Univerzitet u Beogradu – Građevinski fakultet
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Studijski program: **Građevinarstvo**
Modul: Konstrukcije
Godina/Semestar: **III godina / V semestar**

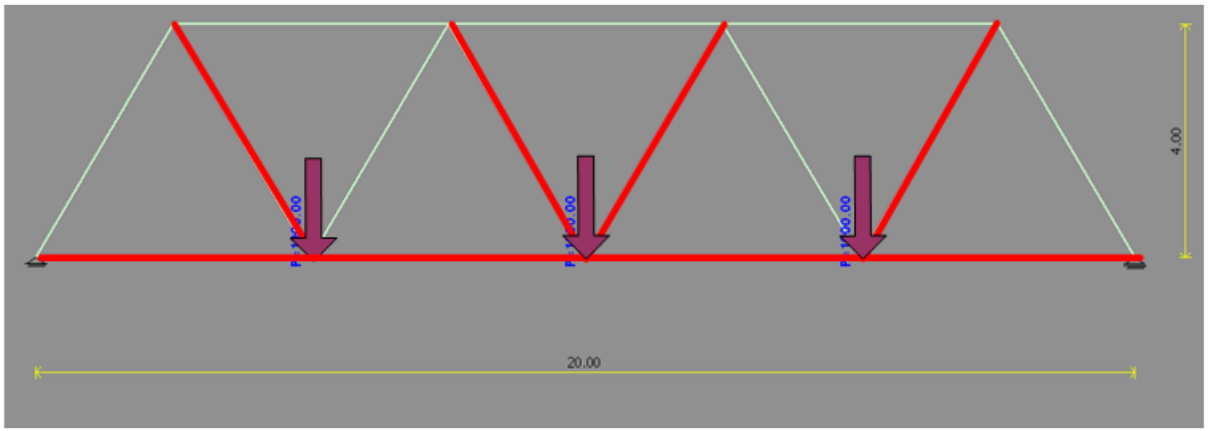
Naziv predmeta (šifra): **Teorija betonskih konstrukcija 1 (b2κ3b1)**

Nastavnik: **Ivan Ignjatović**

Naslov vežbi: **Centrična naprezanje.**
Mali ekscentricitet- sila zatezanja

Datum : 03.11.2022.

Centrično zatezanje



Zadatak 17 – **CENTRIČNO ZATEZANJE**

Odrediti potrebnu površinu armature i oblikovati poprečni presek, pravougaonog oblika, centrično zategnutog elementa.
Podaci za proračun:

$N_{G,k}$ = -400 kN	C25/30	XD1
$N_{Q,k}$ = -500 kN	B500 B	

Treba ?

C25/30 ⇒ $f_{cd} = 0.85 \cdot 25/1.5 = 14.2 MPa = 1.42\ kN/cm^2$

B500 B ⇒ $f_{yd} = 500/1.15 = 435\ MPa = 43.5\ kN/cm^2$

Zadatak 17 – CENTRIČNO ZATEZANJE

Granična sila ZATEZANJA:

