

Betonske konstrukcije

Vežba br.2

- Centrični pritisak
- Centrično zatezanje
- Mali ekcentricitet - zatezanje



KONCEPT
PRORAČUNA
AB PRESEKA

PREDAVANJA!

TEORIJA
DOPUŠTENIH
NAPONA

TEORIJA
GRANIČNIH
STANJA

GRANIČNA
STANJA

PREDAVANJA !

NOSIVOST

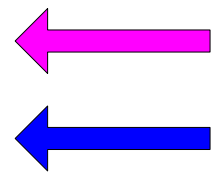
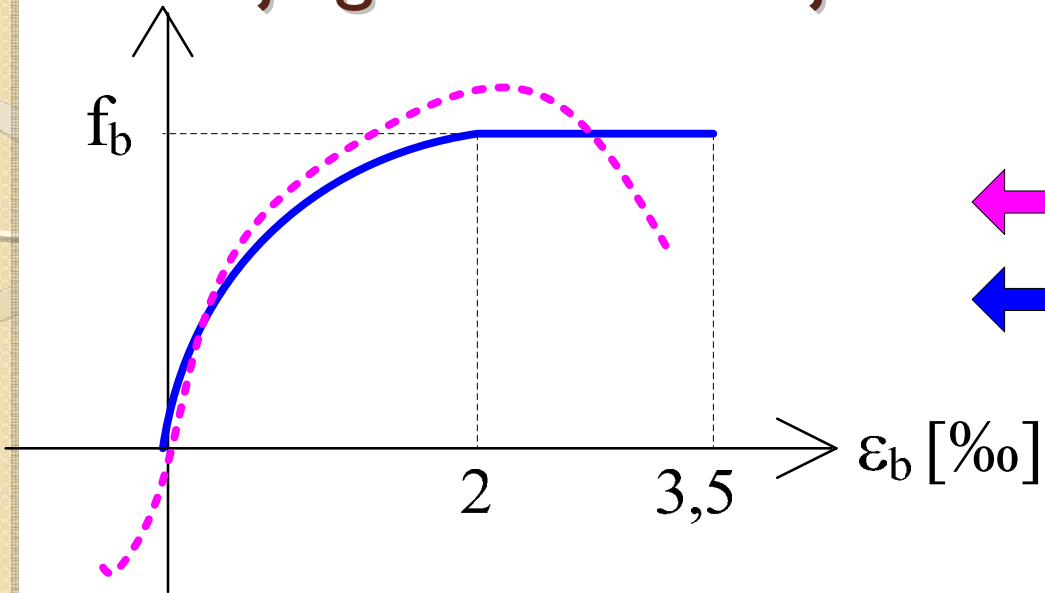
UPOTREBLJIVOST

PRSLINE

DEFORMACIJE

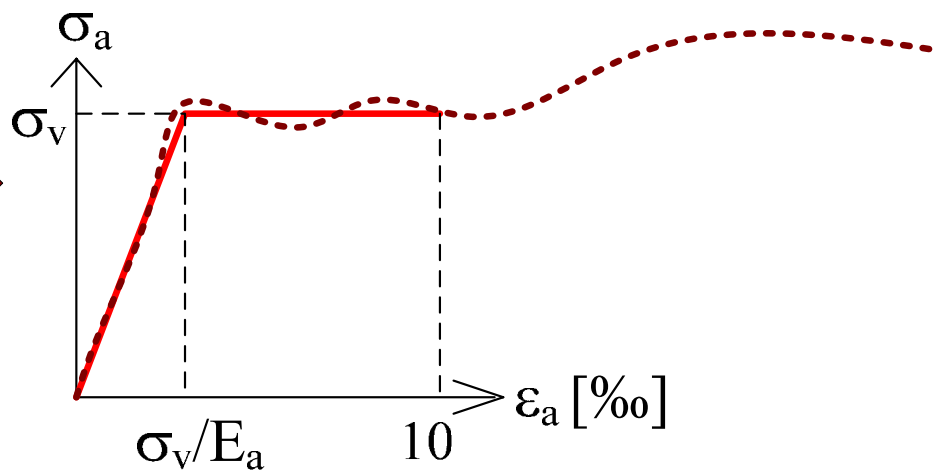
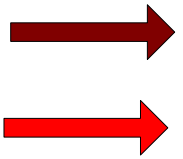
Teorija graničnih stanja

PREDAVANJA!

