VIJAČNI SPOJI

NEPREDNAPETI
PREDNAPETI
PRILAGODNI
GIBALNI

← NI SILE PREDNAPETJA V STEBLU VIJAKA F_v
← SILA $F_v > \emptyset$
VIJAČNI SPOJ

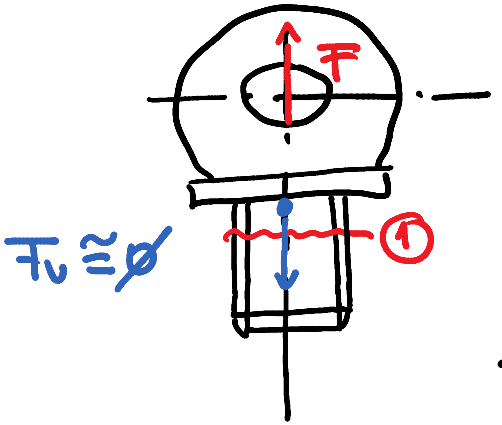
PREDNAPETI VIJAČNI SPOJ PRENAŠA OBREMENITEV S TRENJEM ! ≡ TOPLO KOVANA KOVICA

PRILAGODNI VIJAČNI SPOJ PRENAŠA OBREMENITEV Z OBLIKO ! ≡ HLADNO KOVANA KOVICA

GIBALNI VIJAK PRENAŠA OBREMENITEV S TOČKASTIM TLAKOM ! VZLON ! GONILO

NEPREDNAPETI VIJAČ

OČESNI VIJAČ



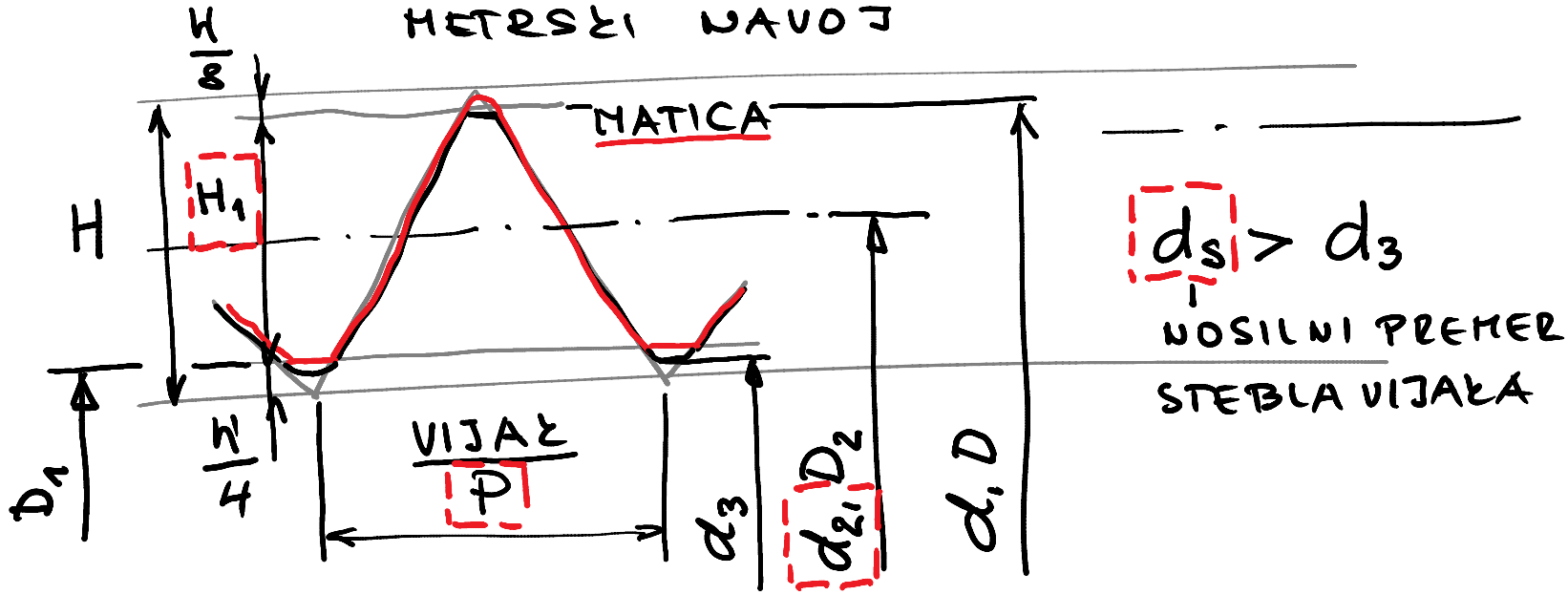
$$A_s = \frac{\pi d_s^2}{4}$$

$$\sigma_1 = \frac{F}{A_s} \leq \sigma_{dop}$$

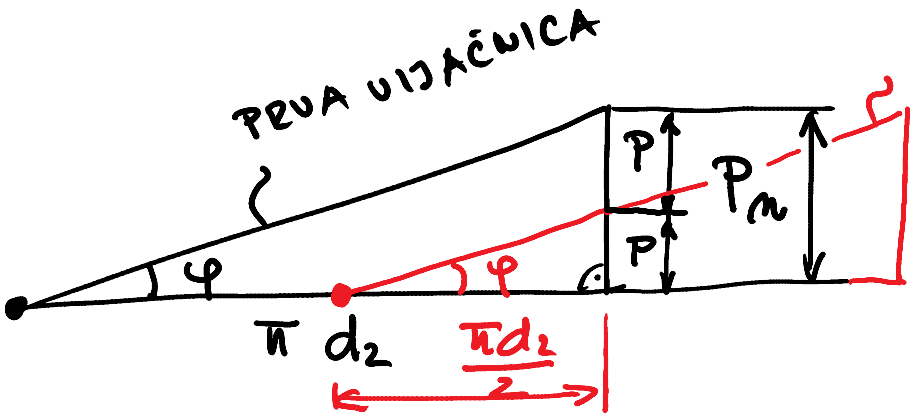
– NOSILNI PREREZ NAVOJA VIJAKA

PREDNAPETI VIJAČ

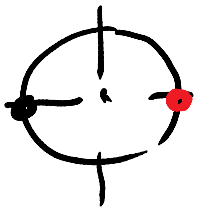
METRSKI NAVOJ



VIJAČNICA IN KORAK NAVOJA



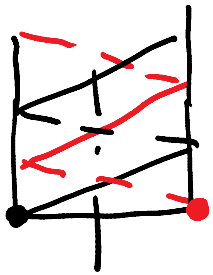
$$\operatorname{tg}\varphi = \frac{P_n}{\pi d_2}$$



P_n – KORAK NAVOJA

$P_n = P \cdot n$

n – ŠT. VIJAČNIC



DELITEV

$n = 1 \Rightarrow P_n = P$

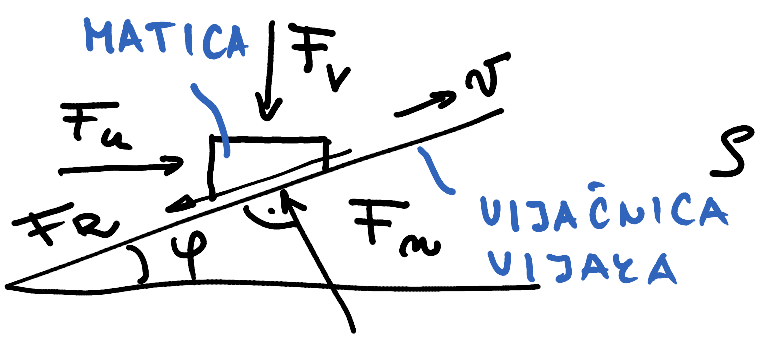
$$\operatorname{tg}\varphi = \frac{P}{\pi d_2}$$

