

PRORACUN CILINDRICNOG ZUPCASTOG PARA

Polazni podaci

- A1 Nominalna snaga $P = 100\text{kW}$
- A2 Broj obrtaja pogon. masine $n_1 = 1400\text{min}^{-1}$
- A3 Broj zubaca pogonskog zupčanika $z_1 = 19$ usvojiti od 18 do 25
- A4 Broj zubaca gonjenog zupčanika $z_2 = 30$ savet da z_1+z_2 bude neparan broj
- A5 Prenosni odnos $u = \frac{z_2}{z_1}$ $u = 1.579$
- A6 Ugao nagiba bocne linije $\beta = 12\text{deg}$ usvojiti od 5 do 25 stepeni
- A7 Modul $m_n = 6\text{mm}$ Tab. 4.2 str. 98
- A8 Ceoni modul $m_t = \frac{m_n}{\cos(\beta)}$ $m_t = 6.134\text{mm}$
- A9 Ugao nagiba profila $\alpha_n = 20\text{deg}$
- A10 Faktor visine temenog dela alata $ha_{0x} = 1.25$
- A11 Faktor poluprecnika zaobljenja alata $roa_{0x} = 0.25$
- A12 Visina noge zupca $h_{fp} = 1.25 \cdot m_n$ $h_{fp} = 7.5\text{mm}$ od 10 do 40 % preko m_n
- A13 Temeni zazor $c = h_{fp} - m_n$ $c = 1.5\text{mm}$
- A14 Sirina zupčanika $b = 130\text{mm}$ usvojeno
- A15 Kvalitet izrade **IT 7** zadato
- A16 Materijal pogonskog zupčanika **C.1531 nitriran** Tab. 4.5 str. 133
- A17 Materijal gonjenog zupčanika **C.1331** usvojiti losiji materijal u odnosu na z_1
- A18 Dinamicka izdržljivost bokova pog. zupčanika $\sigma_{Hlim} = 950 \frac{\text{N}}{\text{mm}^2}$ Tab. 4.5 str. 133
- A19 Dinamicka izdržljivost podnozja pog. zupčanika $\sigma_{Flim} = 300 \frac{\text{N}}{\text{mm}^2}$ Tab. 4.5 str. 133
- A20 Srednja hrapavost $R_a = 1.6 \times 10^{-6}\text{m}$ Tab. 1.1 str. 32 MEI

Geometrija zupčanika

- B1 Precnik podeone kruznice pog. zupčanika $d_1 = m_t \cdot z_1$ $d_1 = 116.547\text{mm}$
- B2 Precnik podeone kruznice gonj. zupčanika $d_2 = m_t \cdot z_2$ $d_2 = 184.021\text{mm}$
- B3 Ugao nagiba profila alata u ceonom preseku $\alpha_t = \text{atan}\left(\frac{\tan(\alpha_n)}{\cos(\beta)}\right)$ $\alpha_t = 20.41\text{deg}$
- B4 Nulto osno rastojanje $ar = \frac{(d_1 + d_2)}{2}$ $ar = 150.284\text{mm}$
- B5 Osno rastojanje $a = 150\text{mm}$ (zaokruziti na blizu peticu)

B6 Precnik kinematske kruznice pog.zupcanika	$dw1 = 2 \cdot a \cdot \frac{z1}{z1 + z2}$	$dw1 = 116.327 \text{ mm}$
B7 Precnik kinematske kruznice gonj.zupcanika	$dw2 = u \cdot dw1$	$dw2 = 183.673 \text{ mm}$
B8 Ugao dodirnice	$\alpha_{wt} = \arccos \left[\frac{mt \cdot (z1 + z2) \cdot \cos(\alpha_t)}{2 \cdot a} \right]$	$\alpha_{wt} = 20.117 \text{ deg}$
B9 Involut funkcija	$\text{inv}(x) = \tan(x) - x$	
B10 Zbir koef. pomeranja profila	$X = (\text{inv}(\alpha_{wt}) - \text{inv}(\alpha_t)) \cdot \frac{(z1 + z2)}{2 \cdot \tan(\alpha_n)}$	$X = -0.047$
B11 Parcijalni koef. pomeranja pogonskog zupcanika	$x1 = 0$	
B12 Parcijalni koef. pomeranja gonjenog zupcanika	$x2 = X - x1$	$x2 = -0.05$
B13 Precnik podnozne kruznice pog.zupcanika	$df1 = d1 + 2 \cdot x1 \cdot mn - 2 \cdot hfp$	$df1 = 101.547 \text{ mm}$
B14 Precnik podnozne kruznice gonj.zupcanika	$df2 = d2 + 2 \cdot x2 \cdot mn - 2 \cdot hfp$	$df2 = 168.457 \text{ mm}$
B15 Precnik temene kruznice pog.zupcanika	$da1 = 2 \cdot a - df2 - 2 \cdot c$	$da1 = 128.543 \text{ mm}$
B16 Precnik temene kruznice gonj.zupcanika	$da2 = 2 \cdot a - df1 - 2 \cdot c$	$da2 = 195.453 \text{ mm}$
B17 Precnik osnovne kruznice pog.zupcanika	$db1 = d1 \cdot \cos(\alpha_t)$	$db1 = 109.23 \text{ mm}$
B18 Precnik osnovne kruznice gonj.zupcanika	$db2 = d2 \cdot \cos(\alpha_t)$	$db2 = 172.468 \text{ mm}$
B19 Podeoni korak u normalnoj ravni	$pn = \pi \cdot mn$	$pn = 18.85 \text{ mm}$
B20 Podeoni korak u ceonoj ravni	$pt = \pi \cdot mt$	$pt = 19.271 \text{ mm}$
B21 Osnovni (sprezni) korak	$pet = pt \cdot \cos(\alpha_t)$	$pet = 18.061 \text{ mm}$
B22 Aktivna duz.dodirnice	$g\alpha = \frac{1}{2} \cdot \left(\sqrt{da1^2 - db1^2} + \sqrt{da2^2 - db2^2} \right) - a \cdot \sin(\alpha_{wt})$	$g\alpha = 28.273 \text{ mm}$
B23 Stepen sprezanja profila	$\epsilon\alpha = \frac{g\alpha}{pet}$	$\epsilon\alpha = 1.565$ mora biti $1 < \epsilon\alpha < 2$
B24 Stepen sprezanja bocnih linija	$\epsilon\beta = \frac{b \cdot \tan(\beta)}{pt}$	$\epsilon\beta = 1.434$ iskustveno $1 < \epsilon\beta < 1.5$
B25 Ukupni stepen sprezanja	$\epsilon\gamma = \epsilon\alpha + \epsilon\beta$	$\epsilon\gamma = 2.999$ najpogodnije u pogledu dinamike ako je ceo broj
B26	$\alpha_{tx1} = \arctan \left[\frac{1}{\cos(\alpha_t)} \cdot \sqrt{\sin(\alpha_t)^2 + 4 \cdot \frac{x1}{z1} \cdot \left(1 + \frac{x1}{z1} \right)} \right]$	$\alpha_{tx1} = 20.41 \text{ deg}$
B27	$\alpha_{tx2} = \arctan \left[\frac{1}{\cos(\alpha_t)} \cdot \sqrt{\sin(\alpha_t)^2 + 4 \cdot \frac{x2}{z2} \cdot \left(1 + \frac{x2}{z2} \right)} \right]$	$\alpha_{tx2} = 19.92 \text{ deg}$
B28 Ugao nagiba bocne linije	$\beta_b = \arcsin(\sin(\beta) \cdot \cos(\alpha_n))$	$\beta_b = 11.267 \text{ deg}$
B29 Merni broj zubaca z1	$z_{w1r} = \frac{z1}{\pi} \cdot \left(\frac{\tan(\alpha_{tx1})}{\cos(\beta_b)^2} - \text{inv}(\alpha_t) \right) - \frac{2 \cdot x1 \cdot \tan(\alpha_t)}{\pi} + 0.5$	$z_{w1r} = 2.744$ na blizi ceo broj $z_{w1} = 3$
B30 Merni broj zubaca z2	$z_{w2r} = \frac{z2}{\pi} \cdot \left(\frac{\tan(\alpha_{tx2})}{\cos(\beta_b)^2} - \text{inv}(\alpha_t) \right) - \frac{2 \cdot x2 \cdot \tan(\alpha_t)}{\pi} + 0.5$	$z_{w2r} = 3.958$ na blizi ceo broj $z_{w2} = 4$

B31 Mera preko zubaca pogonskog zupcanika

$$W1 = mn \cdot \cos(\alpha_n) \cdot [\pi \cdot (z_{w1} - 0.5) + z_1 \cdot \text{inv}(\alpha_t)] + 2 \cdot x_1 \cdot mn \cdot \sin(\alpha_n) \quad W1 = 45.983 \text{ mm}$$

B32 Mera preko zubaca gonjenog zupcanika

$$W2 = mn \cdot \cos(\alpha_n) \cdot [\pi \cdot (z_{w2} - 0.5) + z_2 \cdot \text{inv}(\alpha_t)] + 2 \cdot x_2 \cdot mn \cdot \sin(\alpha_n) \quad W2 = 64.487 \text{ mm}$$