N_{Ed} = 1.35·(-400) + 1.5·(-500) = -1290kN

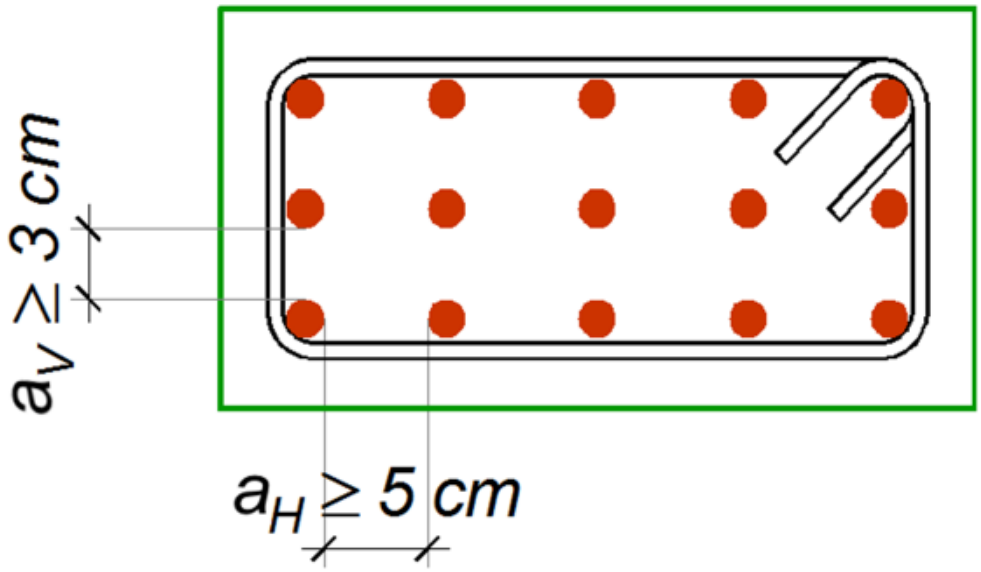
Proračun površine armature:

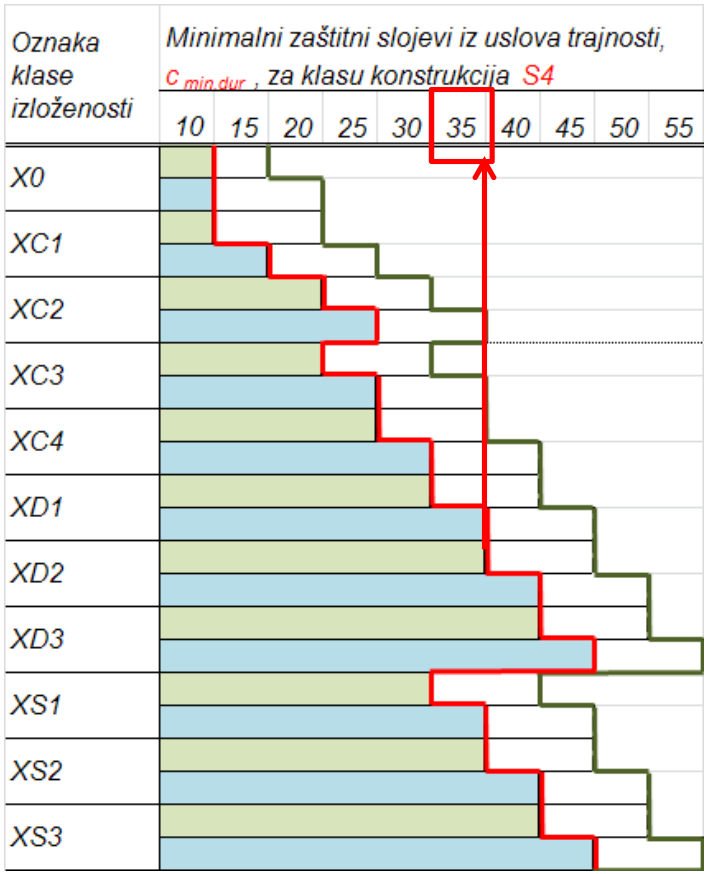
$$A_{s1} = \frac{N_{Ed}}{f_{yd}} = \frac{1290}{43.5} = 29.7 cm^2$$

Usvojeno: 15 Ø16 (30.15 cm^2)

Zadatak 17 – CENTRIČNO ZATEZANJE

$$b \geq 2c_{nom} + 2\varnothing_s + m\times\varnothing + (m-1)\times a_H$$
$$h \geq 2c_{nom} + 2\varnothing_s + n\times\varnothing + (n-1)\times a_V$$