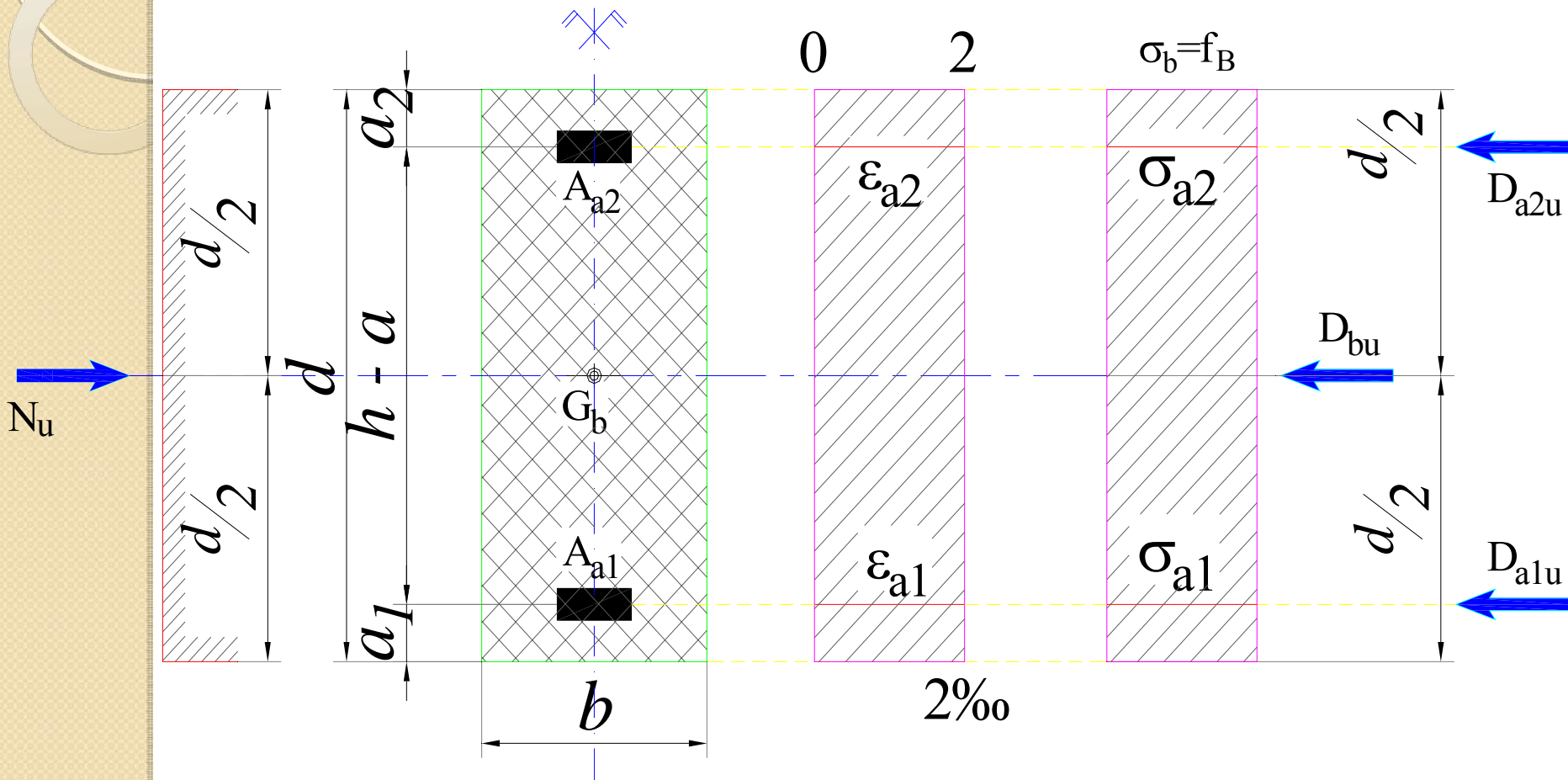


»Realni« dijagram betona
Računski dijagram betona

»Realni« dijagram čelika
Računski dijagram čelika



CENTRIČNO PRITISNUTI ELEMENTI



PREDAVANJA !

CENTRIČNO PRITISNUTI ELEMENTI

$$\Sigma N_u = 0 :$$

$$D_{au} = \sigma_{au} \cdot A_a \quad (\sigma_{au} = \sigma_v)$$

$$N_u = D_{bu} + D_{au1} + D_{au2}$$

$$N_u = A_b \cdot f_B + A_a \cdot \sigma_v$$

ili

$$N_u = f_B \cdot A_b \cdot (1 + \bar{\mu})$$

Mehanički koef. armiranja

$$\bar{\mu} = \mu \cdot \frac{\sigma_v}{f_B}$$

MINIMALNI PROCENTI ARMIRANJA

CENTRIČNI PRITISAK:

$$\mu_{\min} = \frac{A_a}{A_b} \cdot 100 = 0.3 \cdot \left(1 + \frac{\sigma_b}{f_B} \right) (\%)$$