Opterećenje

C1 Faktor spoljasnih dinamičkih sila $KA = 1.25$ Tab.4.3 str.127 za ravnomeran radC2 Ugaona brzina pogonskog zupcanika $\omega_1 = 2 \cdot \pi \cdot n_1$ $\omega_1 = 146.608 \text{ s}^{-1}$ C3 Obrtni moment na pogonskom vratilu $T_1 = \frac{P}{\omega_1}$ $T_1 = 682.093 \text{ N}\cdot\text{m}$ C4 Obimna sila na podelenom cilindru pog.zupcanika $F_{t1} = \frac{2 \cdot T_1}{d_1}$ $F_{t1} = 1.171 \times 10^4 \text{ N}$ C5 Obimna sila na podelenom cilindru gonj.zupcanika $F_{t2} = F_{t1}$ $F_{t2} = 1.171 \times 10^4 \text{ N}$ C6 Obimna brzina zupcanika $v = \frac{d_1}{2} \cdot \omega_1$ $v = 8.543 \frac{\text{m}}{\text{s}}$ C7 Parametar brzine $\frac{v \cdot z_1}{100} = 1.623 \frac{\text{m}}{\text{s}}$ C8 Faktor unutrašnjih dinamičkih sila $KV\beta = 1.07$ Sl. 4.47 str. 128

$$KV\alpha = 1.13$$

za $\epsilon\beta = 1.434$ $\epsilon\beta > 1$ $KV = KV\beta$ $KV = 1.07$ C9 Faktor raspodele opterećenja $KH\beta = 1.08$ Tab. 4.4 str. 130 za $\frac{b}{d_1} = 1.115$ C10 Ukupni faktor opterećenja $KH = KA \cdot KV\beta \cdot KH\beta$ $KH = 1.445$

Nosivost u odnosu na cvrstocu bokova zubaca

D1 Faktor elasticnosti materijala $Z_{Ec} = 189 \sqrt{\frac{\text{N}}{\text{mm}^2}}$ za kontakt celik po celiku $Z_{Es1} = 163 \sqrt{\frac{\text{N}}{\text{mm}^2}}$ za kontakt celik po sivi livD2 Uticaj elasticnosti materijala $Z = 2.5 \cdot Z_{Ec} \cdot \cos(\beta)$ $Z = 462.175 \sqrt{\frac{\text{N}}{\text{mm}^2}}$ D3 Radni napon boka zupca $\sigma_H = Z \cdot \left(\frac{F_{t1}}{b \cdot d_1} \cdot \frac{u+1}{u} \cdot KH \right)^{\frac{1}{2}}$ $\sigma_H = 623.975 \frac{\text{N}}{\text{mm}^2}$ D4 Kritični napon bokova $\sigma_{Hkr} = \sigma_{Hlim}$ $\sigma_{Hkr} = 950 \frac{\text{N}}{\text{mm}^2}$ D5 Stepen sigurnosti obzirom na bok zupca $SH = \frac{\sigma_{Hkr}}{\sigma_H}$ $SH = 1.5$ **zadovoljava**D6 Dozvoljeni stepen sigurnosti protiv razaranja bokova zubaca $SHd = 1.2$ $SHd = 1.2$ do 2 po preporuci

Nosivost u odnosu na cvrstocu podnozja zubaca

E1 Faktor koncentracije napona $Y_{\Pi} = 1.92$ za $mn = 6 \text{ mm}$

$Y_{\Pi} = 2$ za $mn < \text{ili} = 5$ i $Ra < 10 \mu\text{m}$
 $Y_{\Pi} = 1.7 \text{ do } 2$ za $mn > 5$ i/ili $Ra > 10 \mu\text{m}$ manje vrednosti uzimati za vece Ra

E2 Kritični napon $\sigma_{FM} = Y_{\Pi} \cdot \sigma_{Flim}$ $\sigma_{FM} = 576 \frac{N}{\text{mm}^2}$

E3 Faktor oblika zupca $Y_{Fa} = 2.91$ Tab.4.8 str.139

$$z_n = \frac{z_1}{\cos(\beta)^3} \quad z_n = 20.3 \quad i \quad x_1 = 0 \quad \text{iz geometrije}$$

E4 Faktor koncentracije napona $Y_{Sa} = 1.66$ Sl.4.54 str.137

E5 Faktor položaja $Y_{\epsilon} = 0.25 + \frac{0.75}{\epsilon \alpha}$ $Y_{\epsilon} = 0.729$

E6 Uticaj oblika kosozubih zupcanika $Y_{\beta} = 1 - \epsilon_{\beta} \cdot \frac{\beta}{120 \text{deg}}$ $Y_{\beta} = 0.857$

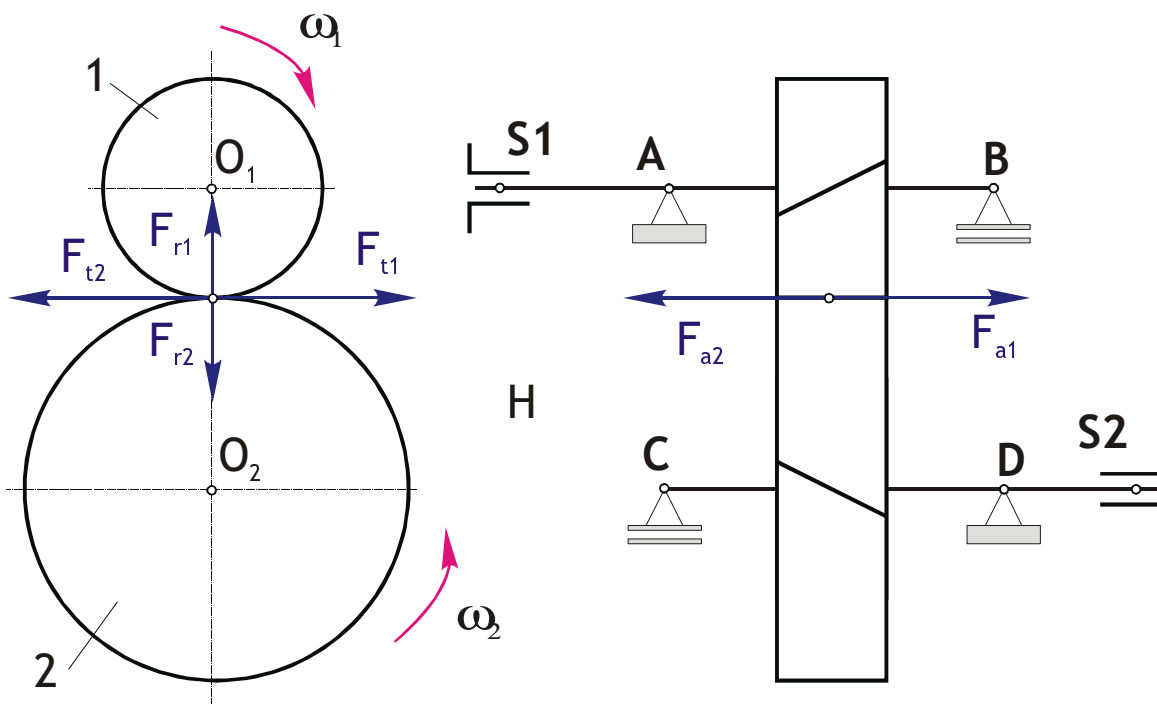
E7 Faktor raspodele opterećenja $K_{F\beta} = 1.06$ Tab.4.4 str.130 za $K_{H\beta} = 1.08$

E8 Napon u podnozju zupca $\sigma_F = Y_{Fa} \cdot Y_{Sa} \cdot Y_{\epsilon} \cdot Y_{\beta} \cdot \frac{F_{t1}}{b \cdot mn} \cdot K_A \cdot K_V \cdot K_{F\beta}$ $\sigma_F = 64.188 \frac{N}{\text{mm}^2}$

E9 Stepen sigurnosti obzirom na lom zupca $SF = \frac{\sigma_{FM}}{\sigma_F}$ **SF = 9** **zadovoljava**