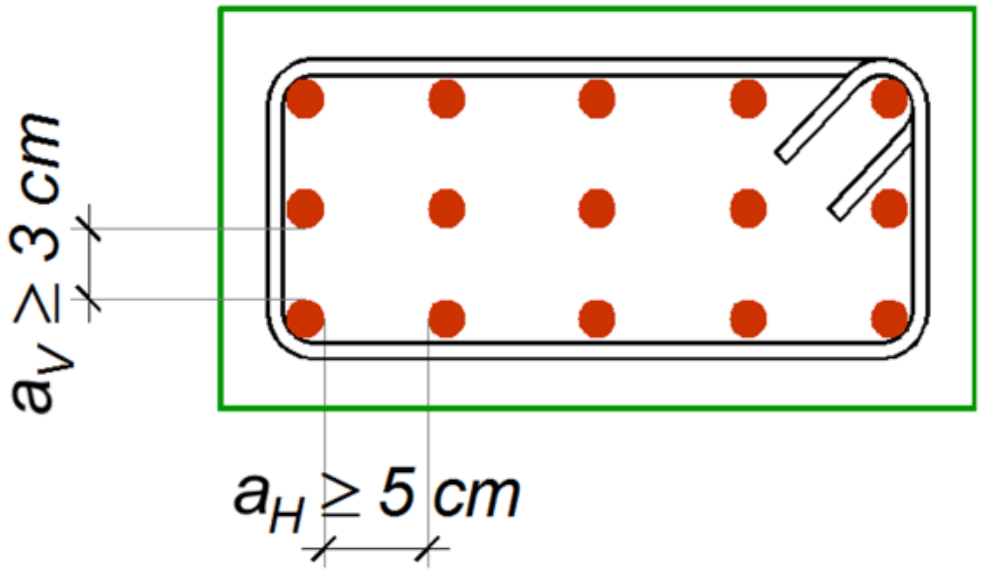


XD1 => c_{nom} = 35 +10 = 45 mm

Pretp. => $\varnothing_s$ = 8 mm

Zadatak 17 – CENTRIČNO ZATEZANJE

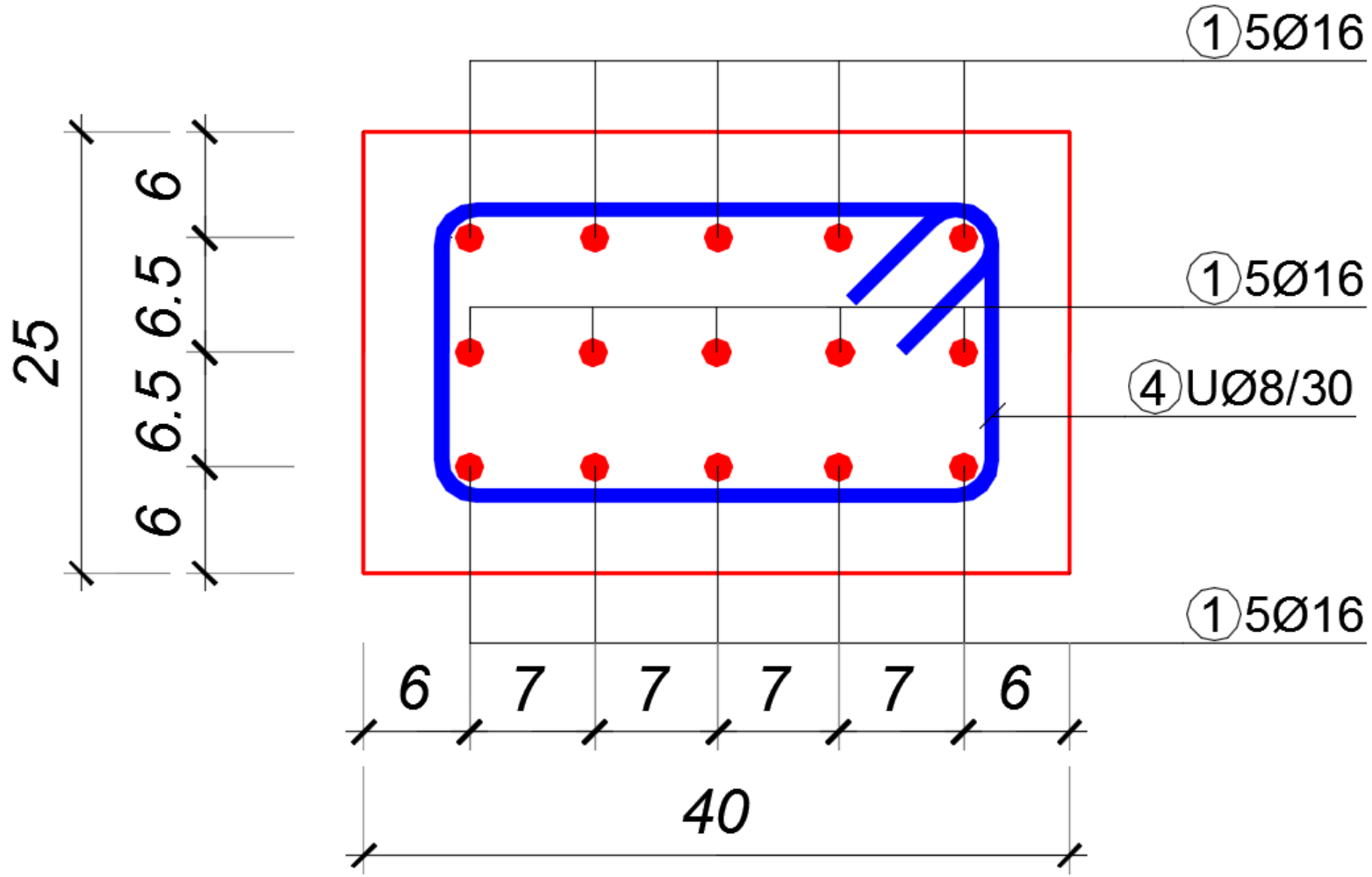
$$b \geq 2c_{nom} + 2\varnothing_s + m\times\varnothing + (m-1)\times a_H$$
$$h \geq 2c_{nom} + 2\varnothing_s + n\times\varnothing + (n-1)\times a_V$$