PREDNAPETI VIJAK $n = 1$; $P_n = P$

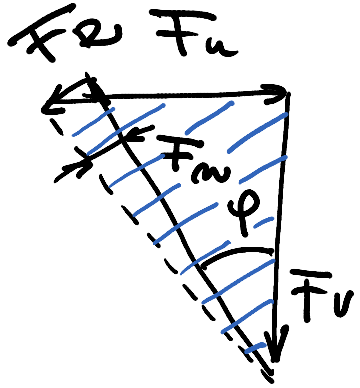
$n > 1$ SAMOZAGIBALNE VIJAKE

PRIVIJANJE IN ODVIJANJE VIJAKA TER MOMENT ključa

PRIVIJANJE



$F_u \rightarrow F_v \rightarrow F_m \rightarrow F_R$



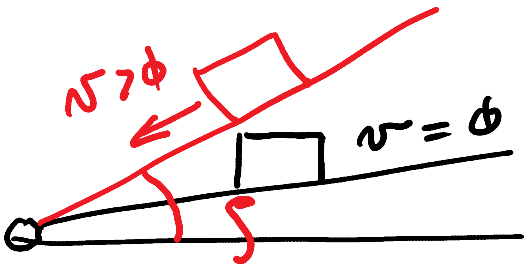
S

OBODNA SILA

$$tg(\varphi + \rho) = \frac{F_u}{F_v}$$

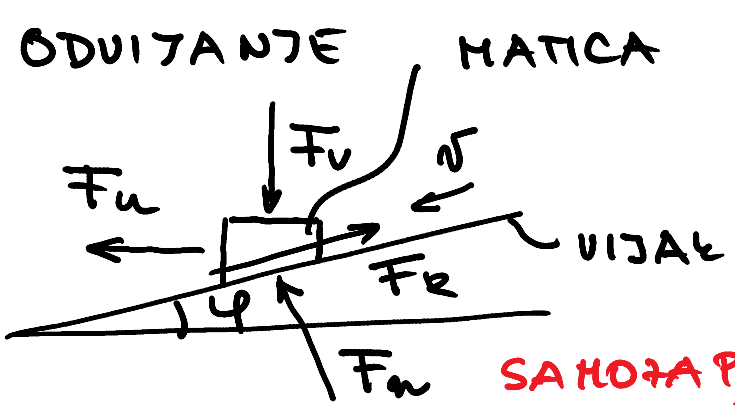
SILA PREDNAP. V VIJAKU

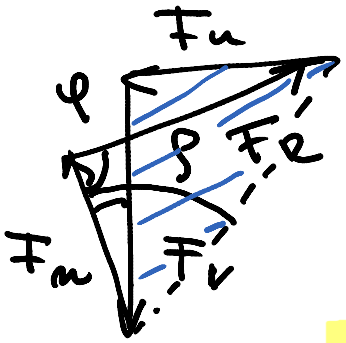
$$tg\,\rho = \frac{F_R}{F_m} = \mu$$ - koeficient trenja



PRIVIJANJE → GIBANJE KLADICE PO STRMINI NAVOJA

ρ - kot samozapornosti





$$tg(\rho-\varphi)=\frac{F_u}{F_v}$$

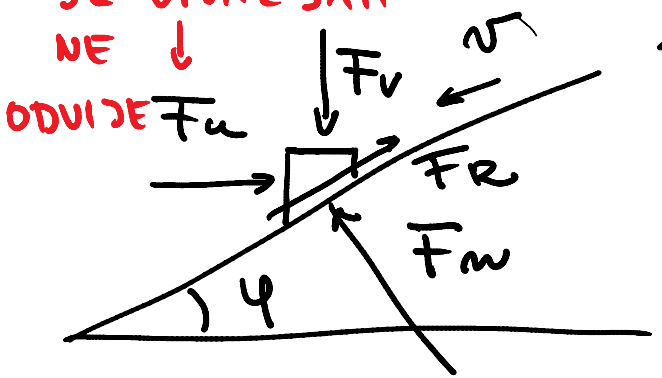
$$tg(-\alpha)=-tg\,\alpha$$

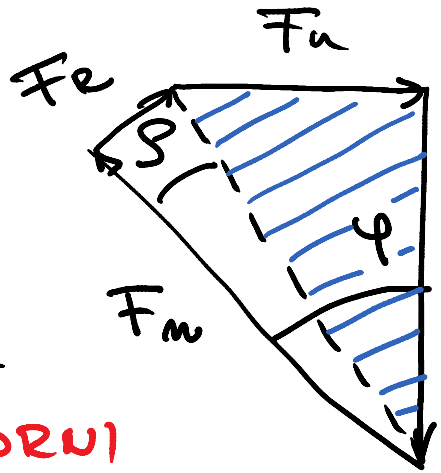
$$tg(\varphi-\rho)=-\frac{F_u}{F_v}$$

↑ PRI SPLOŠNI ENAČBI ZANEMARIMO

SAMOTAPORNI VIJAK $\varphi \leq \rho$

ZADRŽUJEMO, DA SE VIJAK SAM NE ODVIJE





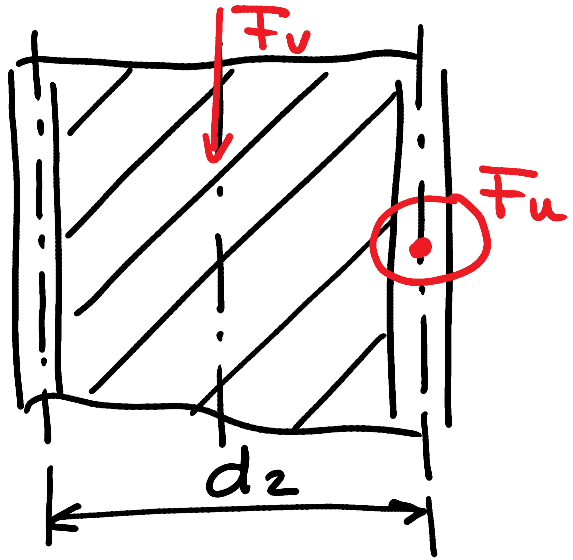
$$tg(\varphi-\rho)=\frac{F_u}{F_v}$$

NESAMOTAPORNI VIJAK $\varphi > \rho$

$$M_G = F_u \cdot \frac{d_2}{2}$$

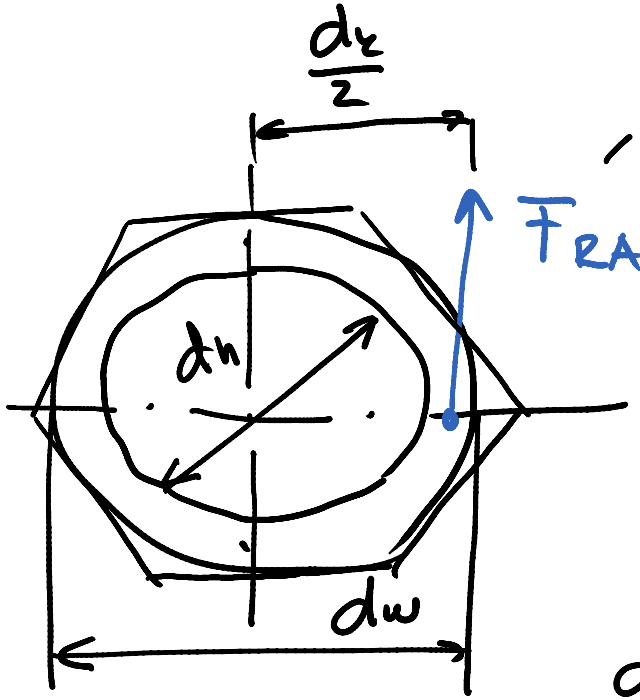
$$= F_u \cdot \frac{d_2}{2} tg(\varphi \pm \rho)$$