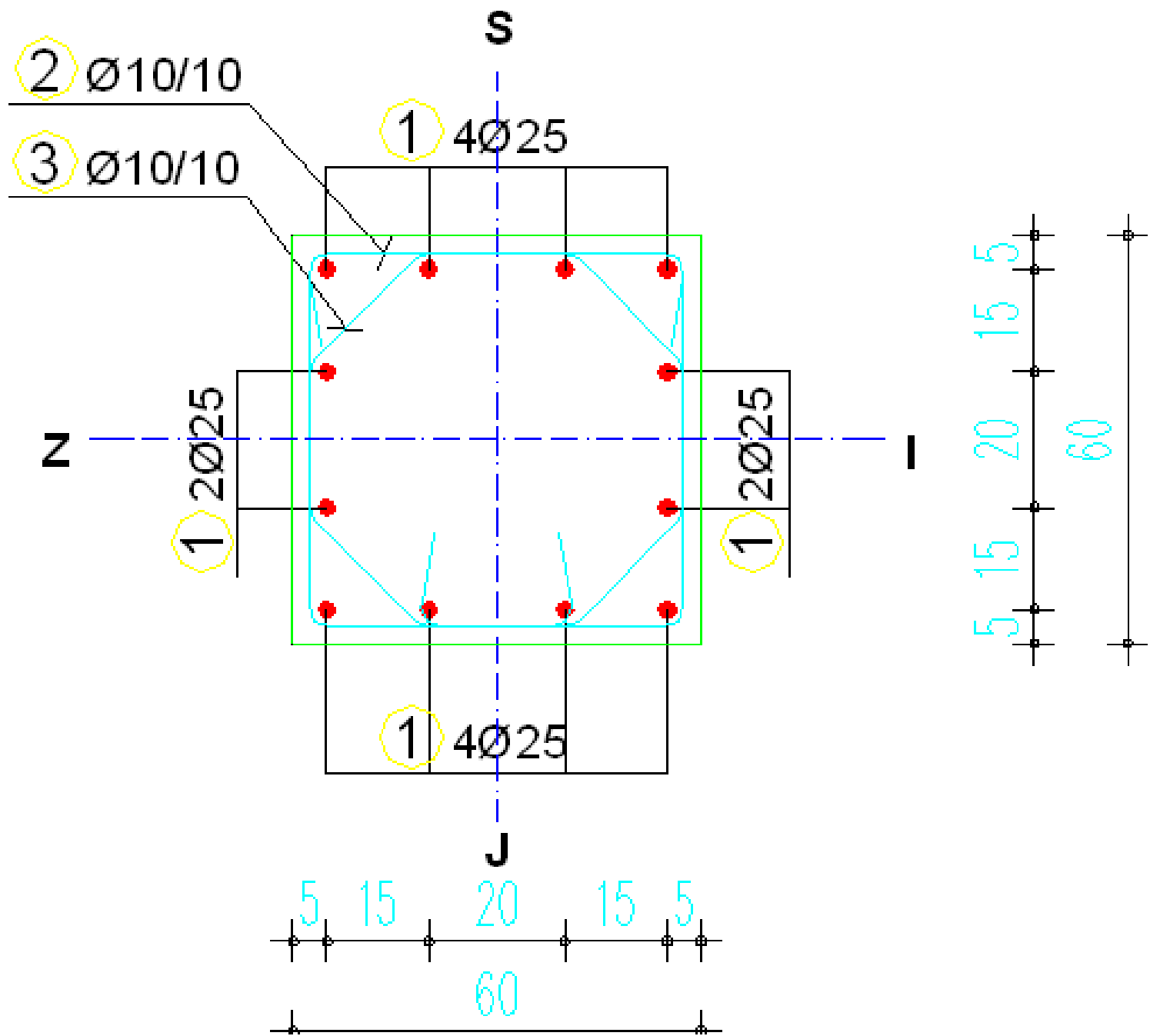
za $\sigma_b = f_b \rightarrow \mu_{\min} = 0.6 \% \quad \mu_{\max} = 6 \%$