SFd = 1.4 preporuka za dozvoljeni stepen sigurnosti

ANALIZA OPTEREĆENJA ZUPCASTOG PRENOSNIKA



PRETHODNI PRORACUN POGONSKOG VRATILA

Sile i sheme opterećenja vratila



Cilindricni zupčanik

Obimna sila $F_{t1} = \frac{2 \cdot T_1}{d_1}$

$$F_{t1} = 1.171 \times 10^4 \text{ N}$$

Radijalna sila $F_{r1} = \frac{F_{t1}}{\cos(\beta)} \cdot \tan(\alpha_n)$

$$F_{r1} = 4.355 \times 10^3 \text{ N}$$

Aksijalna sila $F_{a1} = F_{t1} \cdot \tan(\beta)$

$$F_{a1} = 2.488 \times 10^3 \text{ N}$$



Rastojanje između oslonaca A i B

$$l_1 = 140 \text{ mm}$$

A oslonac je nepokretan, B oslonac je pokretan

Otpori oslonaca u V ravni

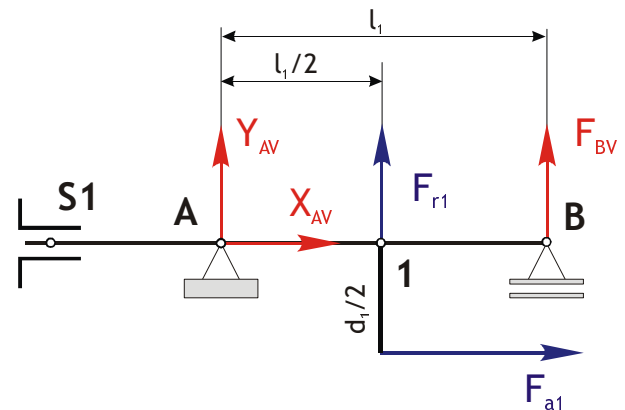
Given

$$\sum X_i = 0 \quad X_{AV} + F_{a1} = 0$$

[V]

$$\sum Y_i = 0 \quad Y_{AV} + F_{r1} + F_{BV} = 0$$

$$\sum M_A = 0 \quad F_{r1} \cdot \frac{l_1}{2} + F_{a1} \cdot \frac{d_1}{2} + F_{BV} \cdot l_1 = 0$$



Otpori oslonaca su

$$X_{AV} = -2.488 \times 10^3 \text{ N}$$

$$Y_{AV} = -1.142 \times 10^3 \text{ N}$$

$$F_{BV} = -3.213 \times 10^3 \text{ N}$$

Otpori oslonaca u H ravni

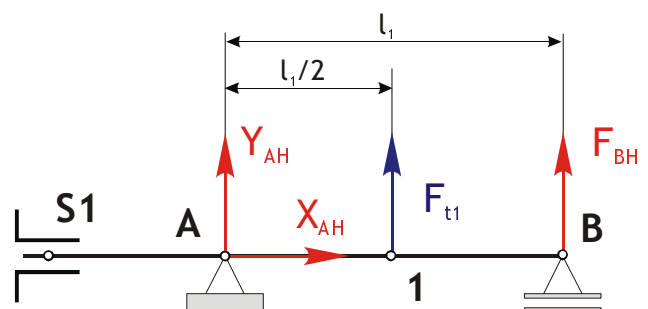
Given

$$\sum X_i = 0 \quad X_{AH} = 0$$

$$\sum Y_i = 0 \quad Y_{AH} + F_{t1} + F_{BH} = 0$$

$$\sum M_A = 0 \quad F_{t1} \cdot \frac{l_1}{2} + F_{BH} \cdot l_1 = 0$$

[H]



Otpori oslonaca su

$$X_{AH} = 0 \text{ N}$$

$$Y_{AH} = -5.853 \times 10^3 \text{ N}$$

$$F_{BH} = -5.853 \times 10^3 \text{ N}$$

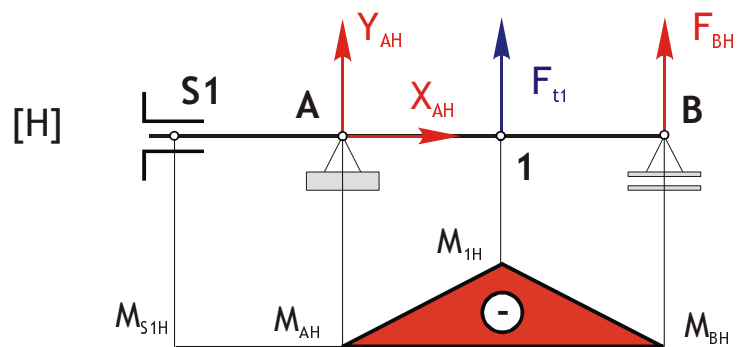
Momenti savijanja u H ravni

$$M_{s1H} = 0 \cdot N \cdot m$$

$$M_{AH} = 0 \cdot N \cdot m$$

$$M_{1H} = F_{BH} \cdot \frac{l_1}{2} \quad M_{1H} = -409.676 \text{ N} \cdot m$$

$$M_{BH} = 0 \cdot N \cdot m$$

**Momenti savijanja u V ravni**

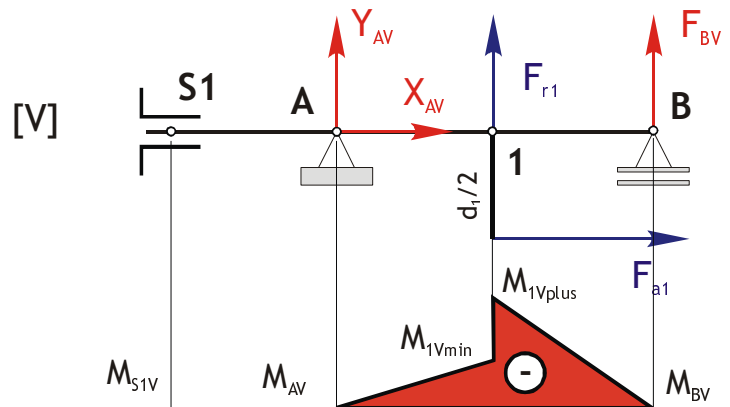
$$M_{s1V} = 0 \cdot N \cdot m$$

$$M_{AV} = 0 \cdot N \cdot m$$

$$M_{1Vmin} = Y_{AV} \cdot \frac{l_1}{2} \quad M_{1Vmin} = -79.95 \text{ N} \cdot m$$

$$M_{1Vplus} = F_{BV} \cdot \frac{l_1}{2} \quad M_{1Vplus} = -224.933 \text{ N} \cdot m$$

$$M_{BV} = 0 \cdot N \cdot m$$

**Rezultujući moment savijanja**

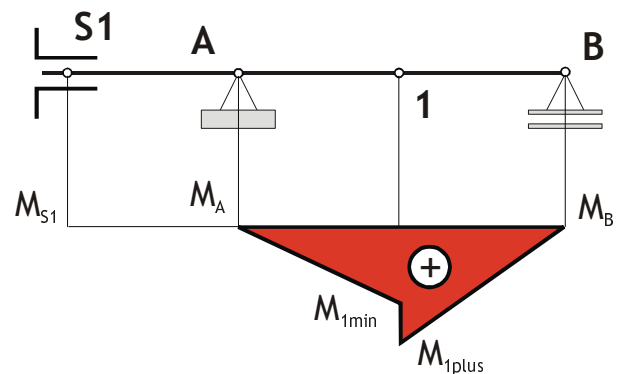
$$M_{s1} = \sqrt{M_{s1H}^2 + M_{s1V}^2} \quad M_{s1} = 0 \text{ N} \cdot m$$

$$M_A = \sqrt{M_{AH}^2 + M_{AV}^2} \quad M_A = 0 \text{ N} \cdot m$$

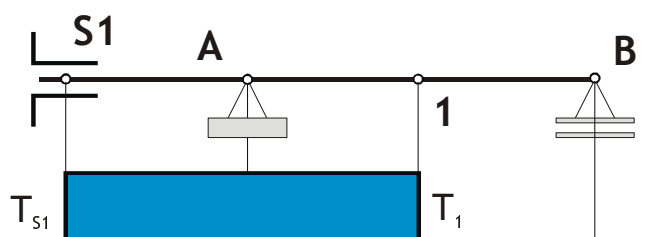
$$M_{1min} = \sqrt{M_{1H}^2 + M_{1Vmin}^2} \quad M_{1min} = 417.405 \text{ N} \cdot m$$

$$M_{1plus} = \sqrt{M_{1H}^2 + M_{1Vplus}^2} \quad M_{1plus} = 467.364 \text{ N} \cdot m$$

$$M_B = \sqrt{M_{BH}^2 + M_{BV}^2} \quad M_B = 0 \text{ N} \cdot m$$

**Merodavni moment uvijanja**

$$T = T_1 \quad T_1 = 682.093 \text{ N} \cdot m$$

**Materijal vratila**

Materijal vratila **C.0645**

Zatezna cvrstoca

$$R_m = 650 \cdot \frac{\text{N}}{\text{mm}^2}$$

T.2.3.str.44 ME I

Savojna dinamička izdržljivost pri naizmenično promenljivom opterećenju

$$\sigma_{D(-)s} = 300 \frac{N}{mm^2} \quad T.2.3.str.45 ME I$$

Uvojna dinamička izdržljivost pri jednosmernom promenljivom opterećenju

$$\tau_{D(0)u} = 210 \frac{N}{mm^2} \quad T.2.3.str.45 ME I$$

Koeficijent svodjenja napona $\alpha = \frac{\sigma_{D(-)s}}{2 \cdot \tau_{D(0)u}} \quad \alpha = 0.714$