MOMENT TRENJA MED NAVOJI



STEBLO VI ALA
V PREREZU

$$M_A = F_u \frac{d_2}{2}$$



SILA TRENJA MED MATICO IN SPENJALNIMI DELI

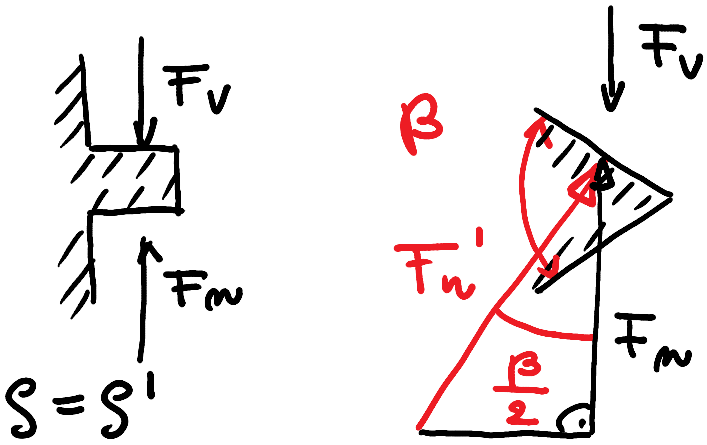
$$M_{RA} = F_{RA} \cdot \frac{d_z}{2}$$

$$F_{RA} = F_u \cdot \mu$$

$$d_z = \frac{d_w + d_n}{2}$$

M_{RA} MOMENT TRENJA MED MATICO IN SPENJALNIMI DELI

VPLIV VRSTE NAVOJA NA M_G



$$F_R = \mu \cdot F_n' = F_w \cdot \frac{\mu}{\cos\frac{\beta}{2}}$$

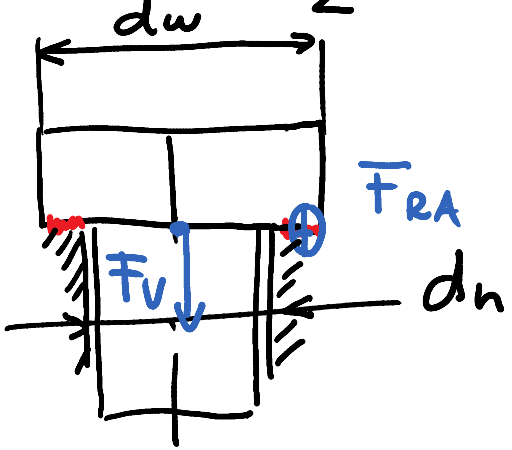
$$F_w = F_n' \cos \beta/2$$

$$\mu'$$

$$\operatorname{tg} \rho' = \mu' > \mu$$

$$M_G = \frac{F_v \cdot d_2}{2} \operatorname{tg}(\varphi \pm \rho')$$

ρ' UPOŠTEVA VRSTO NAVOJA



$$F_{RA} = F_v \cdot \mu$$

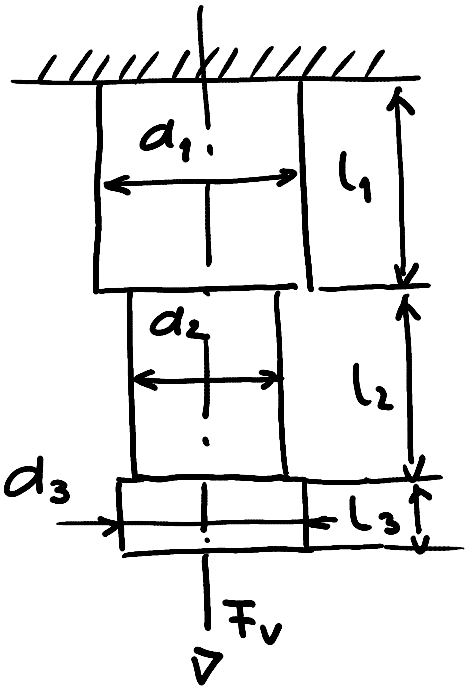
$$M_{RA} = \frac{F_{RA} \cdot d_z}{2} = \frac{F_v \cdot \mu \cdot d_z}{2}$$

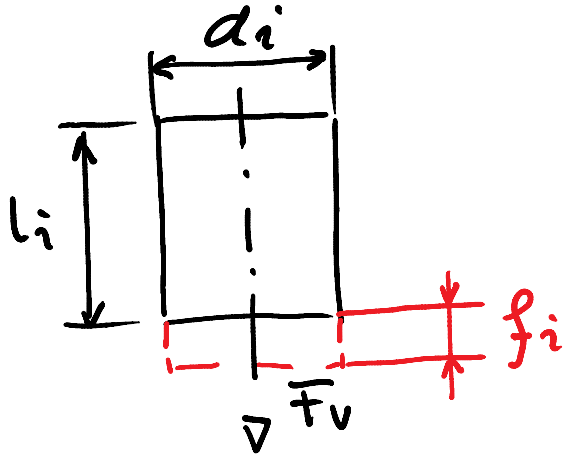
MOMENT TRENJA MED MATICO IN SPENJALNIMI DELI