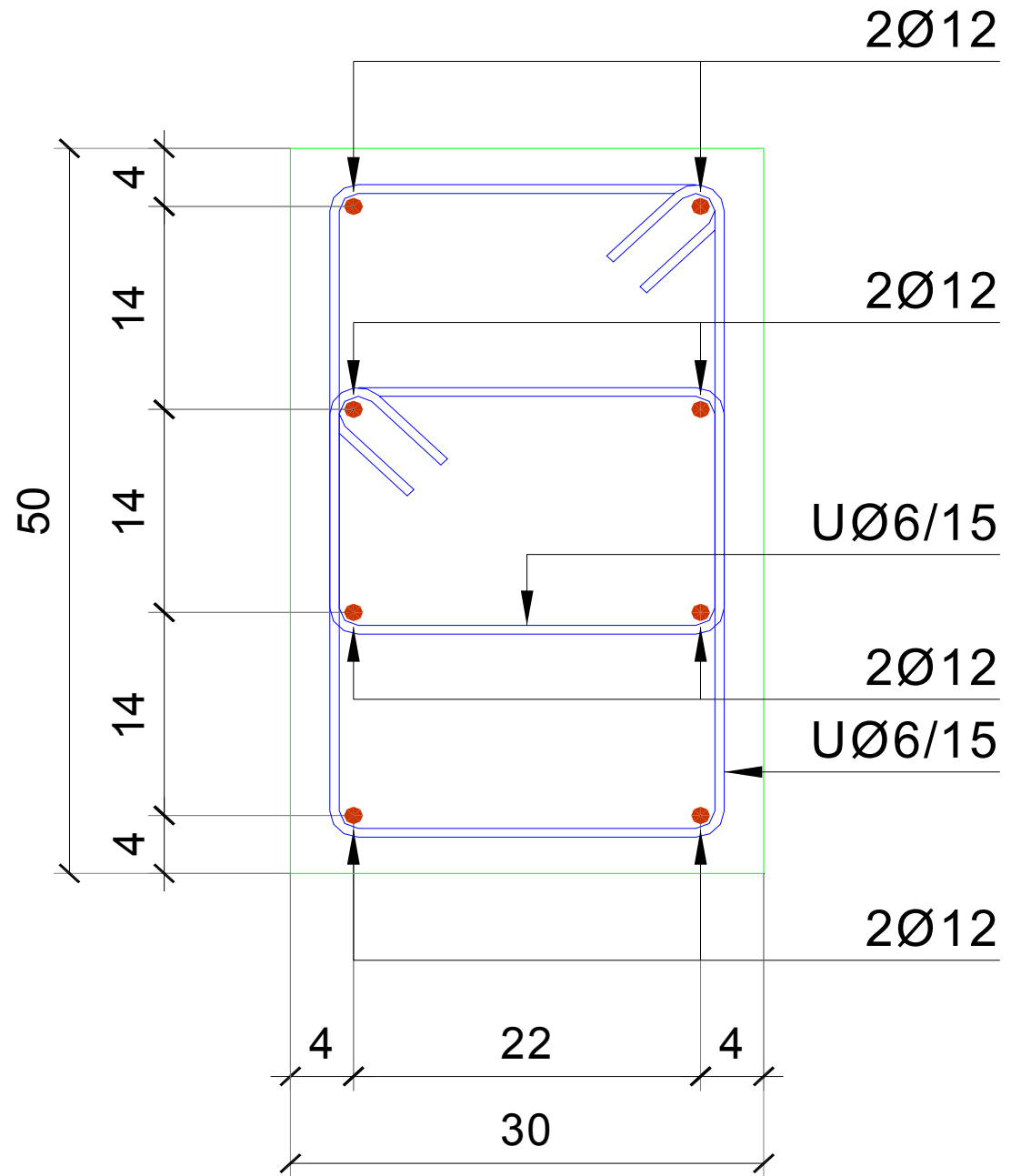
dodatni uslovi :

min 4Ø12 \rightarrow pravougaoni stub
min 6Ø12 \rightarrow kružni stub

Uzengije

$$e_{u,\max.} = \min. \left\{ \begin{array}{l} 15\emptyset \\ \min(b, d) \\ 30 \text{ cm} \end{array} \right\}$$





PRIMER I

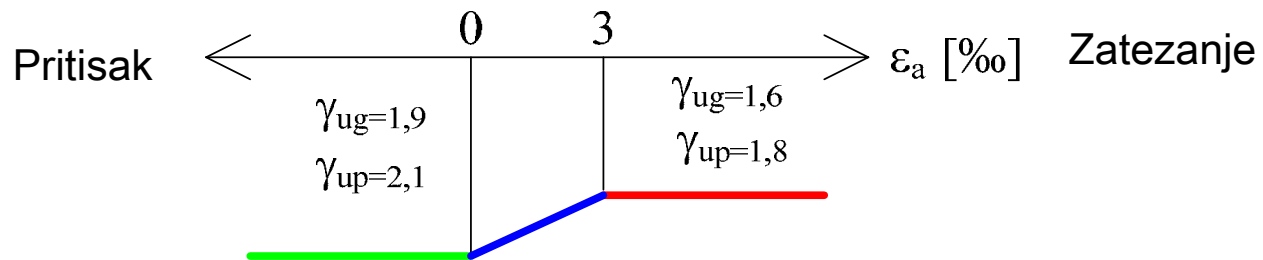
Dimenzionisati **centrično pritisnuti stub pravougaonog poprečnog preseka** (ne uvodeći u proračun izvijanje), zadate širine $b = 30 \text{ cm}$, opterećen silama N_g i N_p .