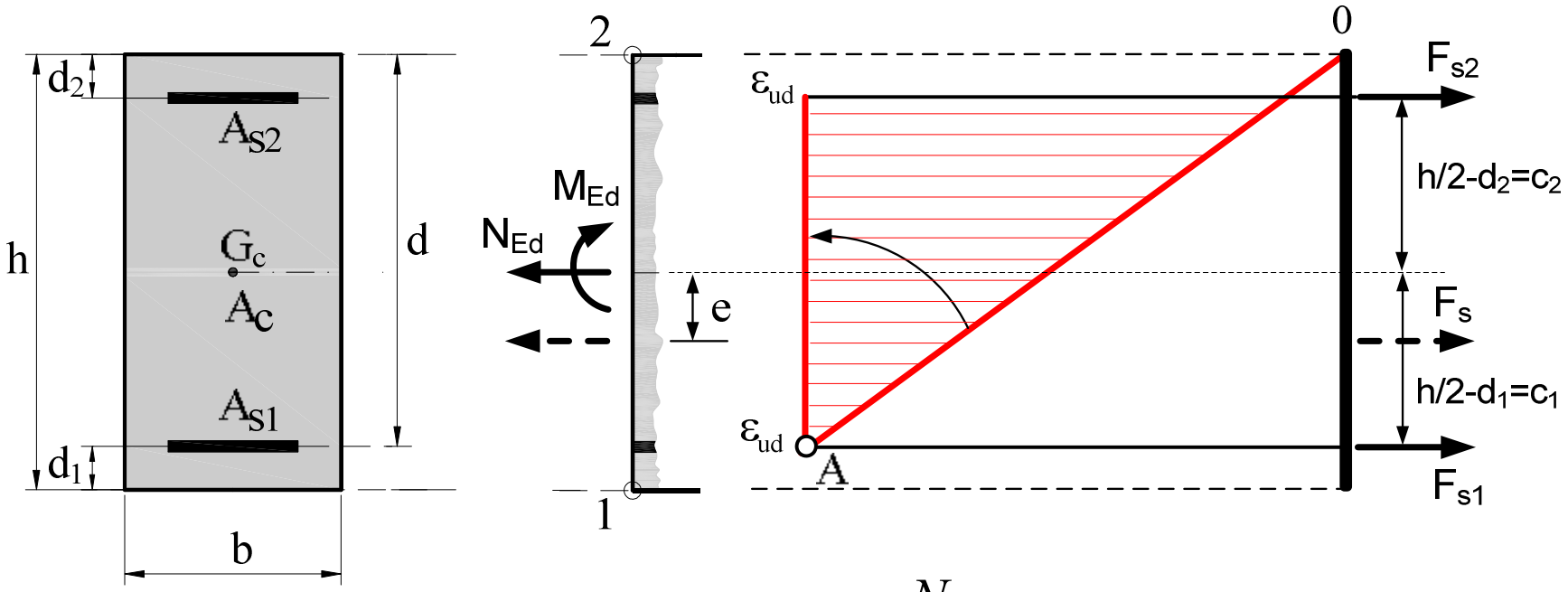
$b \geq 2\times4.5 + 2\times0.8 + 5\times1.6 + (5-1)\times5.0 = 38.6\ cm \Rightarrow b = 40\ cm$