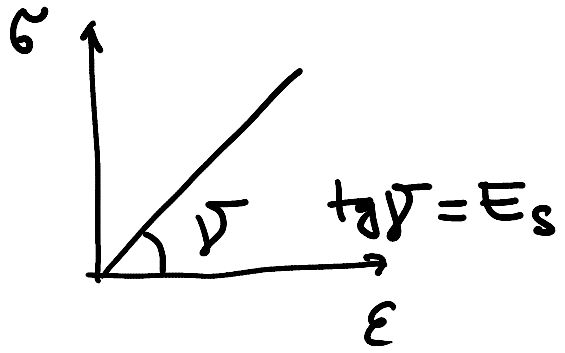
$$d_z = \frac{d_w + d_n}{2}$$

MOMENT ZLJOČA $M_A = M_G + M_{RA}$

PODAJNOST VIJAČA







$$f_s = \sum_i f_i$$

$$= \sum_i \delta_i F_v$$

$$f_s = \delta_s F_v$$

$$\sigma_i = E_s \varepsilon_i$$

$$\frac{F_v}{A_i} = E_s \frac{f_i}{l_i}$$

$$F_v = \frac{E_s A_i}{l_i} f_i$$

$$f_i = \delta_i F_v$$

$$\sum_i \delta_i = \delta_s$$

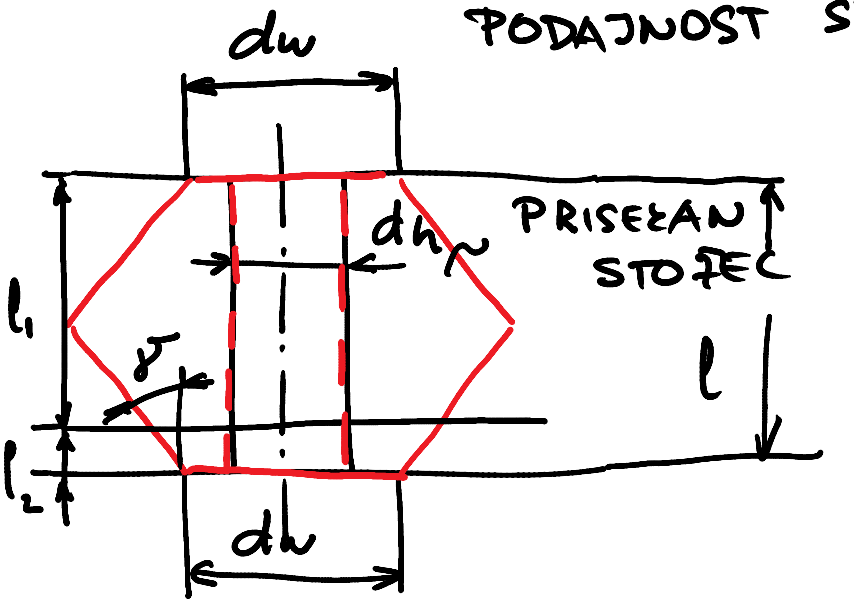
$$C_i = \frac{E_s A_i}{l_i}$$

TOGOST

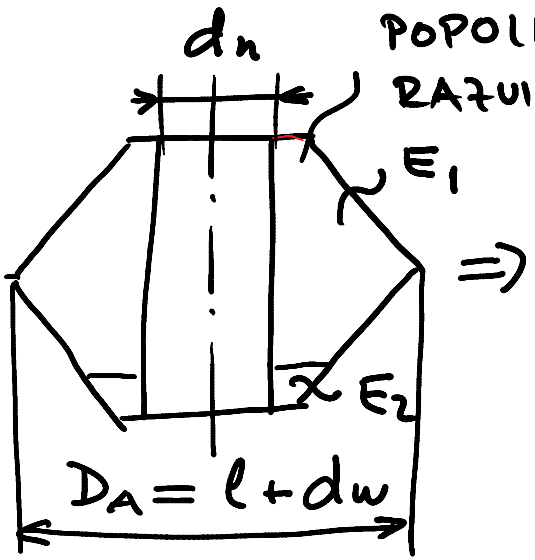
$$\delta_i = \frac{1}{C_i}$$

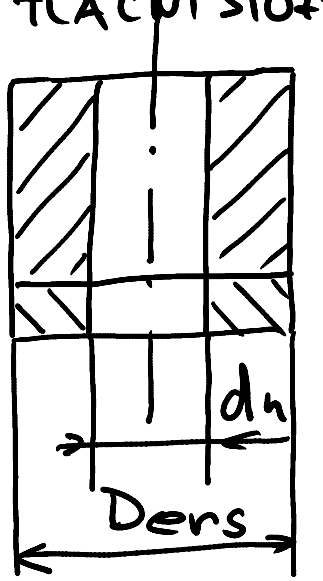
PODAJNOST ALI ELASTIČNOST

PODAJNOST SPENJALNIH DELOV



$\gamma \cong 45°$





Ders IZRAČUNAMO EMPIRIČNO

NADOMESTNI PREMER

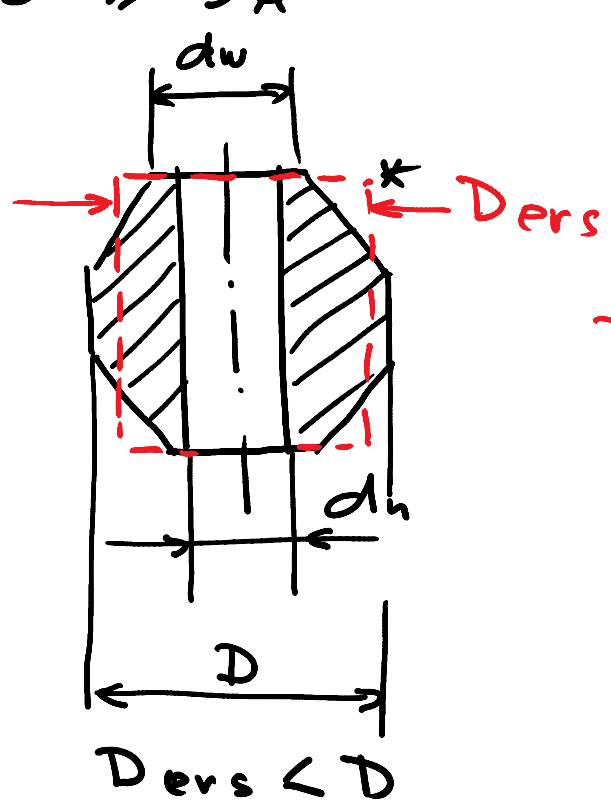
TLAČNI STOŽEC SE NE RAZTUJE VEDNO V POPOLNOSTI!

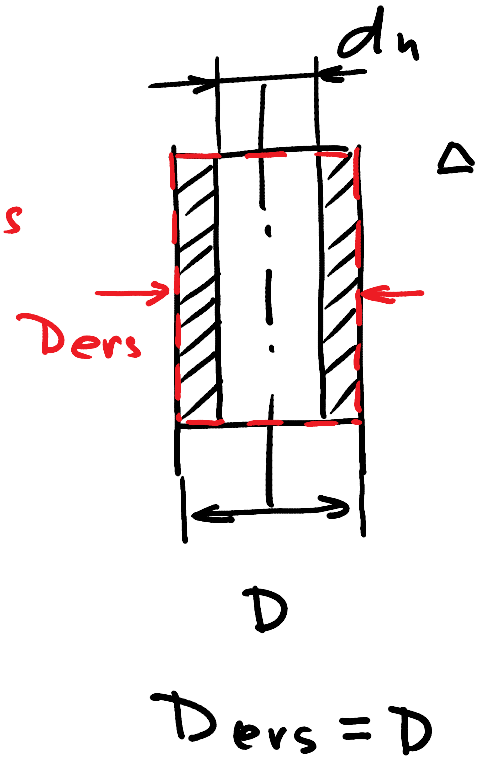
POGOJ ZA TESEN SPOJ JE PREKRIVANJE TLAČNIH STOŽCEV!

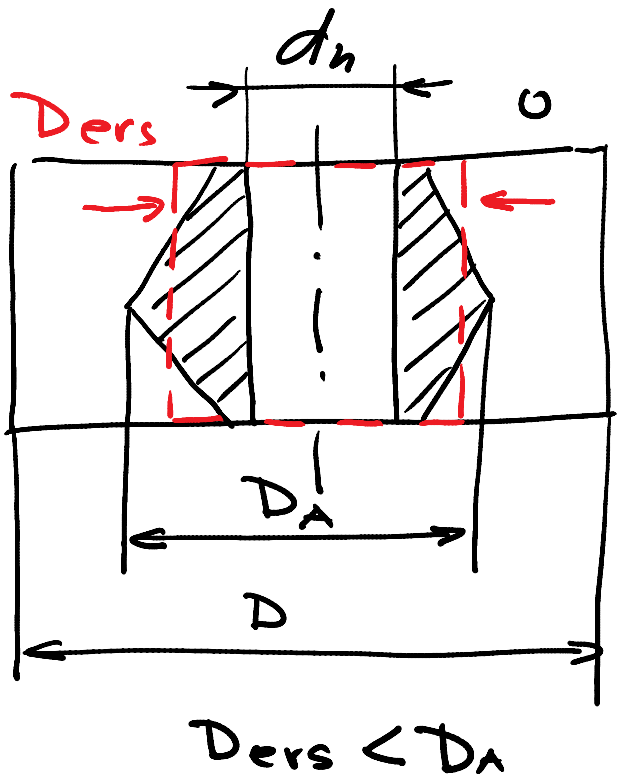
$^{\Delta}\ d_h < D \leq d_w$ → IMAMO TLAČNI VALJ

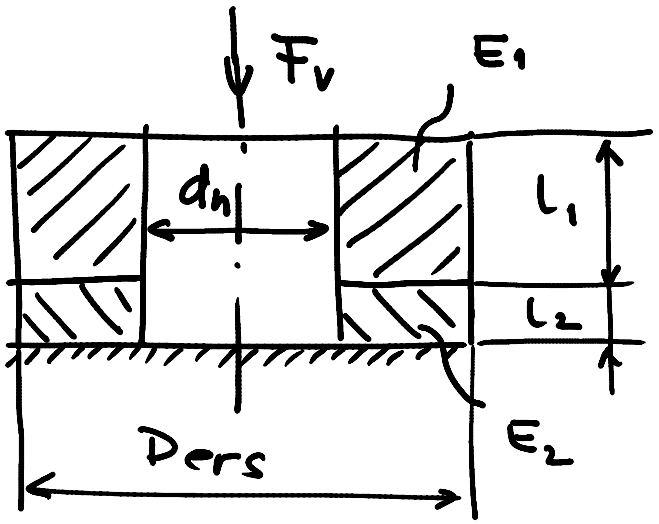
$^{*}\ d_w < D < D_A$ → TLAČNI STOŽEC DELNO RAZTUT

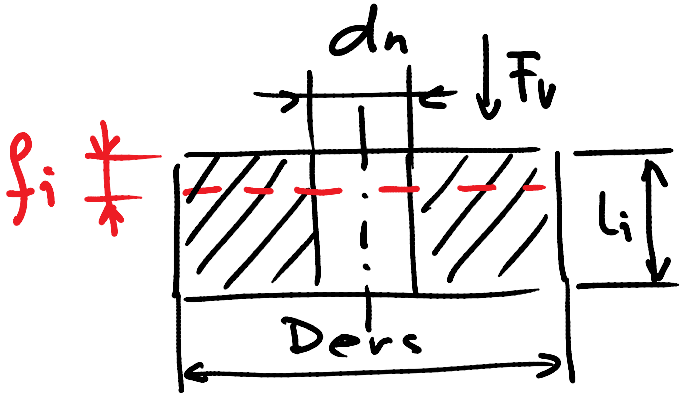
$^{\circ}\ D \geq D_A$ → TLAČNI STOŽEC V CELOTI RAZTUT

