

• tangencijalni :  $\tau_{dop} = 0,4 \cdot R_{eH}$ , vijaka

• dopuštni tlak osn. materijala :

$$p_{dop} = 0,93 \cdot R_{eH}, \text{ osn. mat.}$$

① Dimenzionirajte vijakno zvezo

a) bez konca matice ( $d, b = ?$ )

$$F = 10 \text{ kN} = 10000 \text{ N} = 1 \text{ t}$$



~ motraji presjek ( $A_j'$ ), prenaša opterećenje.  
metrični navoj, 8.8

•  $\sigma_{dej} \leq \sigma_{dop}$ .

$$\frac{F}{A_j'} \leq 0,4 \cdot R_{eH}$$

$$A_j' \geq \frac{F}{0,4 \cdot R_{eH}} = \frac{10000 \text{ N/mm}^2}{0,4 \cdot 640 \text{ N}}$$

$$= 39,0625 \text{ mm}^2$$

Prvi 3 navoji noseju većinu opterećenja.

$$R_{eH} = f(8.8) = 8.8 \cdot 10 = 640 \text{ MPa}$$

(motraji presjek)



Priručnik 580 : zaduži stolpce (presjeci jedar) : polišćemo narednjega većega (M9 - se ga je treba izogibati), izberemo narednjega : M10

Podatki za M10:

$$A_j' = 52,3 \text{ mm}^2$$

$$P(\text{borak}) = 1,5 \text{ mm}$$

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

$$d_1 = 8,376 \text{ mm}$$

jelka

$$S355 \rightarrow R_{eH} = 355$$

• minimalna potrebna dužina navoja :

$$p_{dej} \leq p_{dop}, \text{ osn. mat.}$$

$$\frac{F}{\pi(d^2 - d_1^2)} \cdot \frac{b}{p}$$

$p_{dop}, \text{ osn. mat.}$

$$0,83 \cdot R_{eH}, \text{ osn. mat.} = f(355) = 355 \text{ MPa}$$

navojni presjek

to se porazdeli med vse navoje



# VAJE

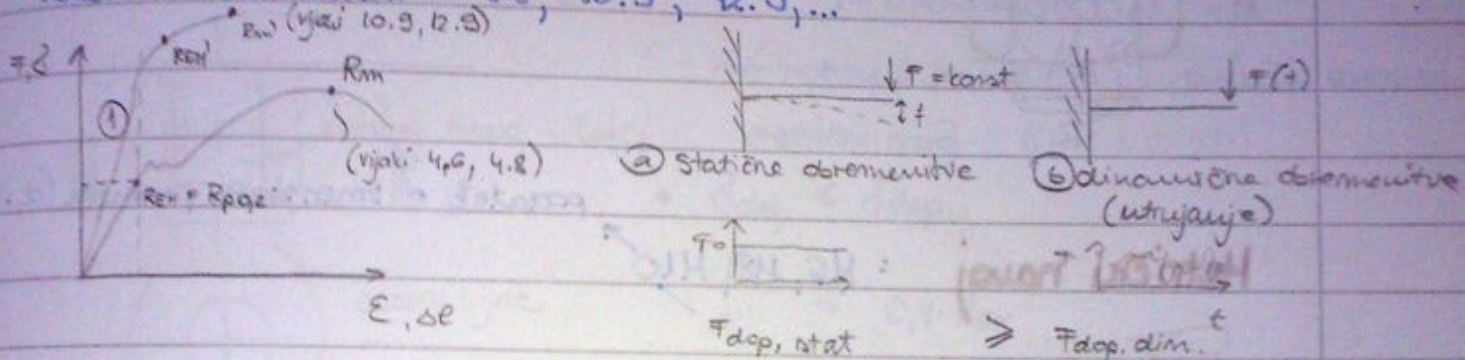
15.10.2012

vijak + matica + podložka = vijakna zveza

Osnovni element je navoj (notranji, zunanji)

Trdnostni razredi vijakov: 4.6, 4.8, 5.6, ...

Visokotrdnostni razredi: 8.8, 10.9, 12.9, ...