Idealni (svedeni) moment savijanja

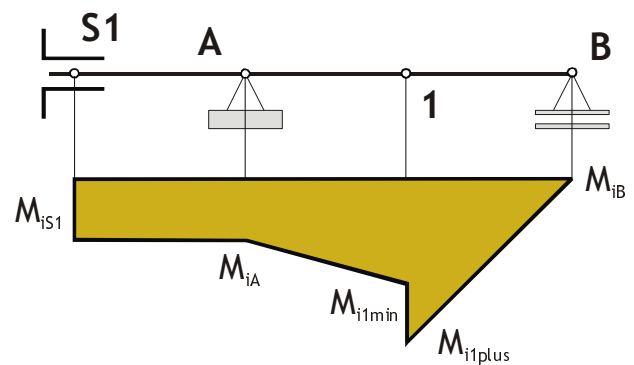
$$M_{is1} = \sqrt{M_{s1}^2 + (\alpha \cdot T)^2} \quad M_{is1} = 487.209 \text{ N}\cdot\text{m}$$

$$M_{iA} = \sqrt{M_A^2 + (\alpha \cdot T)^2} \quad M_{iA} = 487.209 \text{ N}\cdot\text{m}$$

$$M_{i1min} = \sqrt{M_{1min}^2 + (\alpha \cdot T)^2} \quad M_{i1min} = 641.56 \text{ N}\cdot\text{m}$$

$$M_{i1plus} = \sqrt{M_{1plus}^2 + (\alpha \cdot T)^2} \quad M_{i1plus} = 675.131 \text{ N}\cdot\text{m}$$

$$M_{iB} = \sqrt{M_B^2} \quad M_{iB} = 0 \text{ N}\cdot\text{m}$$



Dozvoljeni napon

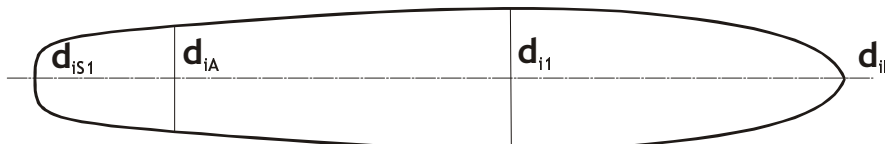
Stepen sigurnosti $S = 4$

Dozvoljeni napon na savijanje $\sigma_d = \frac{\sigma_{D(-)s}}{S} \quad \sigma_d = 75 \frac{N}{mm^2}$

Idealni precnici

$$d_{is1} = \sqrt[3]{\frac{32 \cdot M_{is1}}{\pi \cdot \sigma_d}} \quad d_{is1} = 40.447 \text{ mm} \quad d_{i1} = \sqrt[3]{\frac{32 \cdot M_{i1plus}}{\pi \cdot \sigma_d}} \quad d_{i1} = 45.093 \text{ mm}$$

$$d_{iA} = \sqrt[3]{\frac{32 \cdot M_{iA}}{\pi \cdot \sigma_d}} \quad d_{iA} = 40.447 \text{ mm} \quad d_{iB} = \sqrt[3]{\frac{32 \cdot M_{iB}}{\pi \cdot \sigma_d}} \quad d_{iB} = 0 \text{ mm}$$



Stvarni precnici

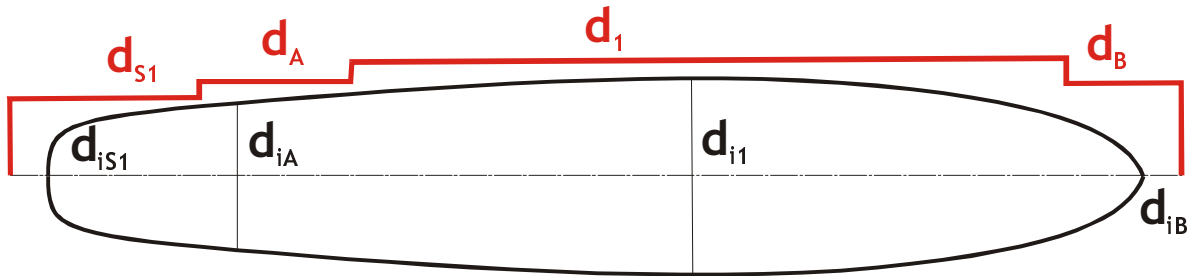
Zbog zleba za klin na mestu spojnice S1

$$d_{s1r} = 1.2d_{i1} \quad d_{s1r} = 48.536 \text{ mm} \quad \text{usvajam} \quad d_{s1} = 55 \text{ mm}$$

Na mestu lezaja A, precnik vratila treba uskladiti sa standardnim precnicima za lezaj $d_A = 60 \text{ mm}$

Zbog zleba za klin na mestu zupcanika 1

$$d_{1r} = 1.2d_{i1} \quad d_{1r} = 54.112 \text{ mm} \quad \text{usvajam} \quad d_1 = 65 \text{ mm}$$

Na mestu lezaja B, precnik vratila treba uskladiti sa standardnim precnicima za lezaj $d_B = 60 \text{ mm}$ **PROVERA POGONSKOG VRATILA NA DINAMICKU IZDRZLJIVOST****Kriticni presek S1**F1 Precnik vratila u kriticom preseku $d_{s1} = 55 \text{ mm}$ F2 Dubina zleba za klin $t = 6.2 \text{ mm}$ T.4.7.str.107 ME IF3 Poluprecnik zaobljenja zleba $r = 0.5 \text{ mm}$ T.4.7.str.107 ME IF4 Odnos $\frac{r}{t} = 0.081$ F5 Geometrijski faktor koncentracije napona zbog zleba za klin $\alpha_k = 3.8$ SI.2.12b.str.47 ME IF6 Faktor osetljivosti materijala na koncentraciju napona $\eta_k = 1.1 \cdot 10^{-3} \cdot \frac{\text{mm}^2}{\text{N}} \cdot R_m$ $\eta_k = 0.715$ F7 Efektivni faktor koncentracije napona $\beta_k = (\alpha_k - 1) \cdot \eta_k + 1$ $\beta_k = 3.002$ F8 Faktor velicine preseka pri uvijanju $\xi_{1u} = 0.75$ T.2.4 str.49 ME I za $d_{s1} = 55 \text{ mm}$ F9 Faktor stanja površine obrade $\xi_2 = 0.91$ SI.2.14.str.50 ME IF10 Aksijalni otporni moment preseka $W_x = \frac{(d_{s1} - t)^3 \cdot \pi}{32}$ $W_x = 1.141 \times 10^4 \text{ mm}^3$ F11 Polarni otporni moment preseka $W_o = 2 \cdot W_x$ $W_o = 2.282 \times 10^4 \text{ mm}^3$ F12 Napon uvijanja $\tau_{uS1} = \frac{T}{W_o}$ $\tau_{uS1} = 29.892 \frac{\text{N}}{\text{mm}^2}$ F13 Stepen sigurnosti na uvijanje $S_{\tau S1} = \frac{\tau_{D(0)u} \cdot \xi_{1u} \cdot \xi_2}{\beta_k \cdot \tau_{uS1}}$ $S_{\tau S1} = 1.6$ **zadovoljava**F14 Dozvoljeni stepen sigurnosti $S_d = 1.5 \text{ do } 3$

Kritični presek 1

F1 Precnik vratila u kritičnom preseku

$$d1 = 65 \text{ mm}$$

F2 Dubina zleba za klin

$$t = 6.8 \text{ mm}$$

T.4.7.str.107 ME I

F3 Poluprecnik zaobljenja zleba

$$r = 0.5 \text{ mm}$$

T.4.7.str.107 ME I

F4 Odnos $\frac{r}{t} = 0.074$

F5 Geometrijski faktor koncentracije napona zbog zleba za klin

$$\alpha_k = 3.8$$

SI.2.12b.str.47 ME I

F7 Efektivni faktor koncentracije napona

$$\beta_k = (\alpha_k - 1) \cdot \eta_k + 1 \quad \beta_k = 3.002$$

F8 Faktor velicine preseka pri savijanju

$$\xi_{1s} = 0.77$$

T.2.4 str.49 ME I

za $d1 = 65 \text{ mm}$

F9 Faktor velicine preseka pri uvijanju

$$\xi_{1u} = 0.67$$

T.2.4 str.49 ME I

F10 Faktor stanja površine obrade

$$\xi_2 = 0.91$$

SI.2.14.str.50 ME I

F11 Aksijalni otporni moment preseka

$$W_x = \frac{(d1 - t)^3 \cdot \pi}{32}$$

$$W_x = 1.935 \times 10^4 \text{ mm}^3$$

F12 Polarni otporni moment preseka

$$W_o = 2 \cdot W_x$$

$$W_o = 3.871 \times 10^4 \text{ mm}^3$$

F13 Napon savijanja

$$\sigma_{s1} = \frac{M1_{plus}}{W_x}$$

$$\sigma_{s1} = 24.148 \frac{\text{N}}{\text{mm}^2}$$

F14 Napon uvijanja

$$\tau_{u1} = \frac{T}{W_o}$$

$$\tau_{u1} = 17.622 \frac{\text{N}}{\text{mm}^2}$$

F15 Stepen sigurnosti na savijanje

$$S_{\sigma 1} = \frac{\sigma_{D(-1)s} \cdot \xi_{1s} \cdot \xi_2}{\beta_k \cdot \sigma_{s1}}$$

