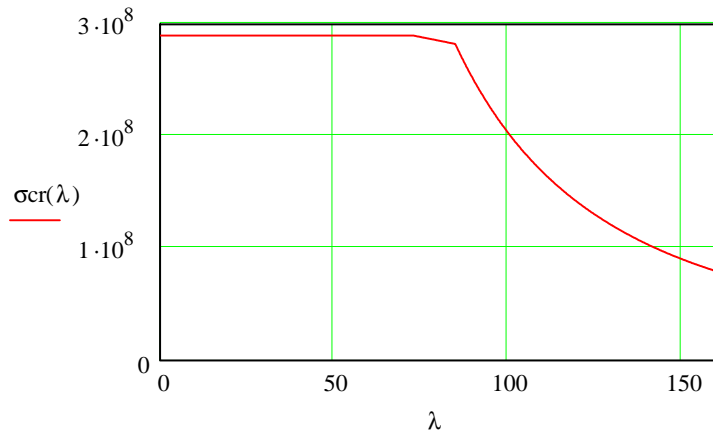
koeficijenti A i B zavise od materijala vretena, za C. 0545 iz ME I, MF Bg-Ni, str.137

$$A - B \cdot \lambda_1 - \frac{\pi^2 \cdot E}{\lambda_1^2} = 0 \text{ solve, } \lambda_1 \rightarrow \begin{pmatrix} -73.114358840637854740 \\ 84.851006689484205068 \\ 528.58593279631493999 \end{pmatrix}$$

$$\lambda_1 := 84.85$$

$$\sigma_{cr}(\lambda) := \begin{cases} \text{ReH} & \text{if } \lambda \leq \lambda_0 \\ (A - B \cdot \lambda) & \text{if } \lambda_0 < \lambda < \lambda_1 \quad \text{proracun po Tetmajeru} \\ \frac{E \cdot \pi^2}{\lambda^2} & \text{if } \lambda > \lambda_1 \quad \text{proracun po Ojleru} \end{cases}$$





redukovana duzina vretena $l_r := 2 \cdot \left(\frac{m}{2} + h + b + h_3 \right) \quad l_r = 1061 \text{ mm}$

moment inercije popreznog preseka vretena $I_{\min} := \frac{d_1^4 \cdot \pi}{64} \quad I_{\min} = 5.5 \times 10^4 \text{ mm}^4$

poluprecnik inercije $i_{\min} := \sqrt{\frac{I_{\min}}{A_1}} \quad i_{\min} = 8.1 \text{ mm}$

vitkost $\lambda := \frac{l_r}{i_{\min}} \quad \lambda = 130.6$ $\lambda_1 = 84.8$

$\lambda_0 = 72.6$

$\sigma_{cr}(\lambda) = 119.2 \frac{N}{\text{mm}^2}$ kritični napon

Stepen sigurnosti protiv izvijanja

$S := \frac{\sigma_{cr}(\lambda)}{\sigma_i} \quad S = 2.2$ S > Sd Sd := 3

Sd=3 do 6 za proračun po Ojleru

Sd=2 do 4 za proračun po Tetmajeru

stepen sigurnosti na izvijanje ne zadovoljava
potrebno je povećati presek vretena