$$N_g = 630 \text{ kN} \quad N_p = 398 \text{ kN} \quad \text{MB 25} \quad \text{GA 240/360}$$

$$\begin{array}{ll} \text{MB 25} & \Rightarrow f_B = 17.25 \text{ MPa} = 1.725 \text{ kN/cm}^2 \\ \text{GA 240/360} & \Rightarrow \sigma_v = 240 \text{ MPa} = 24 \text{ kN/cm}^2 \end{array}$$

PRIMER I

- RAČUNSKI STATIČKI UTICAJI:



- $N_u = 1.9 \cdot N_g + 2.1 \cdot N_p = 1.9 \cdot 630 + 2.1 \cdot 398 = 2032.8 \text{ kN}$
- usv. $\mu = \mu_{\min} = 0.6\%$

$$\bar{\mu} = 0.6 \times \frac{240}{17.25} = 8.35\%$$

PRIMER I

- POTREBNA POVRŠINA BETONA:

$$N_u = f_B \cdot A_b \cdot (1 + \bar{\mu}) \longrightarrow$$

$$A_{b, \text{potr.}} = \frac{N_u}{f_B \times (1 + \bar{\mu})} = \frac{2032.8}{1.725 \times (1 + 8.35 \times 10^{-2})} = 1087.6 \text{ cm}^2$$

$$d_{\text{potr.}} = \frac{A_{b, \text{potr.}}}{b} = \frac{1087.6}{30} = 36.3 \text{ cm} \longrightarrow$$

usvaja se : **b/d = 30/40 cm**

PRIMER I

$$A_{a,\text{potr}} = 0.6 \cdot 10^{-2} \times 1087.6 = 6.53 \text{ cm}^2$$

Note: In the original image, the value 1087.6 is circled in green, and a green arrow points from it to the label $A_{b,\text{potr}}$ above.

⇒ usvojeno: ~~4Ø16~~ (8.04 cm²)

$$e_{u,\text{max.}} = \min. \left\{ \begin{array}{l} 15\emptyset = 15 \times 1.6 = 24 \text{ cm} \\ \min(b, d) = 30 \text{ cm} \\ 30 \text{ cm} \end{array} \right\} = 24 \text{ cm}$$

⇒ usvojeno: ~~UØ8/20~~

PRIMER 2

Dimenzionisati **centrično pritisnuti stub pravougaonog poprečnog preseka** (ne uvodeći u proračun izvijanje), zadatih dimenzija **$b/d = 30/50$ cm**, opterećen silama N_g i N_p

$$N_g = 500 \text{ kN} \quad N_p = 700 \text{ kN} \quad \text{MB } 30 \quad \text{RA } 400/500$$

$$\begin{array}{ll} \text{MB } 30 & \Rightarrow f_B = 20.5 \text{ MPa} = 2.05 \text{ kN/cm}^2 \\ \text{RA } 400/500 & \Rightarrow \sigma_v = 400 \text{ MPa} = 40 \text{ kN/cm}^2 \end{array}$$

PRIMER 2

- RAČUNSKI STATIČKI UTICAJI:
- $N_u = 1.9 \cdot N_g + 2.1 \cdot N_p = 1.9 \cdot 450 + 2.1 \cdot 600 = 2420 \text{ kN}$
 $A_b \cdot f_B = 30 \cdot 50 \cdot 2.05 = 3075 > N_u$
Nije potrebna računaska armatura
- usv. $\mu = \mu_{\min} = 0.6\%$ tj. $A_a = 3075 \cdot 0.006 = 18,45 \text{ cm}^2$

PRIMER 2a

(Razlika u odnosu na predhodni primer su dimenzije stuba)

Dimenzionisati **centrično pritisnuti stub pravougaonog poprečnog preseka** (ne uvodeći u proračun izvijanje),

zadatih dimenzija **$b/d = 30/30$ cm**, opterećen silama N_g i N_p

$$N_g = 500 \text{ kN} \quad N_p = 700 \text{ kN} \quad \text{MB } 30 \quad \text{RA } 400/500$$

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PRIMER 2a


- RAČUNSKI STATIČKI UTICAJI:
- $N_u = 1.9 \cdot N_g + 2.1 \cdot N_p = 1.9 \cdot 450 + 2.1 \cdot 600 = 2420 \text{ kN}$
 $A_b \cdot f_B = 30 \cdot 30 \cdot 2.05 = 1845 < N_u$
Potrebna je računaska armatura !!!

$$N_u = f_B \cdot A_b \cdot (1 + \bar{\mu}) \quad \longrightarrow \quad \bar{\mu} = \frac{N_u}{A_b \times f_B} - 1 = \frac{2420}{900 \times 2.05} - 1 = 0.312$$

$$\bar{\mu} = \mu \times \frac{\sigma_v}{f_B} \rightarrow \mu = \bar{\mu} \cdot \frac{f_B}{\sigma_v} \quad \mu = 0.312 \times \frac{2.05}{40} = 0.016$$

$$\mu = \frac{A_a}{A_b} \rightarrow A_a = \mu \cdot A_b \quad A_a = 0.016 \times 900 = 14.4 \text{ cm}^2$$