$$S_{\sigma 1} = 2.9$$

F16 Stepen sigurnosti na uvijanje

$$S_{\tau 1} = \frac{\tau_{D(0)u} \cdot \xi_{1u} \cdot \xi_2}{\beta_k \cdot \tau_{u1}}$$

$$S_{\tau 1} = 2.4$$

F16 Ukupni stepen sigurnosti vratila

$$S_1 = \frac{S_{\sigma 1} \cdot S_{\tau 1}}{\sqrt{S_{\sigma 1}^2 + S_{\tau 1}^2}}$$

$$S_1 = 1.9$$

zadovoljava

F18 Dozvoljeni stepen sigurnosti

$$S_d = 1.5 \text{ do } 3$$

IZBOR I PROVERA KLINOVA

Za vezu sa spojnicom S1

G2 Precnik vratila na mestu spojnice 1

$$d_{s1} = 55 \text{ mm}$$

G3 Sirina klina

$$b = 16 \text{ mm}$$

T.4.7.str.107 ME I

G4 Visina klina

$$h = 10 \text{ mm}$$

T.4.7.str.107 ME I

G5 Dubina zleba za klin

$$t = 6.2 \text{ mm}$$

T.4.7.str.107 ME I

G6 Dubina zleba u glavcini

$$t_1 = h - t \quad t_1 = 3.8 \text{ mm}$$

G7 Duzina klina

$$l = 85 \text{ mm}$$

stand. na str.108 ME I

G8 Korisna duzina klina

$$l_k = l - b \quad l_k = 69 \text{ mm}$$

G9 Obimna sila na klinu

$$F_{tk1} = \frac{2 \cdot T_1}{d_{s1}}$$

$$F_{tk1} = 2.48 \times 10^4 \text{ N}$$

G10 Površinski pritisak između klina i glavčine

$$p = \frac{F_{tk1}}{l_k \cdot t_1}$$

$$p = 94.597 \frac{\text{N}}{\text{mm}^2}$$

zadovoljava

G11 Dozvoljeni površinski pritisak

$$p_d = 100 \frac{\text{N}}{\text{mm}^2}$$

$p_d = 75$ do 100 N/mm^2

za glavčinu od celika

$p_d = 45$ do 65 N/mm^2

za glavčinu od SL

G12 Usvojen je klin

16 x 10 x 85 - C.0645 - JUS M.C2.060

Za vezu sa pogonskim zupčanikom

G2 Precnik vratila na mestu zupčanika 1

$$d_1 = 65 \text{ mm}$$

G3 Sirina klina

$$b = 18 \text{ mm}$$

T.4.7.str.107 ME I

G4 Visina klina

$$h = 11 \text{ mm}$$

T.4.7.str.107 ME I

G5 Dubina zleba za klin

$$t = 6.8 \text{ mm}$$

T.4.7.str.107 ME I

G6 Dubina zleba u glavcini

$$t_1 = h - t \quad t_1 = 4.2 \text{ mm}$$

G7 Duzina klina

$$l = 85 \text{ mm}$$

stand. na str.108 ME I

G8 Korisna duzina klina

$$l_k = l - b \quad l_k = 67 \text{ mm}$$

G9 Obimna sila na klinu

$$F_{tk1} = \frac{2 \cdot T_1}{d_1}$$

$$F_{tk1} = 2.099 \times 10^4 \text{ N}$$

G10 Površinski pritisak između klina i glavčine

$$p = \frac{F_{tk1}}{l_k \cdot t_1}$$

$$p = 74.582 \frac{\text{N}}{\text{mm}^2}$$

zadovoljava

G11 Dozvoljeni površinski pritisak

$$p_d = 75 \frac{\text{N}}{\text{mm}^2}$$

G12 Usvojen je klin

18 x 11 x 85 - C.0645 - JUS M.C2.060

IZBOR I PROVERA LEZAJEVA

U osloncu A pretpostavljen lezaj **6412**

H1 Precnik rukavca lezaja $d_A = 60 \text{ mm}$

H2 Spoljni precnik lezaja $D = 150 \text{ mm}$ T.2.6 str.57 ME II

H3 Sirina lezaja $B = 35 \text{ mm}$ T.2.6 str.57 ME II

H4 Radijus zaobljenja lezaja $r = 3.5 \text{ mm}$ T.2.6 str.57 ME II

H5 Dinamička nosivost lezaja $C = 88 \times 10^3 \cdot \text{N}$ T.2.8 str.59 ME II

H6 Statička nosivost lezaja $C_0 = 70 \times 10^3 \cdot \text{N}$ T.2.8 str.59 ME II

H7 Aksijalna sila u osloncu $F_{aA} = \sqrt{XAV^2 + XAH^2}$ $F_{aA} = 2.488 \times 10^3 \text{ N}$

H8 Radijalna sila u osloncu $F_{rA} = \sqrt{YAV^2 + YAH^2}$ $F_{rA} = 5.963 \times 10^3 \text{ N}$

H9 Odnos aksijalne i radijalne sile u osloncu $\frac{F_{aA}}{F_{rA}} = 0.417$

H10 Odnos aksijalne sile u osloncu i statičke nosivosti lezaja $\frac{F_{aA}}{C_0} = 0.036$

H11 Koeficijent $e = 0.25$ T.2.1.str.45 ME II

H12 Faktor radijalne sile $X = 0.56$ T.2.1.str.45 ME II

H13 Faktor aksijalne sile $Y = 1.75$ T.2.1.str.45 ME II

za $\frac{F_{aA}}{F_{rA}} > e$

H14 Ekvivalentno dinamičko opterećenje $F_A = X \cdot F_{rA} + Y \cdot F_{aA}$ $F_A = 7.693 \times 10^3 \text{ N}$

H15 Temperaturni faktor smanjenja nosivosti $f_t = 1$ str.46 ME II

H16 EkspONENT $\alpha = 3$

$\alpha = 3$ za kuglicne lezaje
 $\alpha = 10/3$ za valjcane lezaje

H17 Vek lezaja u obrtima $L = \left(\frac{C \cdot f_t}{F_A} \right)^\alpha \cdot 10^6$ $L = 1.497 \times 10^9$

H19 Vek lezaja u casovima $L_{hA} = \frac{L}{n_1}$ $L_{hA} = 1.782 \times 10^4 \text{ hr}$ **zadovoljava**

Potreban radni vek lezaja za reduktore je izmedju 8000 i 45000 h

H21 Izabran je lezaj **6412 (60 x 150 x 35)**

U osloncu B pretpostavljen lezaj **6412** isti kao u osloncu A

H1 Precnik rukavca lezaja $d_B = 60 \text{ mm}$

H2 Spoljni precnik lezaja $D = 150 \text{ mm}$ T.2.6 str.57 ME II

H3 Sirina lezaja $B = 35 \text{ mm}$ T.2.6 str.57 ME II

H4 Radijus zaobljenja lezaja $r = 3.5 \text{ mm}$ T.2.6 str.57 ME II

H5 Dinamicka nosivost lezaja $C = 88 \times 10^3 \cdot \text{N}$ T.2.8 str.59 ME II

H6 Staticka nosivost lezaja $C_0 = 70 \times 10^3 \cdot \text{N}$ T.2.8 str.59 ME II

H7 Aksijalna sila u osloncu $F_{aB} = 0$

H8 Radijalna sila u osloncu $F_{rB} = \sqrt{F_{BV}^2 + F_{BH}^2}$ $F_{rB} = 6.677 \times 10^3 \text{ N}$

H14 Ekvivalentno dinamicko opterecenje $F_B = F_{rB}$ posto je aksijalna sila 0

H15 Temperaturni faktor smanjenja nosivosti $f_t = 1$ str.46 ME II

H16 Eksponent $\alpha = 3$

$\alpha = 3$ za kuglicne lezaje
 $\alpha = 10/3$ za valjcane lezaje

H17 Vek lezaja u obrtima $L = \left(\frac{C \cdot f_t}{F_B} \right)^\alpha \cdot 10^6$ $L = 2.29 \times 10^9$

H19 Vek lezaja u casovima $L_{hB} = \frac{L}{n_1}$ $L_{hB} = 2.726 \times 10^4 \text{ hr}$ **zadovoljava**

H21 Izabran je lezaj **6412 (60 x 150 x 35)**

PRETHODNI PRORACUN GONJENOG VRATILA

Sile i sheme opterećenja vratila



Obrtni moment na gonjenom vratilu $T_2 = u \cdot T_1$

Cilindricni zupcanik

Obimna sila	$F_{t2} = \frac{2 \cdot T_2}{d_2} \cdot K_A$	$F_{t2} = 1.463 \times 10^4 \text{ N}$	$F_{t2} = F_{t1}$
Radijalna sila	$F_{r2} = \frac{F_{t2}}{\cos(\beta)} \cdot \tan(\alpha_n)$	$F_{r2} = 5.444 \times 10^3 \text{ N}$	$F_{r2} = F_{r1}$
Aksijalna sila	$F_{a2} = F_{t2} \cdot \tan(\beta)$	$F_{a2} = 3.11 \times 10^3 \text{ N}$	$F_{a2} = F_{a1}$