$R_{eH}$  meja plastičnosti =  $R_{p0.2}$

$R_m$  največja napetost

a) A B  
4.6

$$R_{EH} = A \cdot B \cdot 10 = 4.6 \cdot 10 = 240 \text{ MPa} = \text{N/mm}^2$$

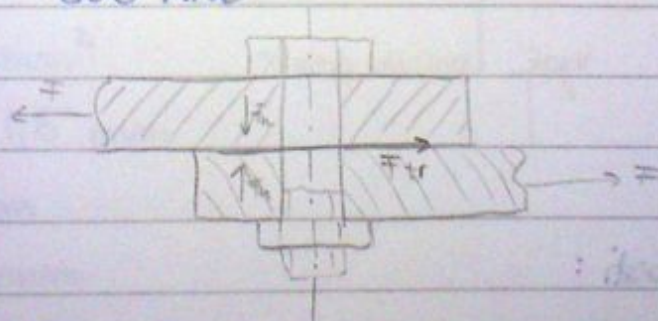
$$R_m = A \cdot 100 = 400 \text{ MPa}$$

b) 8.8

$$R_{EH} = 8.8 \cdot 10 = 640 \text{ MPa}$$

$$R_m = 800 \text{ MPa}$$

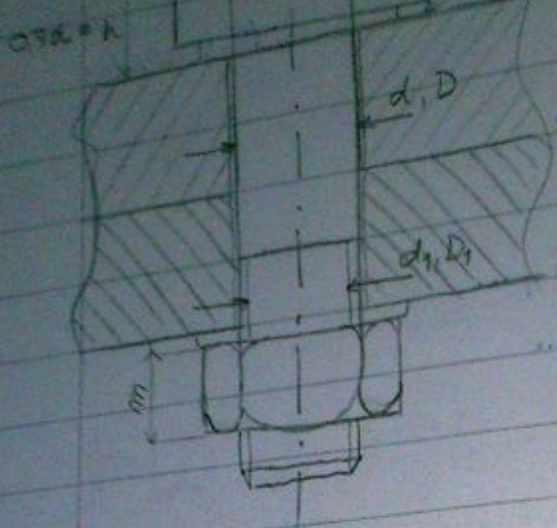
- strig
- nateg
- trenje



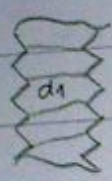
$$F_{tr} = F_n \cdot \mu$$

Strojniški priručnik: 625

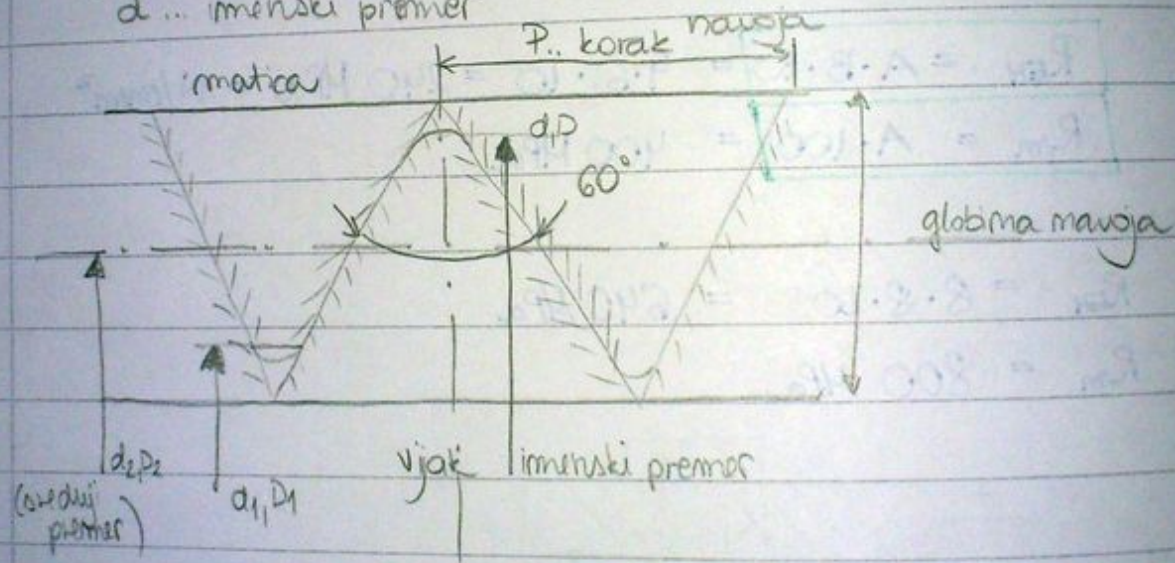




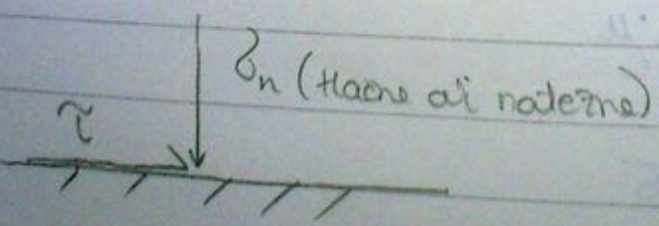
**Metrični navoji** : M6, M8, M10 → *počatež o imenskom premeru (d)*