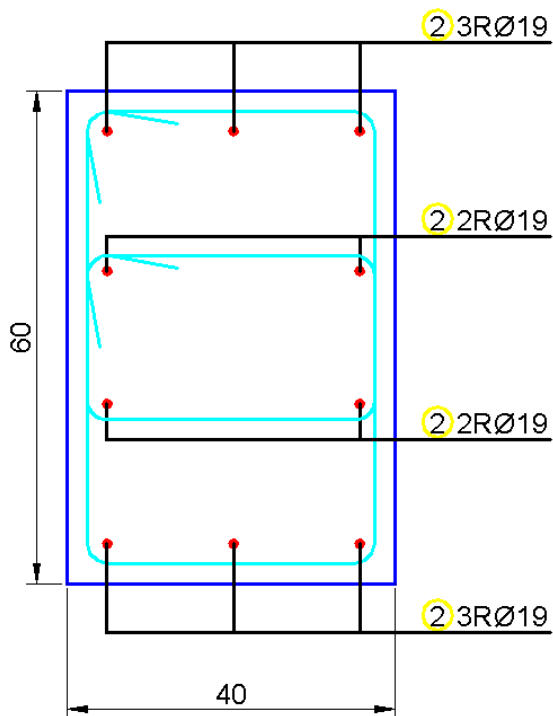
usvojeno: **8RØ16 (16.08cm²)**


$$e_{u,\max.} = \min. \left\{ \begin{array}{l} 15\emptyset = 15 \times 2.2 = 33 \text{ cm} \\ \min(b, d) = 30 \text{ cm} \\ 30 \text{ cm} \end{array} \right\} = 30 \text{ cm}$$

PRIMER 3

Odrediti koliku silu od povremenog opterećenja može da prihvati stub napravljen od betona MB 30 armiran kao na slici. Sila od stalnog opterećenja je $N_g = 1000 \text{ kN}$

$$\begin{aligned} \text{MB 30} &\Rightarrow f_B = 20.5 \text{ MPa} = 2.05 \text{ kN/cm}^2 \\ \text{RA 400/500} &\Rightarrow \sigma_v = 400 \text{ MPa} = 40 \text{ kN/cm}^2 \end{aligned}$$



PRIMER 3

- $N_u = A_b \cdot f_B + A_a \cdot \sigma_v$

$$N_u = (40 \cdot 60 \cdot 2.05) + (10 \cdot 2.84 \cdot 40) = 4920 + 1136 = 6056 \text{ kN}$$

- $N_u = 1.9 \cdot N_g + 2.1 \cdot N_p$

$$N_p = \frac{N_u - 1.9 \cdot N_g}{2.1} = \frac{6056 - 1.9 \cdot 1000}{2.1} = 1979.1 \text{ kN}$$

CENTRIČNO ZATEZANJE

- LUK SA ZATEGOM
- ZATENUT POJAS REŠETKI
- UKUPNU SILU ZATEZANJA PRIHVATA ARMATURA !

$$A_a = \frac{Z_u}{\sigma_v}$$

PRIMER 4

Odrediti potrebnu površinu armature i oblikovati pravougaoni poprečni presek centrično zategnutog elementa

$$Z_g = 305 \text{ kN} \quad Z_p = 337 \text{ kN} \quad \text{MB 30} \quad \text{GA 240/360}$$

$$\text{GA 240/360} \quad \Rightarrow \quad \sigma_v = 24 \text{ MPa} = 24 \text{ kN/cm}^2$$

PRIMER 4

RAČUNSKI STATIČKI UTICAJI:

$$Z_u = 1.6 \cdot Z_g + 1.8 \cdot Z_p = 1.6 \cdot 305 + 1.8 \cdot 337 = 1094.6 \text{ kN}$$