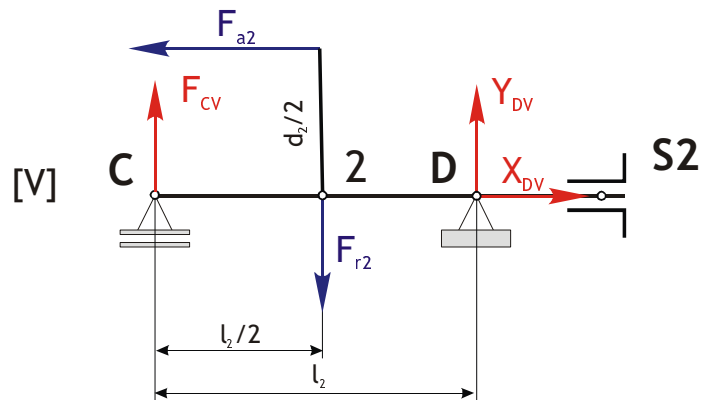
Rastojanje između oslonaca C i D $l_2 = 140 \text{ mm}$ usvojeno

Oslonac C je pokretan, oslonac D je nepokretan

Otpori oslonaca u V ravni

Given

$$\begin{aligned} \sum X_i = 0 & \quad X_{DV} - F_{a2} = 0 \\ \sum Y_i = 0 & \quad F_{CV} - F_{r2} + Y_{DV} = 0 \\ \sum M_C = 0 & \quad -F_{r2} \cdot \frac{l_2}{2} + F_{a2} \cdot \frac{d_2}{2} + Y_{DV} \cdot l_2 = 0 \end{aligned}$$



Otpori oslonaca su

$$F_{CV} = 4.766 \times 10^3 \text{ N}$$

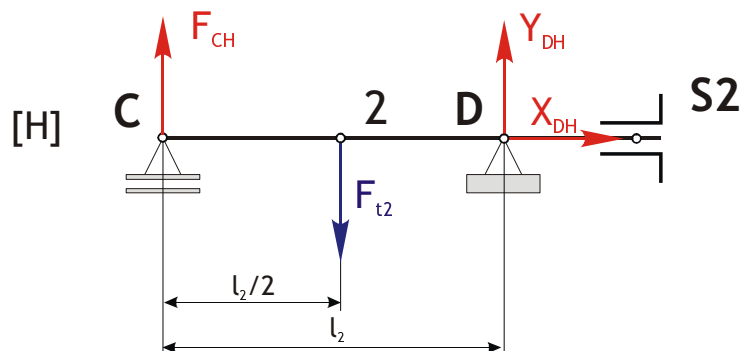
$$X_{DV} = 3.11 \times 10^3 \text{ N}$$

$$Y_{DV} = 678.228 \text{ N}$$

Otpori oslonaca u H ravni

Given

$$\begin{aligned} \sum X_i = 0 & \quad X_{DH} = 0 \\ \sum Y_i = 0 & \quad F_{CH} - F_{t2} + Y_{DH} = 0 \\ \sum M_C = 0 & \quad -F_{t2} \cdot \frac{l_2}{2} + Y_{DH} \cdot l_2 = 0 \end{aligned}$$



Otpori oslonaca su

$$F_{CH} = 7.316 \times 10^3 \text{ N}$$

$$X_{DH} = 0 \text{ N}$$

$$Y_{DH} = 7.316 \times 10^3 \text{ N}$$

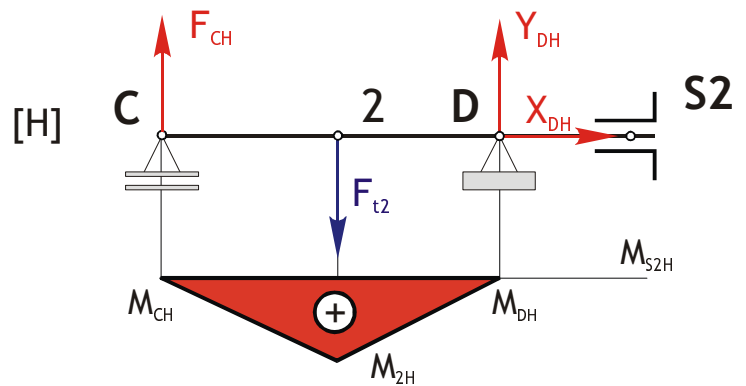
Momenti savijanja u H ravni

$$M_{s2H} = 0 \cdot N \cdot m$$

$$M_{CH} = 0 \cdot N \cdot m$$

$$M_{2H} = Y_{DH} \cdot \frac{12}{2} \quad M_{2H} = 512.095 \text{ N} \cdot m$$

$$M_{DH} = 0 \cdot N \cdot m$$

**Momenti savijanja u V ravni**

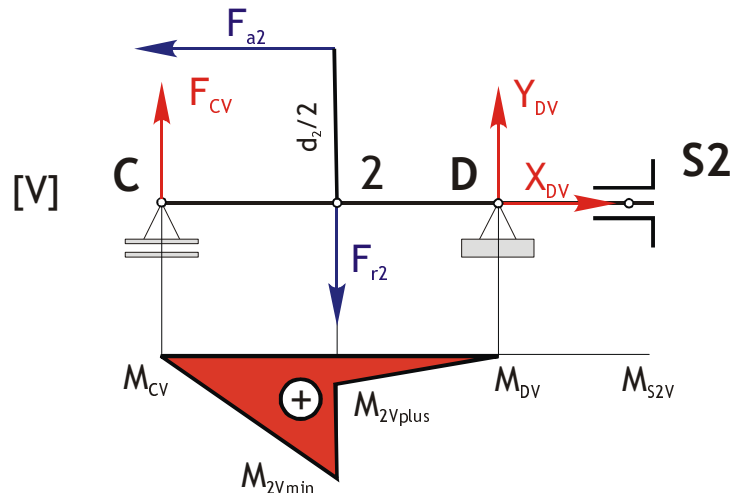
$$M_{CV} = 0 \cdot N \cdot m$$

$$M_{2Vmin} = F_{CV} \cdot \frac{12}{2} \quad M_{2Vmin} = 333.627 \text{ N} \cdot m$$

$$M_{2Vplus} = Y_{DV} \cdot \frac{12}{2} \quad M_{2Vplus} = 47.476 \text{ N} \cdot m$$

$$M_{DV} = 0 \cdot N \cdot m$$

$$M_{s2V} = 0 \cdot N \cdot m$$

**Rezultujući moment savijanja**

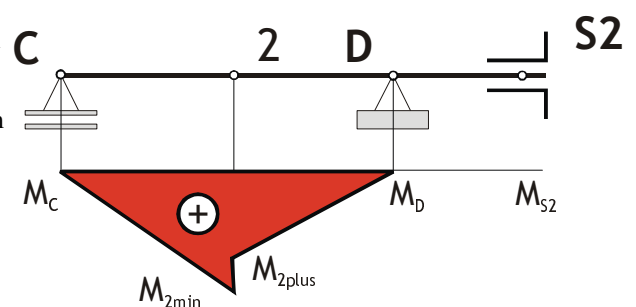
$$M_C = \sqrt{M_{CH}^2 + M_{CV}^2} \quad M_C = 0 \text{ N} \cdot m$$

$$M_{2min} = \sqrt{M_{2H}^2 + M_{2Vmin}^2} \quad M_{2min} = 611.186 \text{ N} \cdot m$$

$$M_{2plus} = \sqrt{M_{2H}^2 + M_{2Vplus}^2} \quad M_{2plus} = 514.291 \text{ N} \cdot m$$

$$M_D = \sqrt{M_{DH}^2 + M_{DV}^2} \quad M_D = 0 \text{ N} \cdot m$$

$$M_{s2} = \sqrt{M_{s2H}^2 + M_{s2V}^2} \quad M_{s2} = 0 \text{ N} \cdot m$$

**Merodavni moment uvijanja**

$$T = T_2 \quad T = 1.077 \times 10^3 \text{ N} \cdot m$$

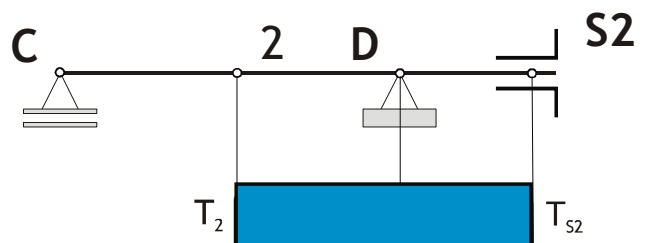
Materijal vratila

Materijal vratila **C.0645**

Zatezna cvrstoca

$$R_m = 650 \cdot \frac{\text{N}}{\text{mm}^2}$$

T.2.3.str.44 ME I



Savojna dinamička izdržljivost pri naizmenično promenljivom opterećenju

$$\sigma_{D(-1)s} = 300 \frac{\text{N}}{\text{mm}^2} \quad \text{T.2.3.str.45 ME I}$$