$d \geq 2\times4.5 + 2\times0.8 + 3\times1.6 + (3-1)\times3.0 = 21.4\ cm \Rightarrow d = 25\ cm$

Zadatak 17 – CENTRIČNO ZATEZANJE



ULS – MALI EKSCENTRICITET, SILA ZATEZANJA



$$A_s = A_{s1} + A_{s2} = \frac{N_{Ed}}{f_{yd}}$$

$$A_{s1} = \frac{N_{Ed}}{f_{yd}} \frac{c_2 + e}{c_1 + c_2}$$

$$A_{s2} = \frac{N_{Ed}}{f_{yd}} \frac{c_1 - e}{c_1 + c_2}$$

Zadatak 18 – **EKSCENTRIČNO ZATEZANJE**

Dimenzionisati pravougaoni poprečni presek zadatih dimenzija, opterećen silom zatezanja i momentom savijanja u fazi malog ekscentriciteta.

Podaci za proračun:

$N_{G,k}$ = -400 kN $M_{G,k}$ = 10 kNm b = 40 cm

$N_{Q,k}$ = -500 kN h = 25 cm

B500 B f_{yd} = 500/1.15 = 435 MPa = 43.5 kN/cm^2

Zadatak 18 – EKSCENTRIČNO ZATEZANJE

N_{Ed} = 1.35·(-400) + 1.5·(-500) = -1290kN

M_{Ed} = 1.35·10 = 13.5 kNm

$$e = \frac{M_{Ed}}{N_{Ed}} = \frac{13.5 \times 10^2}{1290} = 1.05\,cm$$

pretp. $d_1 = d_2 = 6$ cm

$c_1 = c_2 = h/2 - d_1 = 25/2 - 6 = 6.5$ cm

$$A_s = A_{s1} + A_{s2} = \frac{N_{Ed}}{f_{yd}} = \frac{1290}{43.5} = 29.7\,cm^2$$

Zadatak 18 – EKSCENTRIČNO ZATEZANJE

$$A_{s1} = \frac{N_{Ed}}{f_{yd}} \frac{c_2 + e}{c_1 + c_2} = 29.7 \cdot \frac{6.5 + 1.05}{6.5 + 6.5} = 17.2 cm^2$$

≈ 9Ø16

d_1 = 8 cm

c_1 = 25/2 – 8 = 4.5 cm

$$A_{s2} = \frac{N_{Ed}}{f_{yd}} \frac{c_1 - e}{c_1 + c_2} = 29.7 \cdot \frac{6.5 - 1.05}{6.5 + 6.5} = 12.5 cm^2$$

≈ 6Ø16

d_2 = 6 cm

c_2 = 25/2 – 6 = 6.5 cm

Zadatak 18 – EKSCENTRIČNO ZATEZANJE

$$A_{s1} = \frac{N_{Ed}}{f_{yd}} \frac{c_2 + e}{c_1 + c_2} = 29.7 \cdot \frac{6.5 + 1.05}{4.5 + 6.5} = 20.4 cm^2$$