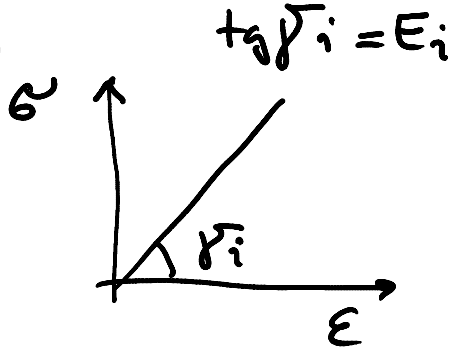












$$\sigma_i = E_i \varepsilon_i$$

$$\frac{F_v}{A_{ers}} = E_i \cdot \frac{f_i}{l_i}$$

$$F_v = \frac{A_{ers} E_i}{l_i} f_i$$

$$\sum_i \sigma_i = \sigma_T$$

$$C_i = \frac{A_{ers} E_i}{l_i}$$

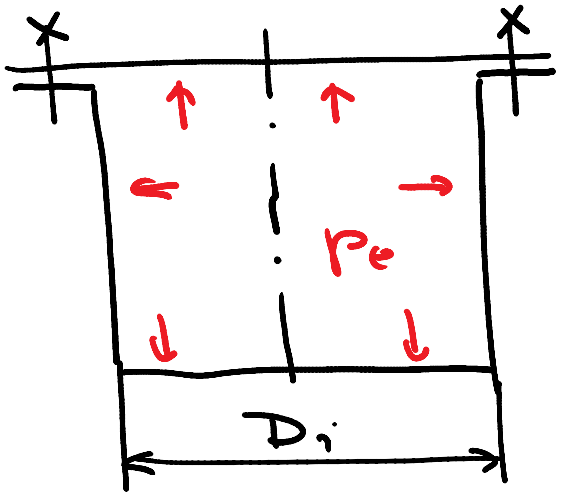
$$\sigma_i = \frac{1}{C_i}$$

$$f_T = \sum_i \sigma_i F_v$$

$$f_T = \sigma_T F_v$$

SILE IN DEFORMACIJE U PREDNAPETEM VIJAKU

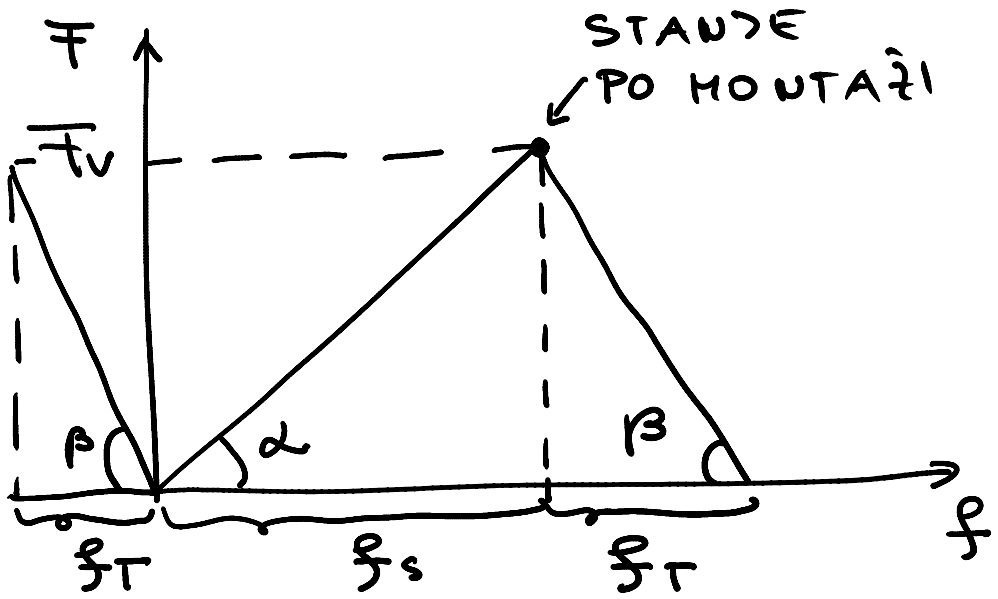
Z VIJAKOU



$$tg\alpha = C_s = \frac{1}{\delta_s}$$

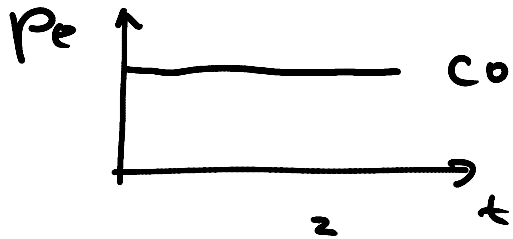
$$tg\beta = C_T = \frac{1}{\delta_T}$$

MONTAŽA IN PREDNAPENJANJE VIJAKOU



UPORABA IN DELOVNA OBREMENITEV

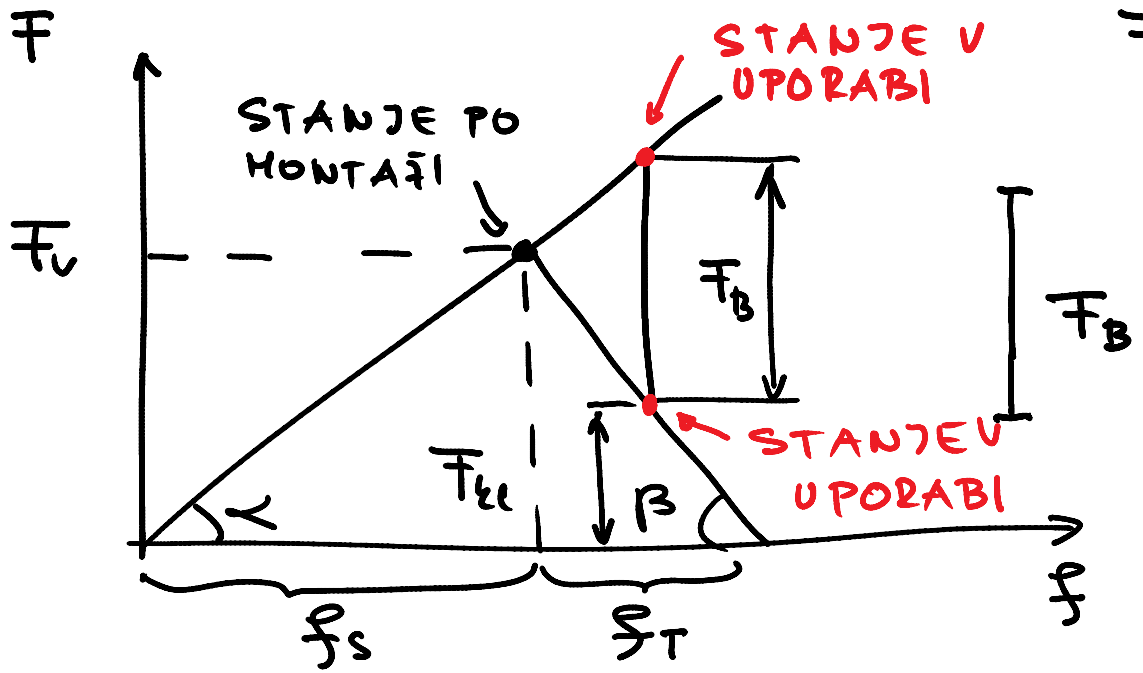
$p_e > 0$



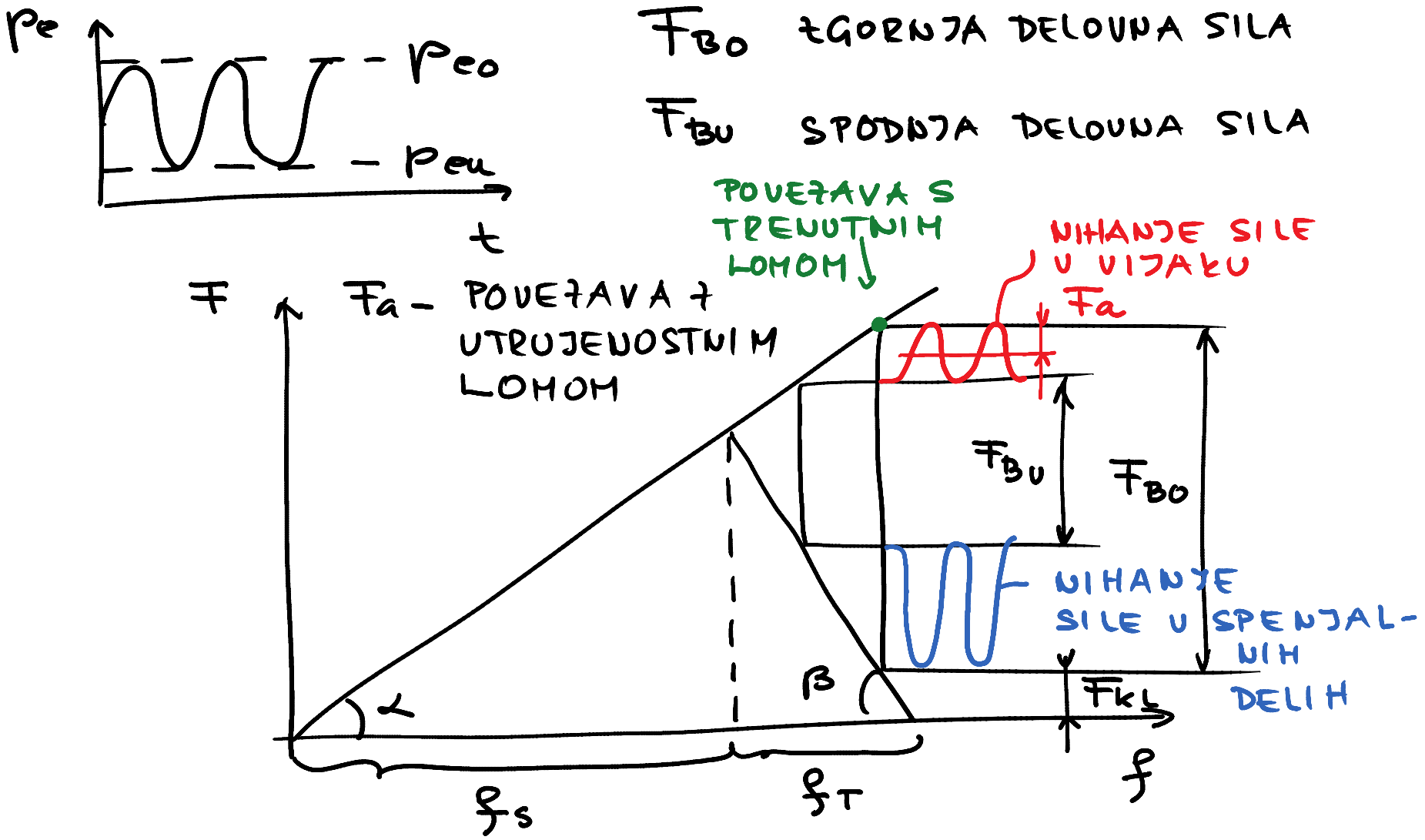
$$F_B \cdot z = p_e \cdot \frac{\pi D_i^2}{4} \rightarrow F_B = \frac{p_e \pi D_i^2}{4 z}$$