Uvojna dinamička izdržljivost pri jednosmernom promenljivom opterećenju

$$\tau_{D(0)u} = 210 \frac{\text{N}}{\text{mm}^2} \quad \text{T.2.3.str.45 ME I}$$

Koeficijent svodjenja napona $\alpha = \frac{\sigma_{D(-1)s}}{2 \cdot \tau_{D(0)u}} \quad \alpha = 0.714$

Idealni (svedeni) moment savijanja

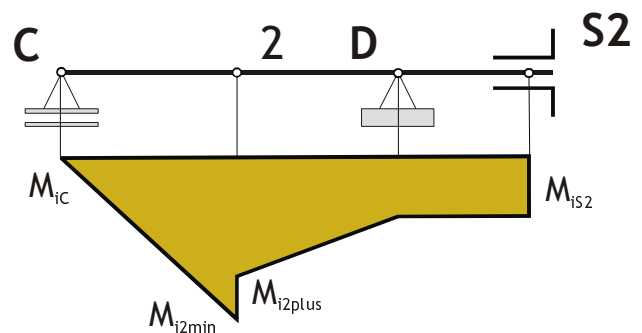
$$M_{iC} = \sqrt{MC^2} \quad M_{iC} = 0 \text{ N}\cdot\text{m}$$

$$M_{i2\text{min}} = \sqrt{M_{2\text{min}}^2 + (\alpha \cdot T)^2} \quad M_{i2\text{min}} = 982.515 \text{ N}\cdot\text{m}$$

$$M_{i2\text{plus}} = \sqrt{M_{2\text{plus}}^2 + (\alpha \cdot T)^2} \quad M_{i2\text{plus}} = 925.356 \text{ N}\cdot\text{m}$$

$$M_{iD} = \sqrt{MD^2 + (\alpha \cdot T)^2} \quad M_{iD} = 769.277 \text{ N}\cdot\text{m}$$

$$M_{is2} = \sqrt{Ms2^2 + (\alpha \cdot T)^2} \quad M_{is2} = 769.277 \text{ N}\cdot\text{m}$$



Dozvoljeni napon

Stepen sigurnosti $S = 4$

Dozvoljeni napon na savijanje $\sigma_d = \frac{\sigma_{D(-1)s}}{S} \quad \sigma_d = 75 \frac{\text{N}}{\text{mm}^2}$

Idealni precnici

$$d_{iC} = \sqrt[3]{\frac{10 \cdot M_{iC}}{\sigma_d}} \quad d_{iC} = 0 \text{ mm} \quad d_{iD} = \sqrt[3]{\frac{10 \cdot M_{iD}}{\sigma_d}} \quad d_{iD} = 46.81 \text{ mm}$$

$$d_{i2} = \sqrt[3]{\frac{10 \cdot M_{i2\text{min}}}{\sigma_d}} \quad d_{i2} = 50.788 \text{ mm} \quad d_{is2} = \sqrt[3]{\frac{10 \cdot M_{is2}}{\sigma_d}} \quad d_{is2} = 46.81 \text{ mm}$$



Stvarni precnici

Na mestu lezaja C, prečnik vratila treba uskladiti sa standardnim precnicima za lezaj

$$d_C = 80 \text{ mm}$$

Zbog zleba za klin na mestu zupčanika 1

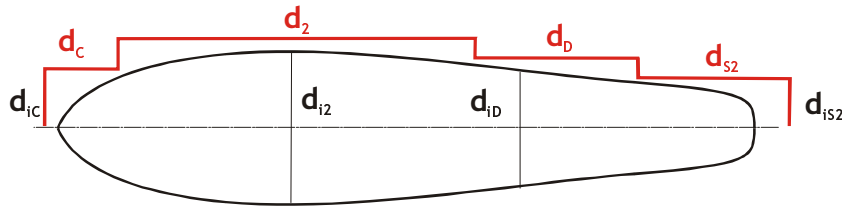
$$d_{2r} = 1.2d_2 \quad d_{2r} = 60.945 \text{ mm} \quad \text{usvajamo} \quad d_2 = 90 \text{ mm}$$

Na mestu lezaja D, prečnik vratila treba uskladiti sa standardnim precnicima za lezaj

$$d_D = 80 \text{ mm}$$

Zbog zleba za klin na mestu spojnice S2

$$d_{s2r} = 1.2d_{s2} \quad d_{s2r} = 56.172 \text{ mm} \quad \text{usvajamo} \quad d_{s2} = 70 \text{ mm}$$



PROVERA GONJENOG VRATILA NA DINAMICKU IZDRZLJIVOST

Kritični presek 2

F1 Prečnik vratila u kritičnom preseku

$$d_2 = 90 \text{ mm}$$

F2 Dubina zleba za klin

$$t = 8.7 \text{ mm}$$

T.4.7.str.107 ME I

F3 Poluprečnik zaobljenja zleba

$$r = 0.6 \text{ mm}$$

T.4.7.str.107 ME I

F4 Odnos

$$\frac{r}{t} = 0.069$$

F5 Geometrijski faktor koncentracije napona zbog zleba za klin

$$\alpha_k = 3.9$$

Sl.2.12b.str.47 ME I

F6 Faktor osetljivosti materijala na koncentraciju napona

$$\eta_k = 1.1 \cdot 10^{-3} \cdot \frac{\text{mm}^2}{\text{N}} \cdot R_m \quad \eta_k = 0.715$$

F7 Efektivni faktor koncentracije napona

$$\beta_k = (\alpha_k - 1) \cdot \eta_k + 1 \quad \beta_k = 3.073$$

F8 Faktor velicine preseka pri savijanju

$$\xi_{1s} = 0.72$$

T.2.4 str.49 ME I

za $d_2 = 90 \text{ mm}$

F9 Faktor velicine preseka pri uvijanju

$$\xi_{1u} = 0.71$$

T.2.4 str.49 ME I

F10 Faktor stanja površine obrade

$$\xi_2 = 0.91$$

Sl.2.14.str.50 ME I

F11 Aksijalni otporni moment preseka

$$W_x = \frac{(d_2 - 2 \cdot t)^3 \cdot \pi}{32}$$

$$W_x = 3.757 \times 10^4 \text{ mm}^3$$

F12 Polarni otporni moment preseka

$$W_o = 2 \cdot W_x$$

$$W_o = 7.513 \times 10^4 \text{ mm}^3$$

F13 Napon savijanja

$$\sigma_{s2} = \frac{M_{2\min}}{W_x}$$

$$\sigma_{s2} = 16.269 \frac{\text{N}}{\text{mm}^2}$$

F14 Napon uvijanja

$$\tau_{u2} = \frac{T}{W_o}$$

$$\tau_{u2} = 14.334 \frac{\text{N}}{\text{mm}^2}$$

$$F15 \text{ Stepen sigurnosti na savijanje} \quad S_{\sigma 2} = \frac{\sigma_{D(-1)s} \cdot \xi_{1s} \cdot \xi_2}{\beta_k \cdot \sigma_{s2}} \quad S_{\sigma 2} = 3.931$$

$$F16 \text{ Stepen sigurnosti na uvijanje} \quad S_{\tau 2} = \frac{\tau_{D(0)u} \cdot \xi_{1u} \cdot \xi_2}{\beta_k \cdot \tau_{u2}} \quad S_{\tau 2} = 3.08$$

$$F17 \text{ Stepen sigurnosti vratila na mestu K} \quad S_2 = \frac{S_{\sigma 2} \cdot S_{\tau 2}}{\sqrt{S_{\sigma 2}^2 + S_{\tau 2}^2}} \quad S_2 = 2.4 \quad \text{zadovoljava}$$

$$F18 \text{ Dozvoljeni stepen sigurnosti} \quad S_d = 1.5 \text{ do } 3$$

Kriticni presek S2

$$F1 \text{ Precnik vratila u kriticom preseku} \quad d_{s2} = 70 \text{ mm}$$

$$F2 \text{ Dubina zleba za klin} \quad t = 7.4 \text{ mm} \quad \text{T.4.7.str.107 ME I}$$

$$F3 \text{ Poluprecnik zaobljenja zleba} \quad r = 0.6 \text{ mm} \quad \text{T.4.7.str.107 ME I}$$

$$F4 \text{ Odnos} \quad \frac{r}{t} = 0.081$$

$$F5 \text{ Geometrijski faktor koncentracije napona zbog zleba za klin} \quad \alpha_k = 3.7 \quad \text{SI.2.12b.str.47 ME I}$$

$$F7 \text{ Efektivni faktor koncentracije napona} \quad \beta_k = (\alpha_k - 1) \cdot \eta_k + 1 \quad \beta_k = 2.931$$

$$F9 \text{ Faktor velicine preseka pri uvijanju} \quad \xi_{1u} = 0.73 \quad \text{T.2.4 str.49 ME I} \quad \text{za} \quad d_{s2} = 70 \text{ mm}$$