$$A_a = \frac{Z_u}{\sigma_v} = \frac{1094.6}{24.0} = 45.6 \text{ cm}^2$$

usvojeno: **15Ø20 (47.12 cm²)**

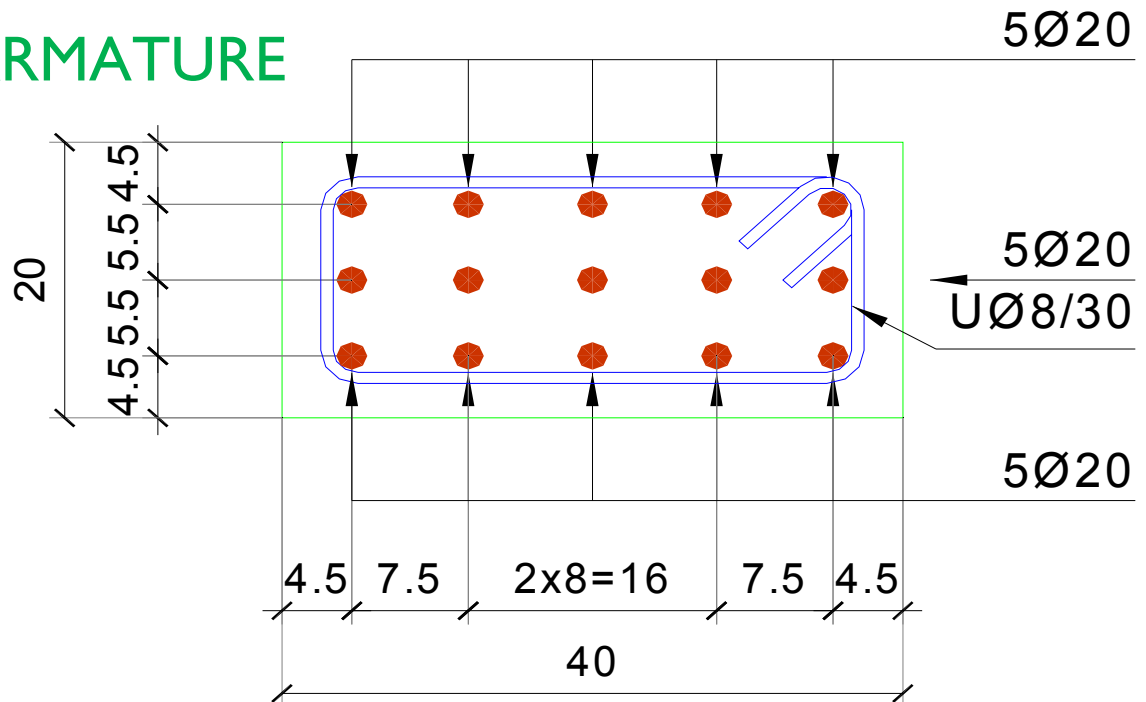
CENTRIČNO ZATEZANJE

- OBLIKOVANJE PRESEKA** $b = 2a_0 + 2\phi_u + n \cdot \phi + (n - 1) \cdot 5$
 $b \geq 2 \times 2.5 + 2 \times 0.8 + 5 \times 2.0 + (5 - 1) \times 5.0 = 36.6 \text{ cm}$ **$b = 40$**
cm

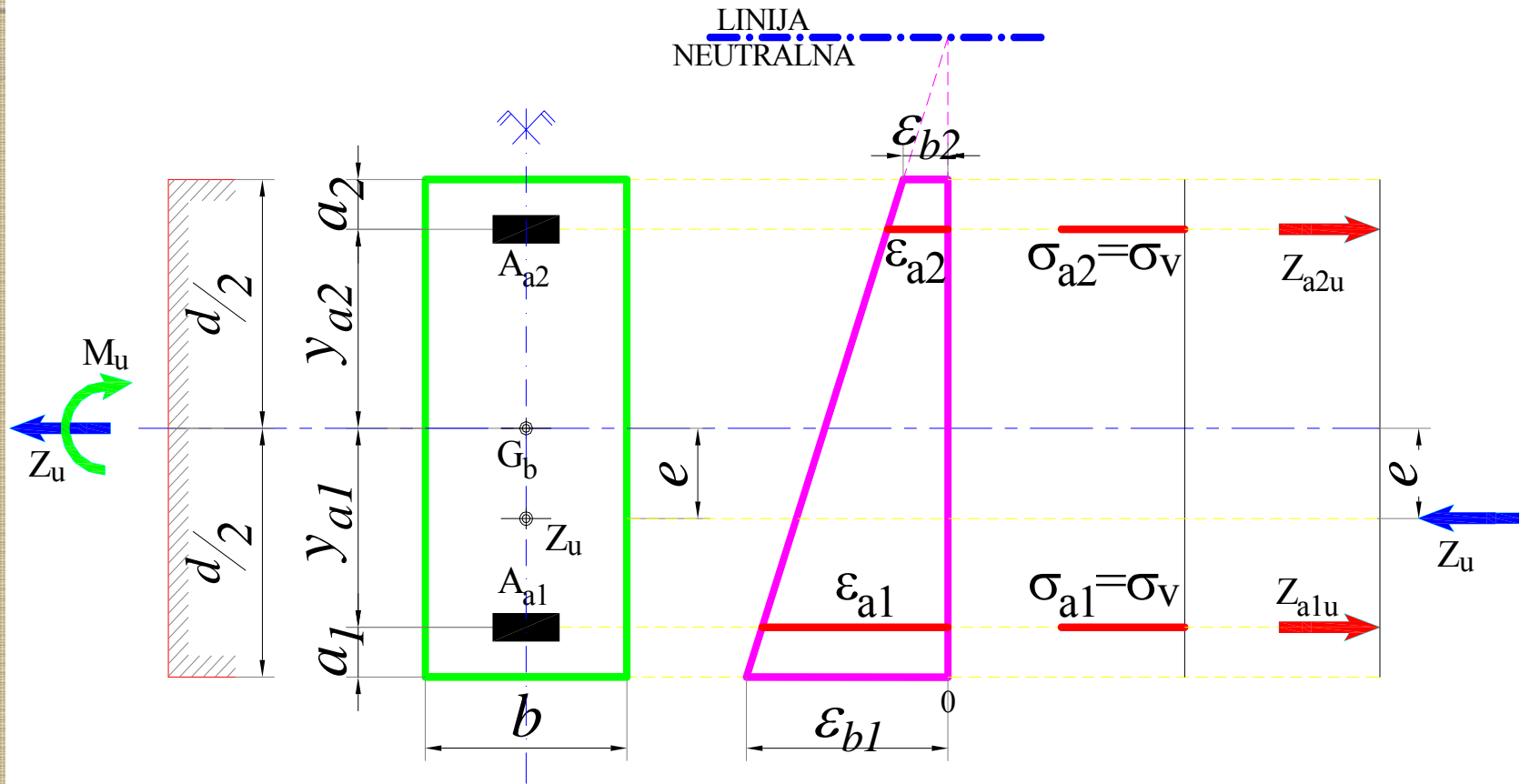
$$d \geq 2 \times 2.5 + 2 \times 0.8 + 3 \times 2.0 + (3 - 1) \times 3.0 = 18.6 \text{ cm} \quad \mathbf{d = 20}$$