$F_B \cdot z$ — SILA NA POTROU

DELOVNA SILA

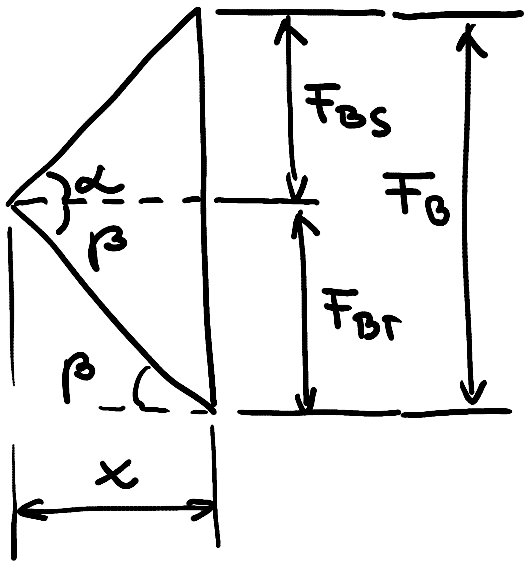


F_{kl} – TESNILNA SILA


Pe
Peo
Peu
t
F_{BO} ZGORNJA DELOVNA SILA
F_{BU} SPODNJA DELOVNA SILA
POVEZAVA S TRENUTNIM LOMOM
NIHANJE SILE V VIJAKU
Fa
F
Fa - POVEZAVA Z UTRUJENOSTNIM LOMOM
F_{BU}
F_{BO}
NIHANJE SILE V SPENJALNIH DELIH
F_{kL}
α
β
f_S
f_T
f

RAZČLENITEV DELOVNE SILE F_B NA F_{BS} IN F_{BT}

k2 RRP 2018



$$F_B = F_{BS} + F_{BT}$$

$$tg\alpha = \frac{F_{BS}}{x} = C_S = \frac{1}{\delta_S}$$

$$tg\beta = \frac{F_{BT}}{x} = C_T = \frac{1}{\delta_T}$$

$$x = F_{BS}\,\delta_S = F_{BT}\,\delta_T$$

$$F_{BT} = F_{BS} \cdot \frac{\delta_S}{\delta_T}$$

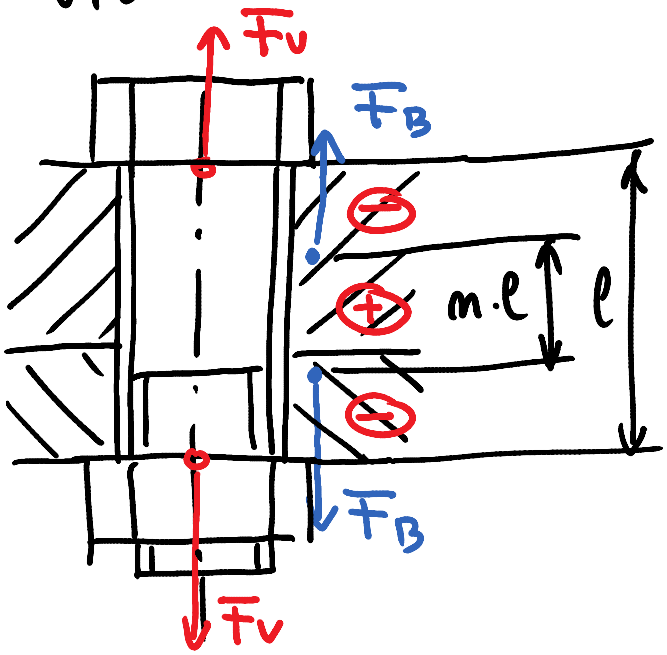
$$F_B = F_{BS}\left(1 + \frac{\delta_S}{\delta_T}\right) = F_{BS}\,\frac{\delta_S + \delta_T}{\delta_T}$$

$$F_{BS} = F_B \cdot \frac{\delta_T}{\delta_S + \delta_T} \quad ; \quad \Phi_L = \frac{\delta_T}{\delta_S + \delta_T}$$