≈ 10Ø16

d_1 = 8.25 cm

c_1 = 25/2 – 8.25 = 4.25 cm

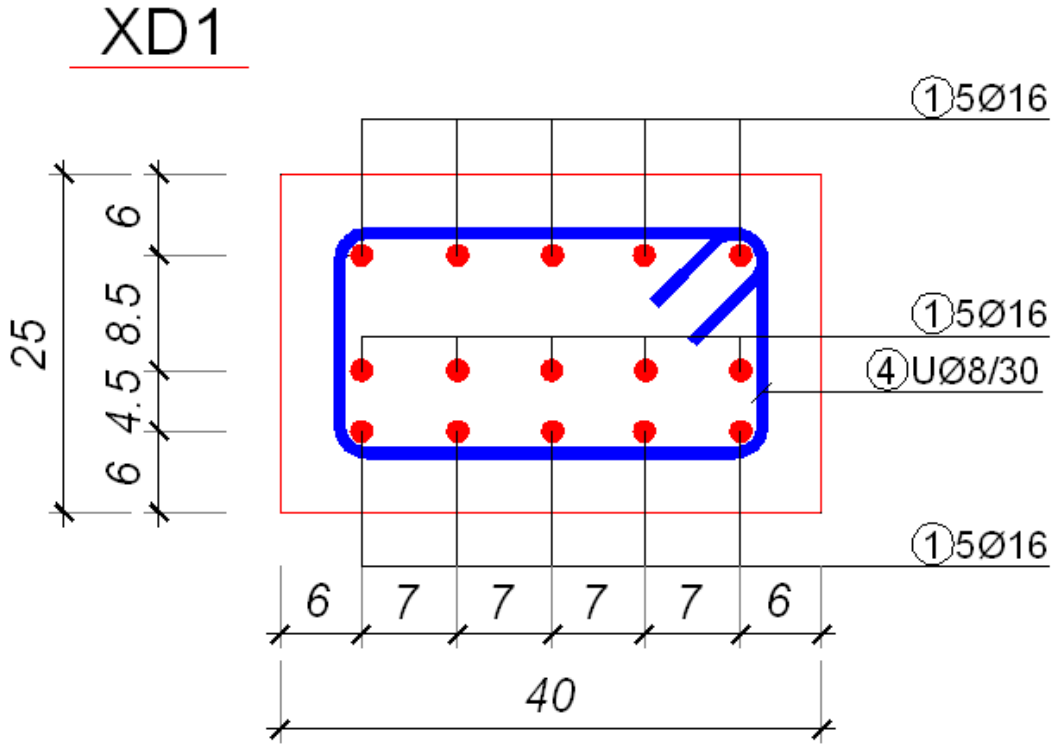
$$A_{s2} = \frac{N_{Ed}}{f_{yd}} \frac{c_1 - e}{c_1 + c_2} = 29.7 \cdot \frac{4.5 - 1.05}{4.5 + 6.5} = 9.3 cm^2$$