cm

- RASPORED ARMATURE**



MALI EKSCENTRICITET SILA ZATEZANJA



MALI EKSCENTRICITET SILA ZATEZANJA

$$e < d/2 - a_1$$

$$e = M_u / Z_u$$

$$M_u = \gamma_{ug} \cdot M_g + \gamma_{up} \cdot M_p$$

$$Z_u = \gamma_{ug} \cdot Z_g + \gamma_{up} \cdot Z_p$$

$$\Sigma M(A_{a1}) = 0$$

$$A_{a1} = \frac{Z_u}{\sigma_v} \cdot \frac{y_{a2} + e}{y_{a1} + y_{a2}}$$

$$A_{a2} = \frac{Z_u}{\sigma_v} \cdot \frac{y_{a1} - e}{y_{a1} + y_{a2}}$$

$$\Sigma N_u = 0$$

$$Z_{au1} + Z_{au2} = Z_u \quad A_{a1} + A_{a2} = A_a = \frac{Z_u}{\sigma_v}$$

PRIMER 5

Odrediti potrebnu površinu armature za pravougaoni poprečni presek $b/d=30 \times 25$ opeterćen silom zatezanja i momentom savijanja

$$Z_g = 305 \text{ kN} \quad Z_p = 337 \text{ kN} \quad \text{MB 30} \quad \text{GA 240/360}$$

$$M_g = 6.6 \text{ kNm}$$

$$\text{GA 240/360} \quad \Rightarrow \quad \sigma_v = 240 \text{ MPa} = 24 \text{ kN/cm}^2$$

PRIMER 5

RAČUNSKI STATIČKI UTICAJI:

$$Z_u = 1.6 \cdot Z_g + 1.8 \cdot Z_p = 1.6 \cdot 305 + 1.8 \cdot 337 = 1094.6 \text{ kN}$$

$$M_u = 1.6 \cdot M_g = 1.6 \cdot 6.6 = 10.56 \text{ kNm}$$

$$e = \frac{M_u}{Z_u} = \frac{10.56 \times 10^2}{1094.6} = 0.96 \text{ cm}$$

pretp. $a_1 = a_2 = 4.5 \text{ cm}$

$$y_{a1} = y_{a2} = \frac{d}{2} - a_1 = \frac{25}{2} - 4.5 = 8 \text{ cm}$$

PRIMER 5

$$A_{a1} = \frac{Z_u}{\sigma_v} \times \frac{y_{a2} + e}{y_{a1} + y_{a2}} = \frac{1094.6}{24.0} \times \frac{8.0 + 0.96}{8.0 + 8.0} = 25.55 \text{cm}^2$$

$$A_{a2} = \frac{Z_u}{\sigma_v} \times \frac{y_{a1} - e}{y_{a1} + y_{a2}} = \frac{1094.6}{24.0} \times \frac{8.0 - 0.96}{8.0 + 8.0} = 20.05 \text{cm}^2$$

usvojeno: **5Ø25 (A_{a1})**
4Ø25 (A_{a2})