RAZMERJE SIL

$$F_{BS} = \Phi_L\, F_B \qquad F_{BT} = F_B\,(1 - \Phi_L)$$

VPLIV PRIJEMALIŠČA DELOVNE SILE NA PREDNAPETI VIJAČNI SPOJ



$$F_{BS} = n \, \Phi_z \, F_B$$

$$\Phi = n \, \Phi_z$$

RAZMERJE SIL Z UPOŠTEVANJEM PRIJEMALIŠČA DELOVNE SILE

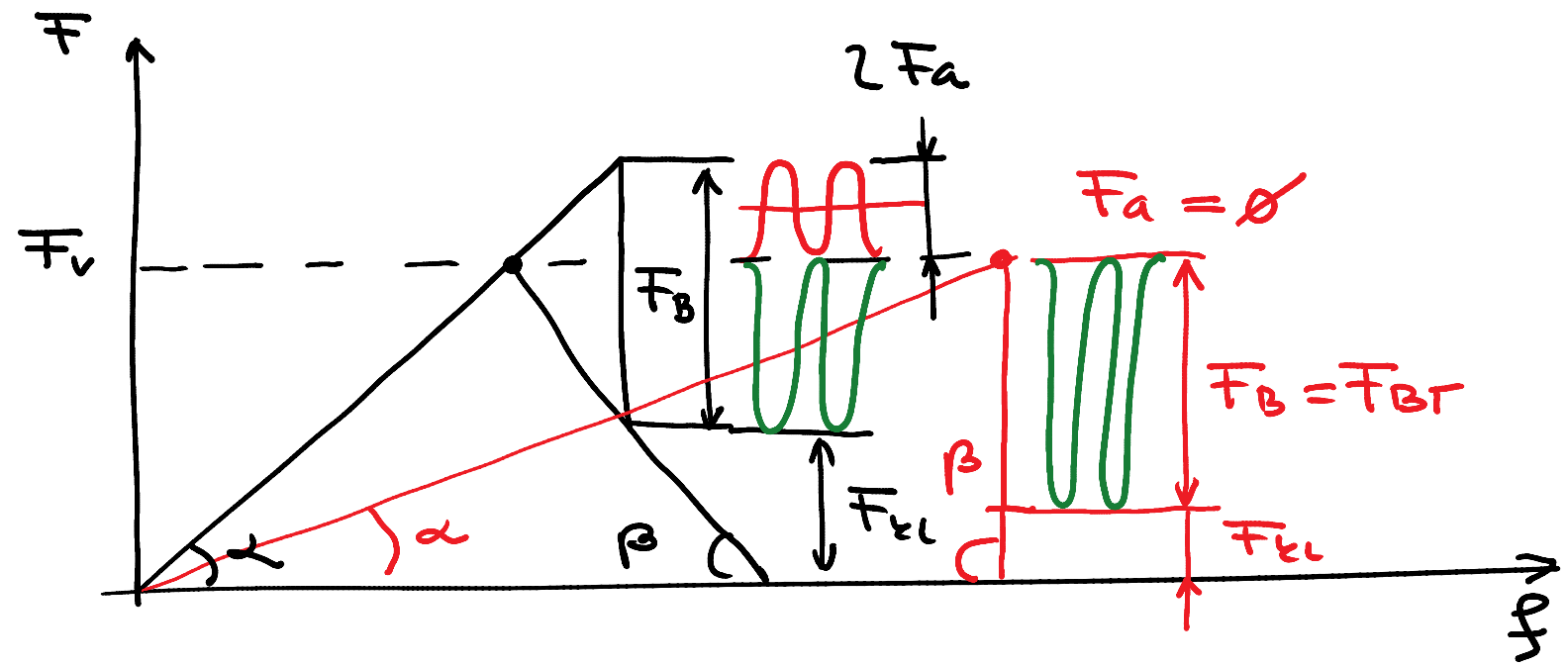
$$F_{BT} = F_B (1 - \Phi)$$

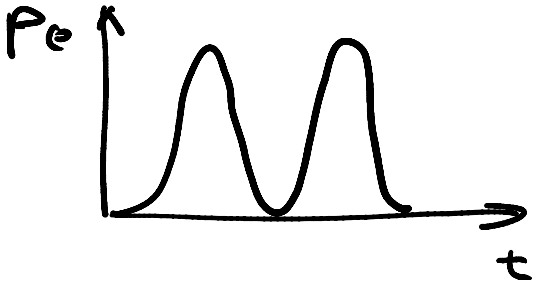
$0 \leq n \leq 1$ ← SILA F_B PRIJEMLJE POD GLAVO VIJAKA IN MATICE

↑
IDEALNO!

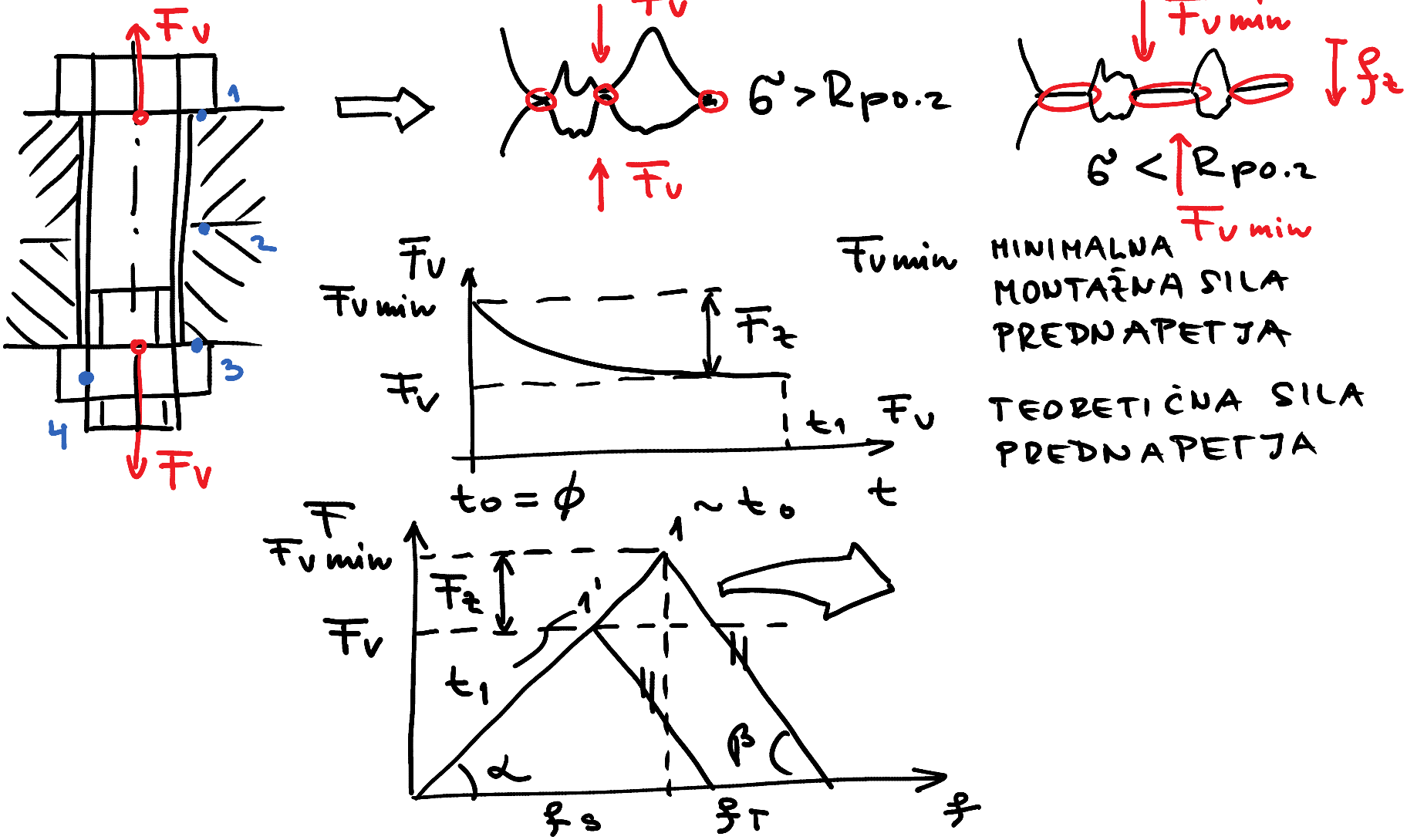
ČE JE $n < 1$, SE BO KOT α ZMANJŠAL, KOT β PA POVEČAL GLEDE NA $n = 1$!