$d$  ... imenski premer



**Dopustne napetosti :**



• normalne :  $\sigma_{dop.n} = 0,4 \cdot R_{EH}, vijaka$



$$b \geq \frac{4 \cdot F \cdot p}{\pi(d^2 - d_1^2) \cdot 0,93 \cdot R_{\text{rezon. mat.}}}$$

$$b \geq \frac{4 \cdot 10000 \text{ N} \cdot 15}{\pi(10^2 - 8,376^2) \cdot 0,93 \cdot 355}$$

$$b \geq 1,93 \text{ mm} \quad \rightarrow \quad b_{\text{min}} \approx 3,86 \text{ mm}$$

Zaradi varnosti vzamemo vsaj  $\times 2$  navoja.

Standardne dolžine so med 35-200 mm ( $l_{\text{v10}}$ )

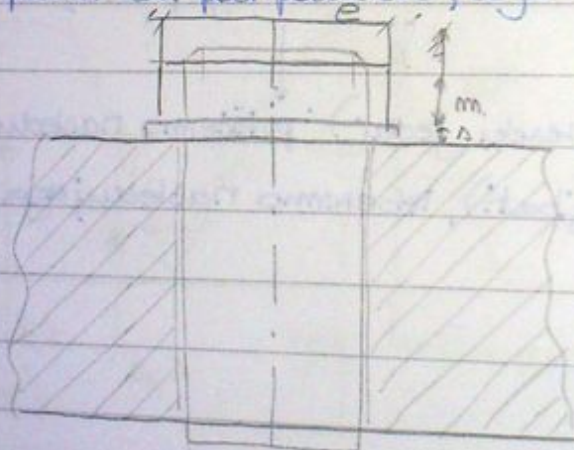
22.10.2012

① Minimalna dolžina navoja

za osnovni material S235  $\neq R_m = 400-600 \text{ MPa}$  im 8.8

$$b \approx 1,2 \cdot d = 1,2 \cdot 10 = 12 \text{ mm}$$

b) preveri tlak pod podložko, če je zveča izvedena s kontra matico



$$p = \sigma_H - \text{tlacna napetost}$$

e.. premer matice

A.. širina podložke

m.. širina matice



$$\Delta = 2 \text{ mm}$$

$$e = 18,72 \text{ mm}$$

$$d_g = 21 \text{ mm}$$

$$F = 4 \cdot 10^3 \text{ N}$$

kontrola:  $p_{dej} \leq p_{dop}$ .