Nosac tereta

Materijal nosaca SL 200

Precnik nosaca

$D_4 := D_3 \quad D_4 = 72 \text{ mm}$

Visina nosaca

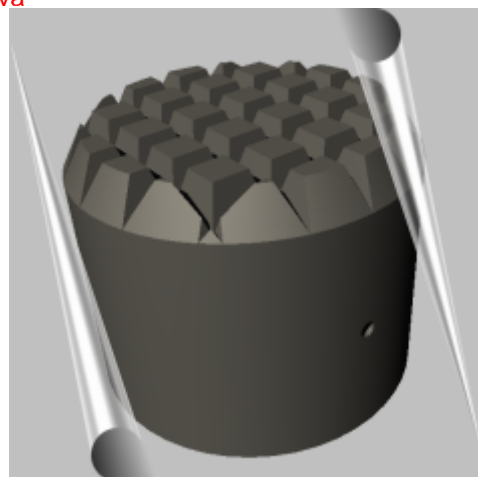
$h_4 := m \quad h_4 = 60 \text{ mm}$

Poluga

Materijal rucice C. 0645 sa $ReH := 290 \cdot \frac{N}{\text{mm}^2}$

Duzina rucice

$L_5 := 400 \cdot \text{mm}$



Precnik rucice

$$d5 := 20 \cdot \text{mm}$$

Provera na savijanje

$$l := \frac{T}{Fr} \quad l = 360.4 \text{ mm}$$

$$l1 := l - \frac{D3}{2} \quad l1 = 324.4 \text{ mm}$$

$$M := l1 \cdot Fr \quad M = 1.1 \times 10^2 \text{ N}\cdot\text{m}$$

$$S := \frac{d5^3 \cdot \pi \cdot ReH}{32 \cdot M} \quad S = 2 \quad S > Sd \quad Sd := 2$$

Postolja

Materijal postolja **SL 200**

$$pd := 2 \cdot \frac{N}{\text{mm}^2} \quad \text{za pritisak u podnozju postolja}$$

Visina tela

$$H6 := h + (m - h2) + 40 \cdot \text{mm} \quad H6 = 525 \text{ mm}$$

Nagib tela

$$\beta := 6.6 \cdot \text{deg}$$

Unutrasnji gornji precnik

$$dg := 1.3 \cdot Dn \quad dg = 78 \text{ mm}$$

Unutrasnji donji precnik

$$l6 := H6 - (m - h2) \quad l6 = 480 \text{ mm}$$

$$dd := dg + 2 \cdot l6 \cdot \tan(\beta) \quad dd = 189 \text{ mm}$$

Spoljasnji donji precnik

$$Dd := 1.6 \cdot dd \quad Dd = 303 \text{ mm}$$

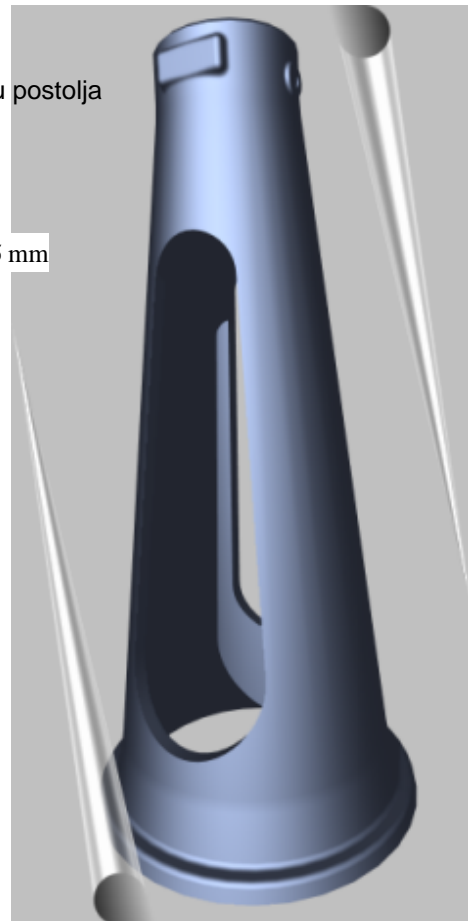
Provera na pritisak

$$p := \frac{4 \cdot Fa}{(Dd^2 - dd^2) \cdot \pi} \quad p = 0.8 \frac{N}{\text{mm}^2} \quad p < pd$$

Provera na povrinski pritisak izmedju navrtke i postolja

$$p := \frac{4 \cdot Fa}{(D2^2 - Dn^2) \cdot \pi} \quad p = 22.6 \frac{N}{\text{mm}^2} \quad p < pd$$

$$pd := 60 \cdot \frac{N}{\text{mm}^2} \quad \text{za bronza - SL}$$

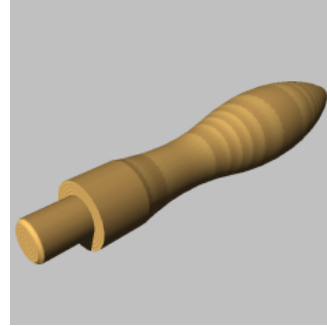


Debljina zida

$$\delta := 0.25 \cdot d \quad \delta = 10 \text{ mm}$$

Spoljasnji gornji precnik

$$D_g := d_g + 2 \cdot \delta \quad D_g = 98 \text{ mm}$$

**Vijak za osiguranje navrtke****Dimenzije i standard**

$$\text{duzina vijka} \quad l := \frac{D_g - D_n}{2} - 5 \cdot \text{mm} \quad l = 14 \text{ mm}$$