≈ 5Ø16

d_2 = 6 cm

c_2 = 25/2 – 6 = 6.5 cm

Zadatak 18 – EKSCENTRIČNO ZATEZANJE



$d^{I} = c_{nom} + Ø_s + Ø/2$

$a^{I} = 4.5 + 0.8 + 1.6/2 = 6.1$ cm

usv. $d^{I} = 6$ cm

$d^{II} = d^{I} + a_V + 2\times Ø/2$

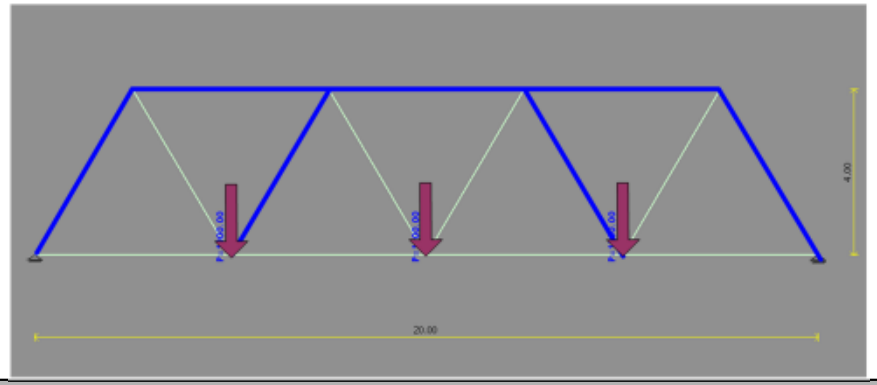
$d^{II} = 6 + 3.0 + 2\times 1.6/2 = 10.6$ cm

usv. $d^{II} = 10.5$ cm

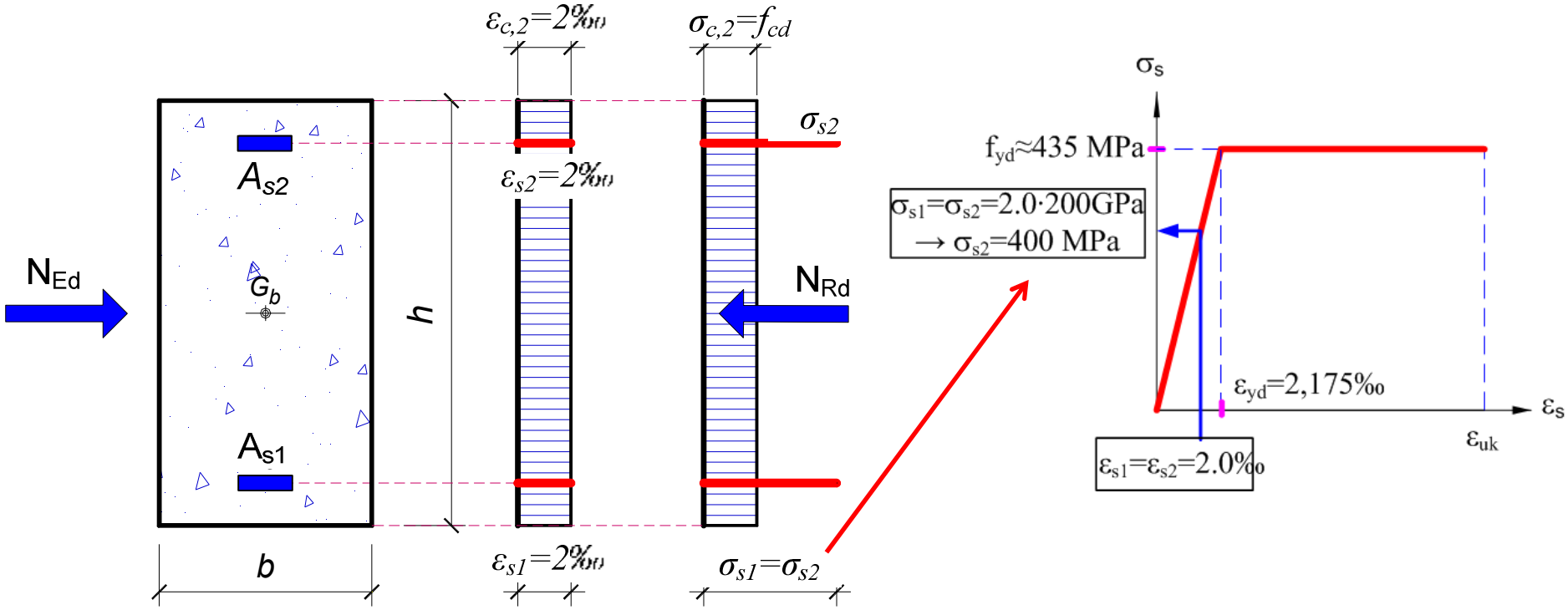
$a_1 = (5\times 6 + 5\times 10.5)/10$

$d_1 = 8.25$ cm

Centrični pritisak



Centrični pritisak



$$\Sigma N = 0: \qquad N_{Rd} = N_{Ed} = A_c \cdot f_{cd} + A_s \cdot \sigma_s$$

Zadatak 19 – **CENTRIČNI PRITISAK**

Odrediti potrebnu površinu armature i dimenzije poprečnog preseka, pravougaonog oblika, centrično pritisnutog elementa.
Podaci za proračun:

$N_{G,k}$ = 600 kN C25/30 XC3

$N_{Q,k}$ = 800 kN B500 B b = 35 cm

C25/30 ➡ $f_{cd} = 0.85 \cdot 25/1.5 = 14.2 MPa = 1.42\ kN/cm^2$

B500 B ➡ $f_{yd} = 500/1.15 = 435\ MPa = 43.5\ kN/cm^2$

Zadatak 19 – CENTRIČNI PRITISAK

Granična sila PRITISKA:

N_{Ed} = 1.35·600 + 1.5·800 = 2010 kN

Uslov ravnoteže normalnih sila:

$$N_{Rd} = N_{Ed} = A_c \cdot f_{cd} + A_s \cdot \sigma_s$$

ω

$$N_{Ed} = A_c \cdot f_{cd} \cdot \left(1 + \frac{A_s}{A_c} \cdot \frac{\sigma_s}{f_{cd}}\right) = A_c \cdot f_{cd} \cdot \left(1 + \frac{A_s}{A_c} \cdot \frac{\sigma_s}{f_{cd}} \cdot \frac{f_{yd}}{f_{yd}}\right) = A_c \cdot f_{cd} \cdot \left(1 + \omega \cdot \frac{\sigma_s}{f_{yd}}\right)$$

Minimalni geometrijski koeficijent armiranja:

$\rho_{l,min}$ = 0.3% => ω = 0.3·43.5/1.42 = 9.19%

$$A_{c,pot} = \frac{N_{Ed}}{f_{cd} \cdot \left(1 + \omega_1 \frac{\sigma_s}{f_{yd}}\right)} = \frac{2010}{1.42 \cdot \left(1 + 0.0919 \frac{40}{43.5}\right)} = 1305 cm^2$$

Zadatak 19 – CENTRIČNI PRITISAK

$h_{pot} = A_{c,pot}/b = 1305/35 = 37.3$ cm => **usv. h = 40 cm**

Sračunavanje potrebne površine armature:

$$A_s = \max\left\{\begin{array}{l} 0.15\cdot\dfrac{N_{Ed}}{f_{yd}} = 0.15\cdot\dfrac{2010}{43.5} = 6.93cm^2 \\ 0.003\cdot A_c = 0.003\cdot 40\cdot 35 = 4.2cm^2 \\ 4\text{Ø}12 = 4\cdot 1.13 = 4.48cm^2 \end{array}\right\} = 6.93cm^2$$

8 Ø12 (8.96 cm²)

Maksimalno rastojanje poprečne armature (**EC2**):

$$s_{cl,t\max} = \min\left\{\begin{array}{l} 20\text{Ø}_{\min} \\ \min(b,h) \\ 40cm \end{array}\right\} = \min\left\{\begin{array}{l} 20\cdot 1.2 = 24cm \\ \min(b,h) = 35cm \\ 40cm \end{array}\right\} = 24cm$$

Zadatak 19 – CENTRIČNI PRITISAK

Maksimalno rastojanje poprečne armature (**EN1992-1-1/NA**):

$$s_{cl,t\max} = \min\begin{Bmatrix} 12\varnothing_{\min} \\ \min(b,h) \\ 30cm \end{Bmatrix} = \min\begin{Bmatrix} 12\cdot 1.2 = 14.4cm \\ \min(b,h) = 35cm \\ 30cm \end{Bmatrix} = 14.4cm$$

Zadatak 19 – CENTRIČNI PRITISAK

Usvojena podužna armatura: 8 Ø12 (8.96 cm^2)

Usvojena poprečna armatura: Ø6/12.5