$$\frac{F}{A_{podložka}} \leq 0,93 \cdot R_{ex, os, mat.}$$

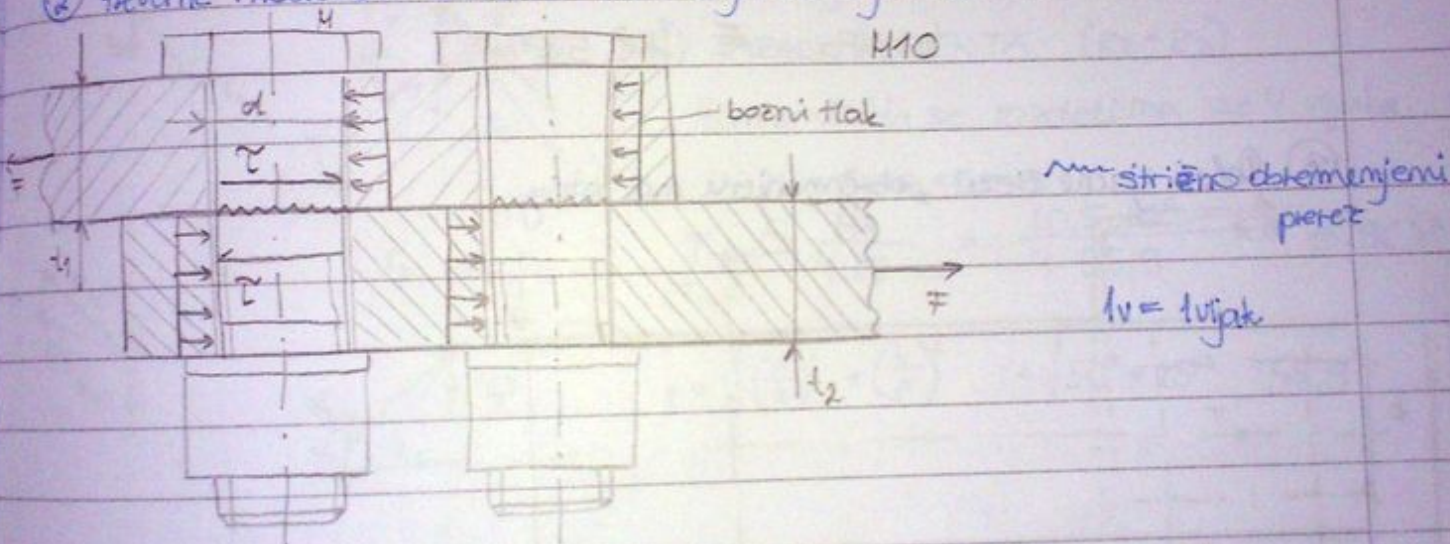
$$R_{ex, os, mat} = f(385) = 355 \text{ MPa}$$

$$\frac{F \cdot 4}{(d_g^2 - d^2) \pi} \leq 0,93 \cdot R_{ex, os, mat.}$$

$$\frac{4 \cdot 10 \cdot 10^3 \text{ N}}{(21^2 - 10^2) \pi} \leq 0,93 \cdot 355 \text{ MPa}$$

$$37,338 \text{ MPa} \leq 330,15 \text{ MPa}$$

② Zevrite nosivost strižno obremenjenih vijakov.



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

$$t_1 = t_2 = 25 \text{ mm}$$

$$8.8, S235$$

$$F = 20 \text{ kN}$$

10 kN na vsak prečez

kontrola:  $\tau_{dej, lv} \leq \tau_{dop, lv}$  (za 1 vijak)

$$\frac{F_{lv}}{A_{st, lv}} \leq 0,4 \cdot R_{ex} \text{ (meta plastičnost vijaka)}$$

$$\frac{F_{lv}}{d^2 \cdot \pi} \leq 0,4 \cdot 640 \text{ MPa}$$

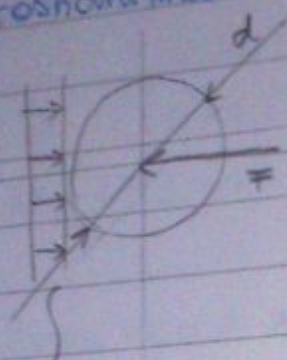
$$\frac{10 \cdot 10^3 \text{ N} \cdot 4}{10^2 \cdot \pi} \leq 0,4 \cdot 640 \text{ MPa}$$

$$127,324 \text{ MPa} \leq 256 \text{ MPa}$$

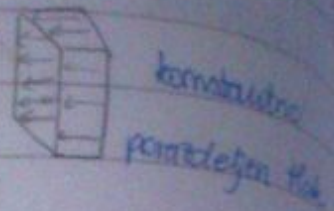
$$R_{ex} = f(8.8) = 640 \text{ MPa (str. 626)}$$