M 4 x 15 JUS M.B1.290**Materijal**

4.8

sa

$$ReH := 320 \cdot \frac{N}{\text{mm}^2}$$

Provera vijka na smicaje

$$\text{broj vijaka} \quad z := 3$$

$$\xi_T := 1 \quad \text{za vijak opterecen na glatkom delu}$$

$$\xi_1 := 1.3 \quad \text{za vijak opterecen na uvijanje nazivnog precnika 6 mm}$$

$$A_1 := 7.75 \cdot \text{mm}^2 \quad \text{iz tablice}$$

$$F_{s1} := \frac{2 \cdot T}{z \cdot D_n} \quad F_{s1} = 1401.4 \text{ N} \quad \text{smicajna sila na jednom vijku}$$

$$S := \frac{0.8 \cdot ReH \cdot \xi_T \cdot \xi_1 \cdot A_1}{F_{s1}} \quad S = 1.84 \quad S > S_d \quad S_d := 1.5$$

$$S_d = 1.25 \text{ do } 1.6 \quad \text{po preporuci}$$

Vijak za osiguranje nosaca tereta**Dimenzije i standard**

$$\text{duzina vijka} \quad l := \frac{D_4 - d_3}{2} - 5 \cdot \text{mm} \quad l = 16 \text{ mm}$$

M 4 x 15 JUS M.B1.291**Materijal**

4.8

sa

$$ReH := 320 \cdot \frac{N}{\text{mm}^2}$$

Komada

z := 2

Vijak za osiguranje vretena**Dimenzije i standard**

$$\text{duzina vijka} \quad l := 0.7 \cdot d \quad l = 28 \text{ mm}$$

M 8 x 30 levi JUS M.B1.055

Materijal 4.6 sa $ReH := 240 \cdot \frac{N}{mm^2}$

Provera vijka na zatezanje

broj vijaka $z := 1$

$\xi_T := 1.1$ za navoj koji se izradjuje rezanjem materijala 4.6

$\xi_1 := 1.1$ za M8 napregnut na zatezanje

$A_1 := 32.8 \cdot mm^2$ iz tablice

$F_z := 0.2 \cdot F_a$ $F_z = 7200 N$

$S := \frac{ReH \cdot \xi_T \cdot \xi_1 \cdot A_1}{F_z}$ $S = 1.3$ $S > S_d$ $S_d := 1.25$

$S_d = 1.25$ do 1.6 po preporuci

Ulezistenje uputstvo

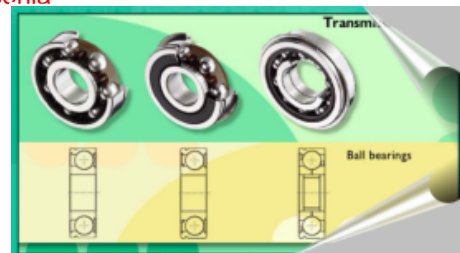
Izbor lezaja

mozemo usvojiti da lezaj miruje ili lagano osciluje (broj obrtaja $n < 15 \text{ min}^{-1}$), te proracun vrsimo na osnovu staticke moci nosenia

$P_0 := F_a$

$f_0 := 1.5$

$C_0 := f_0 \cdot P_0$ $C_0 = 5.4 \times 10^4 N$



Tip i oznaka

izabrani lezaj je kolutni kuglicni aksijalni jednoređi oznake **51306**

na osnovu $d_3 = 30 \text{ mm}$

Parametri lezaja

$C_0 := 60 \cdot 10^3 \cdot N$

$H := 21 \cdot \text{mm}$

$d := 30 \cdot \text{mm}$

$C := 36.9 \cdot 10^3 \cdot N$

$D := 60 \cdot \text{mm}$

$d_1 := 32 \cdot \text{mm}$

$D_1 := 60 \cdot \text{mm}$

Stepen korisnog dejstva

$\eta := \frac{\tan(\phi)}{\tan(\phi + \rho v)}$ $\eta = 0.32$