$$F10 \text{ Faktor stanja površine obrade} \quad \xi_2 = 0.91 \quad \text{SI.2.14.str.50 ME I}$$

$$F11 \text{ Aksijalni otporni moment preseka} \quad W_x = \frac{(d_{s2} - 2 \cdot t)^3 \cdot \pi}{32} \quad W_x = 1.651 \times 10^4 \text{ mm}^3$$

$$F12 \text{ Polarni otporni moment preseka} \quad W_o = 2 \cdot W_x \quad W_o = 3.303 \times 10^4 \text{ mm}^3$$

$$F14 \text{ Napon uvijanja} \quad \tau_{u2} = \frac{T}{W_o} \quad \tau_{u2} = 32.611 \frac{\text{N}}{\text{mm}^2}$$

$$F16 \text{ Stepen sigurnosti na uvijanje} \quad S_{\tau 2} = \frac{\tau_{D(0)u} \cdot \xi_{1u} \cdot \xi_2}{\beta_k \cdot \tau_{u2}} \quad S_{\tau 2} = 1.5 \quad \text{zadovoljava}$$

$$F18 \text{ Dozvoljeni stepen sigurnosti} \quad S_d = 1.5 \text{ do } 3$$

IZBOR I PROVERA KLIHOVA

Za vezu sa gonjenim zupcanikom

- G2 Precnik vratila na mestu zupcanika 2 $d_2 = 90 \text{ mm}$
- G3 Sirina klina $b = 25 \text{ mm}$ T.4.7.str.107 ME I
- G4 Visina klina $h = 14 \text{ mm}$ T.4.7.str.107 ME I
- G5 Dubina zleba za klin $t = 8.7 \text{ mm}$ T.4.7.str.107 ME I
- G6 Dubina zleba u glavcini $t_2 = h - t$ $t_2 = 5.3 \text{ mm}$
- G7 Duzina klina $l = 80 \text{ mm}$ stand. na str.108 ME I
- G8 Korisna duzina klina $l_k = l - b$ $l_k = 55 \text{ mm}$
- G9 Obimna sila na klinu $F_{tk2} = \frac{2 \cdot T_2}{d_2}$ $F_{tk2} = 2.393 \times 10^4 \text{ N}$
- G10 Površinski pritisak između klina i glavčine $p = \frac{F_{tk2}}{2 \cdot l_k \cdot t_2}$ $p = 41.052 \frac{\text{N}}{\text{mm}^2}$ **zadovoljava**
- G11 Dozvoljeni površinski pritisak $p_d = 75 \frac{\text{N}}{\text{mm}^2}$
- $p_d = 75 \text{ do } 100 \text{ N/mm}^2$ za glavčinu od celika
 $p_d = 45 \text{ do } 65 \text{ N/mm}^2$ za glavčinu od SL
- G12 Usvojena su dva klina **25 x 14 x 80 - C.0645 - JUS M.C2.060**

Za vezu sa spojnicom S2

- G2 Precnik vratila na mestu spojnice S2 $d_{s2} = 70 \text{ mm}$
- G3 Sirina klina $b = 20 \text{ mm}$ T.4.7.str.107 ME I
- G4 Visina klina $h = 12 \text{ mm}$ T.4.7.str.107 ME I
- G5 Dubina zleba za klin $t = 7.4 \text{ mm}$ T.4.7.str.107 ME I
- G6 Dubina zleba u glavcini $t_2 = h - t$ $t_2 = 4.6 \text{ mm}$
- G7 Duzina klina $l = 100 \text{ mm}$ stand. na str.100 ME I
- G8 Korisna duzina klina $l_k = l - b$ $l_k = 80 \text{ mm}$
- G9 Obimna sila na klinu $F_{tk2} = \frac{2 \cdot T_2}{d_{s2}}$ $F_{tk2} = 3.077 \times 10^4 \text{ N}$
- G10 Površinski pritisak između klina i glavčine $p = \frac{F_{tk2}}{2 \cdot l_k \cdot t_2}$ $p = 41.809 \frac{\text{N}}{\text{mm}^2}$ **zadovoljava**
- G11 Dozvoljeni površinski pritisak $p_d = 45 \frac{\text{N}}{\text{mm}^2}$
- G12 Usvojena su dva klina **20 x 12 x 100 - C.0645 - JUS M.C2.060**

IZBOR I PROVERA LEZAJEVA

U osloncu C pretpostavljen lezaj **30216**

H1 Precnik rukavca lezaja $d_C = 80 \text{ mm}$

H2 Spoljni precnik lezaja $D = \text{ mm}$ T.2.6 str.57 ME II

H3 Sirina lezaja $B = \text{ mm}$ T.2.6 str.57 ME II

H4 Radijus zaobljenja lezaja $r = \text{ mm}$ T.2.6 str.57 ME II

H5 Dinamička nosivost lezaja $C = 96.5 \times 10^3 \cdot \text{N}$ T.2.11 str.62 ME II

H6 Statika nosivost lezaja $C_0 = 88 \times 10^3 \cdot \text{N}$ T.2.11 str.62 ME II

H7 Aksijalna sila u osloncu $F_{aC} = 0$

H8 Radijalna sila u osloncu $F_{rC} = \sqrt{F_{CV}^2 + F_{CH}^2}$ $F_{rC} = 8.731 \times 10^3 \text{ N}$

H14 Ekvivalentno dinamičko opterećenje $F_C = F_{rC}$ posto je aksijalna sila 0

H15 Temperaturni faktor smanjenja nosivosti $f_t = 1$ str.46 ME II

H16 EkspONENT $\alpha = \frac{10}{3}$

$\alpha = 3$ za kuglične lezaje

$\alpha = 10/3$ za valjčane lezaje

H17 Vek lezaja u obrtima $L = \left(\frac{C \cdot f_t}{F_C} \right)^\alpha \cdot 10^6$ $L = 3.007 \times 10^9$

H18 Broj obrtaja vratila $n_2 = \frac{n_1}{u}$ $n_2 = 886.667 \text{ min}^{-1}$

H19 Vek lezaja u casovima $L_h = \frac{L}{n_2}$ $L_h = 5.653 \times 10^4 \text{ hr}$ **zadovoljava**

H20 Preporučeni radni vek lezaja kod reduktora $L_h = 8.000 \text{ do } 45.000 \text{ casova}$

H21 Izabran je lezaj **30216 (x x)**

U osloncu D pretpostavljen lezaj **30216** isti kao u osloncu C

H1 Precnik rukavca lezaja $dD = 80 \text{ mm}$

H2 Spoljni precnik lezaja $D = \text{ mm}$ T.2.6 str.57 ME II

H3 Sirina lezaja $B = \text{ mm}$ T.2.6 str.57 ME II

H4 Radijus zaobljenja lezaja $r = \text{ mm}$ T.2.6 str.57 ME II

H5 Dinamicka nosivost lezaja $C = 96.5 \times 10^3 \cdot \text{N}$ T.2.11 str.62 ME II

H6 Staticka nosivost lezaja $C_0 = 88 \times 10^3 \cdot \text{N}$ T.2.11 str.62 ME II

H7 Aksijalna sila u osloncu $F_{aD} = \sqrt{XDV^2 + XDH^2}$ $F_{aD} = 3.11 \times 10^3 \text{ N}$

H8 Radijalna sila u osloncu $F_{rD} = \sqrt{YDV^2 + YDH^2}$ $F_{rD} = 7.347 \times 10^3 \text{ N}$

H9 Odnos aksijalne i radijalne sile u osloncu $\frac{F_{aD}}{F_{rD}} = 0.423$

H11 Koeficijent $e = 0.42$ T.2.1.str.45 ME II

H12 Faktor radijalne sile $X = 0.4$ T.2.1.str.45 ME II

$$\frac{F_{aD}}{F_{rD}} > e$$

H13 Faktor aksijalne sile $Y = 1.45$ T.2.1.str.45 ME II

H14 Ekvivalentno dinamičko opterećenje $FD = X \cdot F_{rD} + Y \cdot F_{aD}$ $FD = 7.448 \times 10^3 \text{ N}$

H15 Temperaturni faktor smanjenja nosivosti $f_t = 1$ str.29 ME I

H16 EkspONENT $\alpha = \frac{10}{3}$

$\alpha = 3$ za kuglicne lezaje
 $\alpha = 10/3$ za valjcane lezaje

H17 Vek lezaja u obrtima $L = \left(\frac{C \cdot f_t}{FD} \right)^\alpha \cdot 10^6$ $L = 5.108 \times 10^9$

H18 Broj obrtaja vratila $n_2 = 886.667 \text{ min}^{-1}$

H19 Vek lezaja u casovima $L_h = \frac{L}{n_2}$ $L_h = 9.601 \times 10^4 \text{ hr}$ **zadovoljava**

H20 Preporuceni radni vek lezaja kod reduktora $L_h = 8.000 \text{ do } 45.000 \text{ casova}$

H21 Izabran je lezaj **30216 (x x)**