Kontrolama božni tlak:  
 osnovni material bož kritičen



$$p_{dej} = \frac{F}{d \cdot t} \Rightarrow$$



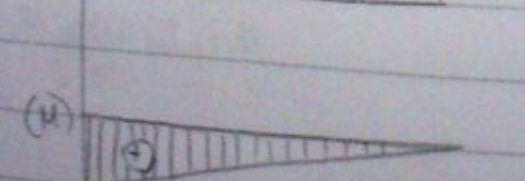
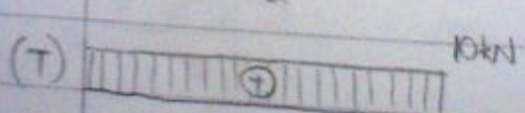
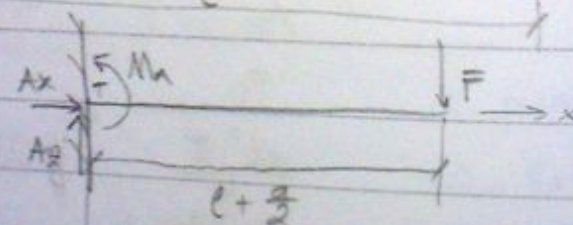
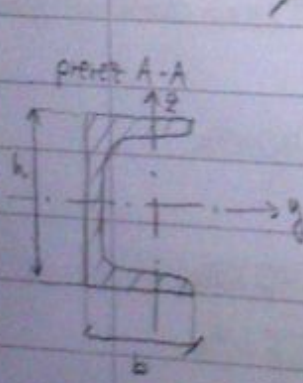
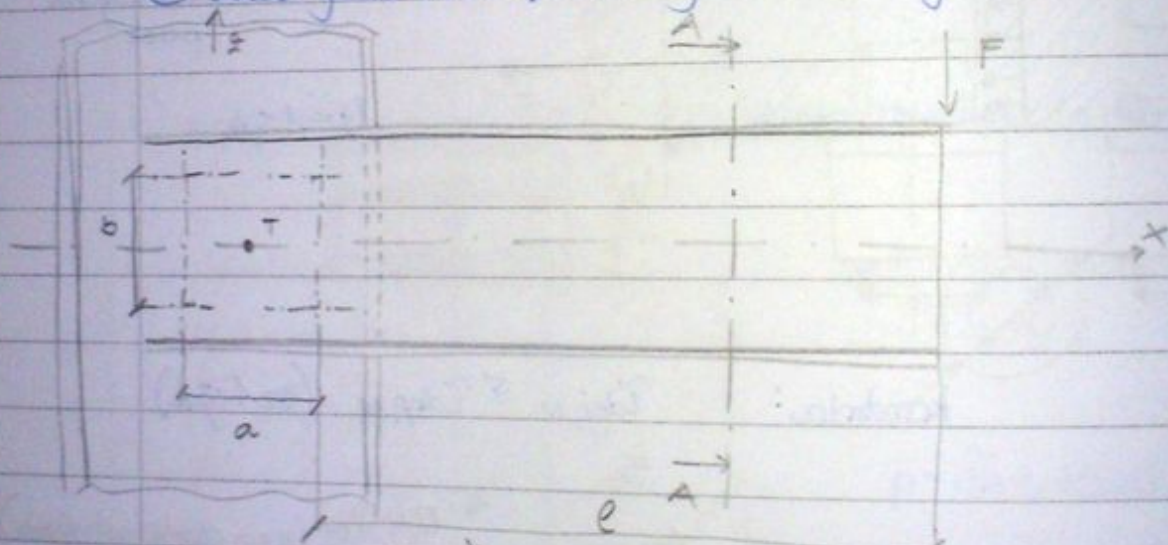
$$p_{dej} \leq p_{dop. os. mat.}$$

$$\frac{F_{iv}}{d \cdot t} \leq 0,93 \cdot R_{ek. os. mat.}$$

$$\frac{10 \cdot 10^3 N}{10 \cdot 25} \leq 0,93 \cdot 235$$

$$40 \text{ MPa} \leq 218,55 \text{ MPa}$$

③ Doloži vjačne zize, obremenjene na strig



- $a = 100$
- $b = 50$
- $l = 1000$
- $F = 10 \text{ kN}$
- $d = ?$

$$M_{max} = 10,5 \cdot 10^6 \text{ Nm} = M_A$$



Razloži:

$$\sum F_{i,x} = 0; A_x = 0$$

$$\sum F_{i,y} = 0; A_z - F = 0$$

$A_z = F = 10 \text{ kN} \rightarrow$  se razdeli na 4 vijake

$$\sum M_{A_i} = 0 \quad M_A - F(e+f) = 0$$

$$M_A = F \cdot (e+f) = 10 \cdot 10^3 \text{ N} (1050 \text{ mm}) = 10,5 \cdot 10^6 \text{ Nmm} = M_{A, \text{max}}$$

$\checkmark$  dej.  $\checkmark$  dop.

$$\frac{F_{N, \text{max}}}{A_{st}} < \checkmark \text{ dop.}$$

Prečna sila T pada na vse 4 vijake enako.

• Obremenitve na vijake:

a) ZARADI PREČNE SILE

$$F_{1,T} = F_{2,T}, \dots = \frac{T}{4} = 2,5 \text{ kN}$$

$R_2$  in  $R_3$  sta večja  $\rightarrow$  vijaka 2 in 3 sta bolj obremenjena od vijakov 1 in 4.