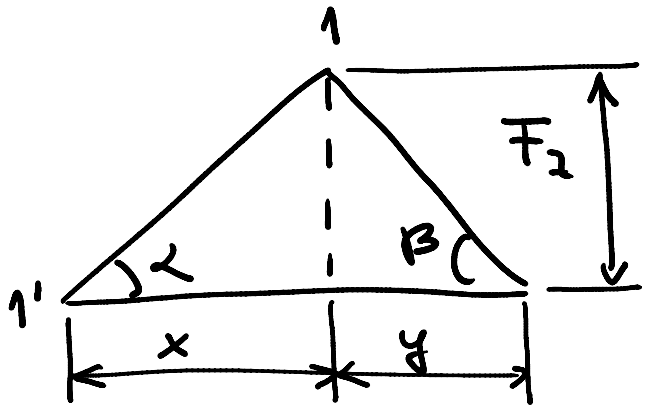
PRIMER $n = 1$ $n = \cancel{\phi}$





VPLIV POSEDANJA PREDNAPETEGA VIJAČNEGA SPOJA





$$\operatorname{tg}\alpha = \frac{F_z}{x} = C_s = \frac{1}{\delta_s}$$

$$\operatorname{tg}\beta = \frac{F_z}{y} = C_T = \frac{1}{\delta_T}$$

$$x = \delta_s F_z$$

$$y = \delta_T F_z$$

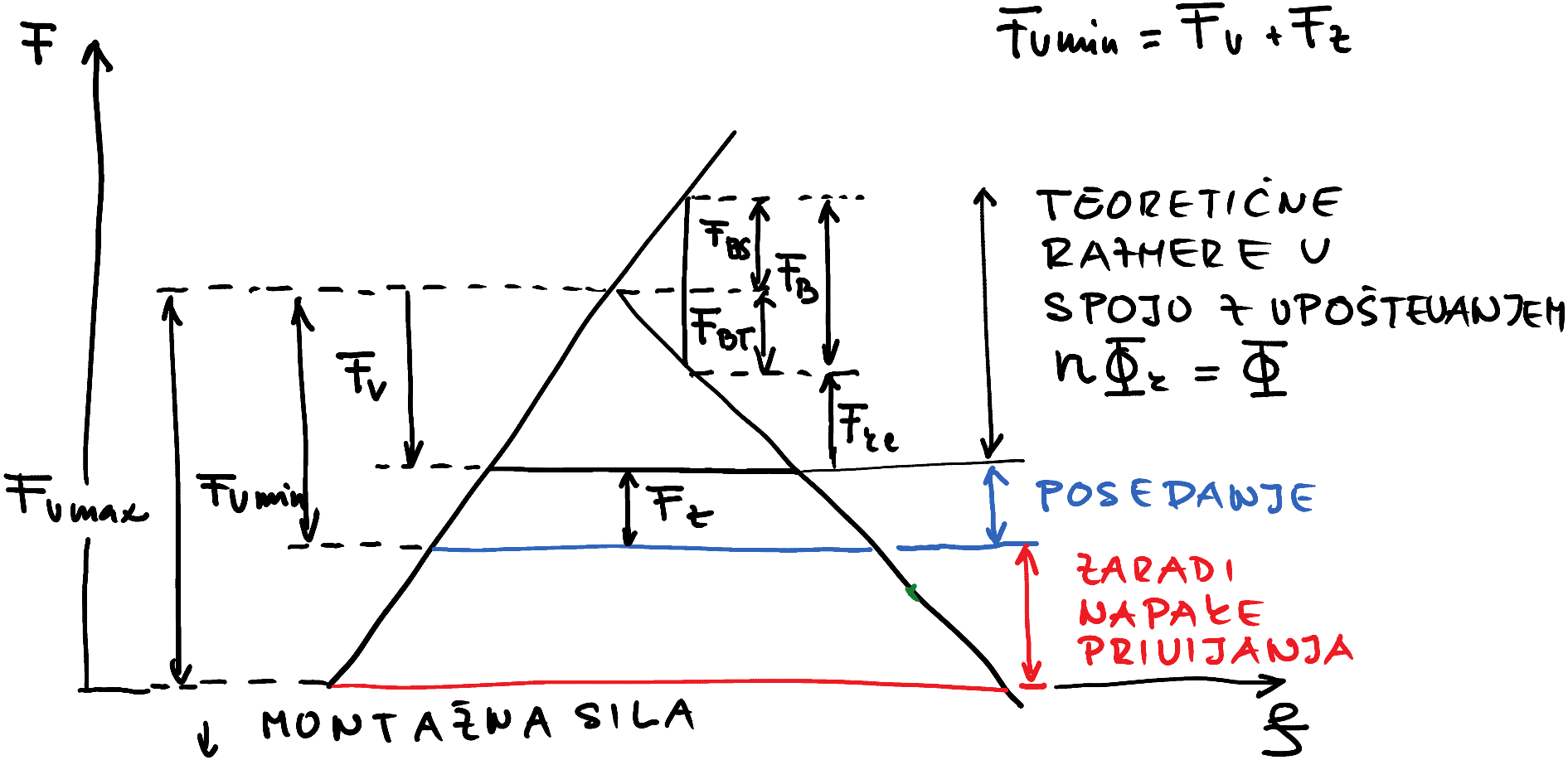
$$f_z = x + y = F_z(\delta_s + \delta_T)$$

$f_z = f($ R$_z$, ST. KONTAKTNIH POVRŠIN

$$F_t = \frac{f_t}{\delta_s + \delta_T}$$

POTREBNA SILA PREDNAPETJA PRI MONTAŽI

$$F_{Umin} = F_V + F_Z$$



$$F_{VM} = F_{Umax} = (F_V + F_Z)\, k_A$$ ✓✓

PRIVIJALNA NAPRAVA	FAKTOR PRIVIJANJA	
OBIČAJEN KLJUČ	$2,5 \div 4.0$	
MOMENTNI KLJUČ	$1,4 \div 2,5$	k_A
HIDRAULIČNA	$1,4 \div 1,6$	
S KONTROLO KOTA	$1,2 \div 1,4$	
ULTRAZVOČNA	$1,05 \div 1,2$	

$$k_A = \frac{F_{u\,max}}{F_{u\,min}}$$

$F_{u\,max}$ - NAJVIŠJA DOSEŽENA SILA PREDNAPETJA

$F_{u\,min}$ - NIMINALNA DOSEŽENA SILA PREDNAPETJA

ČE RAČUNAMO MOMENT KLJUČA, V ENAČBO ZA MOMENT KLJUČA ZA F_u VZAMEMO $F_{u\,max}$ ZA KOEFICIENT TRENJA PA MINIMALNO PRIČAKOVANO VREDNOST!

VREDNOTENJE PREDNAPETEGA VIJAČNEGA SPOJA

NA DINAMIČNO NOSILNOST

$$\sigma_a = \frac{F_a}{A_s} \leq \sigma_A$$

NA SILO PREDNAPETJA

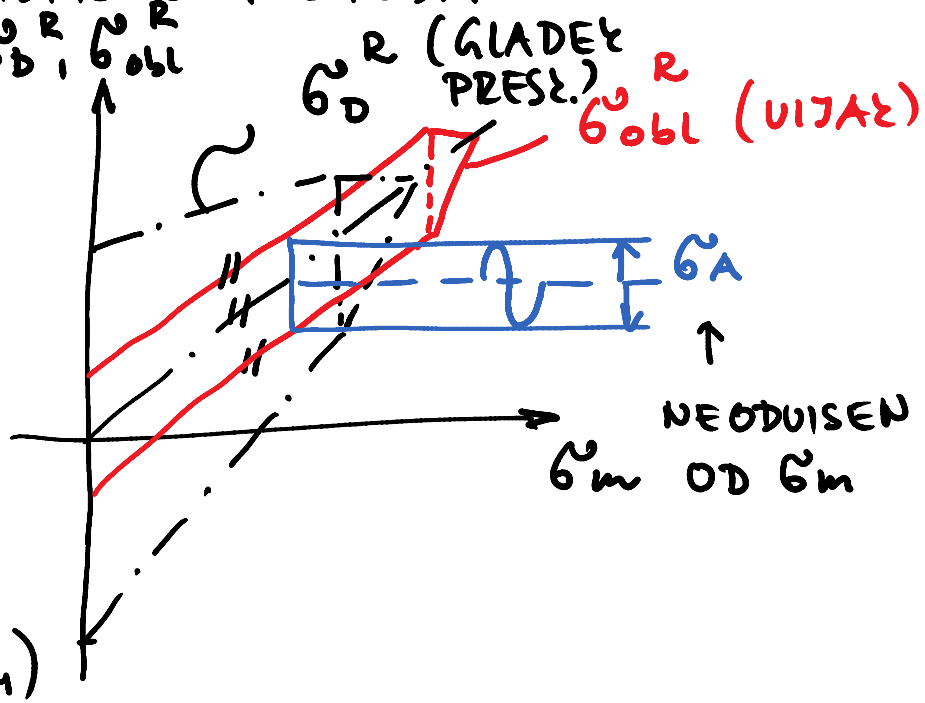
$$\sigma = \frac{F_{VM}}{A_s}$$

$$\tau = \frac{M_G}{W_{PS}} \qquad M_G = f(F_{VM})$$

$$\sigma_v = \sqrt{\sigma^2 + 3\tau^2} \leq 0{,}9\, R_{p0.2}$$

↑ ČE JE = POTEM LAHKO DOLOČIMO SILO PREDNAPETJA F_{sp} KI ZAGOTAVLJA $\sigma_v = 0{,}9\, R_{p0.2}$

$$F_{VM} \leq F_{sp}$$



NA DODATNO SILO V VIJAKU

$$F_{BS} = \Phi F_B \leq 0.1\, R_{p0.2}\, A_S \qquad \Phi = n\, \Phi_z$$

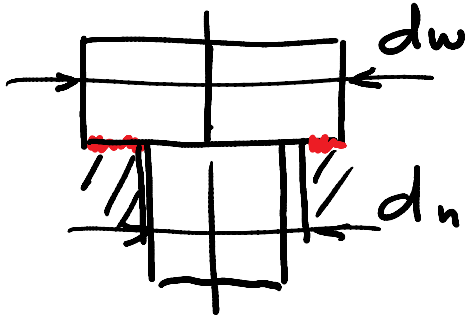
NA MAKSIMALNO MOČNO SILO V VIJAKU

$$\sigma_v = \sqrt{\sigma^2 + 3(k_\tau \tau)^2} \leq R_{p0.2}$$

$$\sigma = \frac{F_{SP} + F_{BS}}{A_S} \qquad \tau = \frac{M_a = f(F_{SP})}{W_{PS}}$$

$k_\tau = 0{,}5$ UPOŠTEVA ZMANJŠANJE M_a ZARADI POSEDANJA

NA TLAK



$$p = \frac{F_{SP} + F_{BS}}{A_p} \leq p_{dop}$$

$$A_p = \frac{\pi}{4}\left(d_w^2 - d_h^2\right)$$