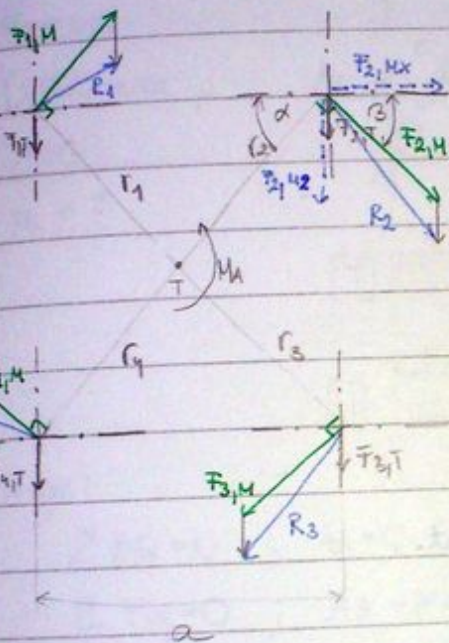
b) ZARADI MOMENTA ( $R_2 = R_3$ )

Moment  $M_A$  se razdeli na vse 4 vijake

$$r_i = r_1 = r_2 = r_3 = r_4$$

$$F_{N_i} = \frac{M_A}{4 \cdot r_i} = \frac{10,5 \cdot 10^6}{4 \cdot 55,9} = 46,96 \text{ kN}$$

$$r = \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{b}{2}\right)^2} = \sqrt{50^2 + 25^2} = 55,9$$



$$\text{tg } \alpha = \frac{b}{a} = \frac{50}{100} = \frac{1}{2}$$

$$\alpha = 26,57^\circ$$

$$\beta = 180^\circ - \alpha - 90^\circ = 63,43^\circ$$

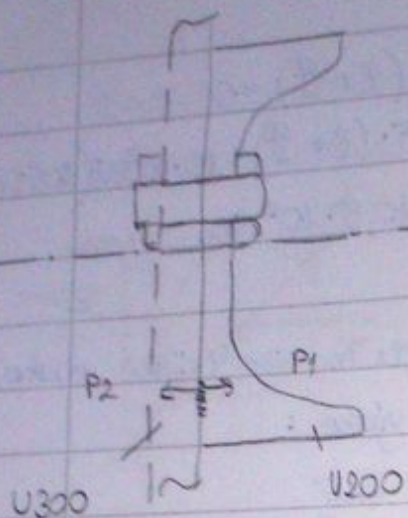
$$F_{2,Mz} = F_{2,M} \cdot \sin \beta = 46,96 \cdot \sin 63,43^\circ = 42 \text{ kN}$$

$$F_{2,Mx} = F_{2,M} \cdot \cos \beta = 46,96 \cdot \cos 63,43^\circ = 21 \text{ kN}$$

Izračunamo  $R_2$

$$R_2 = \sqrt{F_{2,Mx}^2 + (F_{2,Mz} + F_{2,T})^2} = \sqrt{21^2 + (42 + 2,5)^2} = 49,21 \text{ kN}$$





$$\sigma_{dej} < \sigma_{dop.}$$

$$\frac{T_{1, \max}}{A} \leq 0,4 \cdot R_{ex}$$

$$\frac{49,21 \text{ kN}}{\frac{\pi d^2}{4}} \leq 0,4 \cdot 200$$

$$4 \cdot 49,21 \leq 0,4 \cdot 200 \cdot \pi \cdot d^2$$

$$\sqrt{\frac{4 \cdot 49,21 \cdot 10^3}{0,4 \cdot 200 \cdot \pi}}$$

$$d \geq 15,64 \text{ mm}$$

$$d \geq 15,64 \text{ mm}$$

M16

8.8

$$R_{ex} = 88 \cdot 10 = 640 \text{ MPa}$$

$p_1 \geq p_2$  kontrola na bočni tlak.

max. izmed.  $p_1$  in  $p_2$   
 $p_{dej} < p_{dop.}$

$$p_{1, \max} \Rightarrow \frac{R_{\max}}{t_1 \cdot d} \leq 0,93 \cdot R_{ex \text{ ou. mat.}}$$

$$\frac{49,21 \cdot 10^3}{6 \cdot 16} \leq 0,93 \cdot 355$$

$$512,6 < 330,15$$

NE SDRŽI