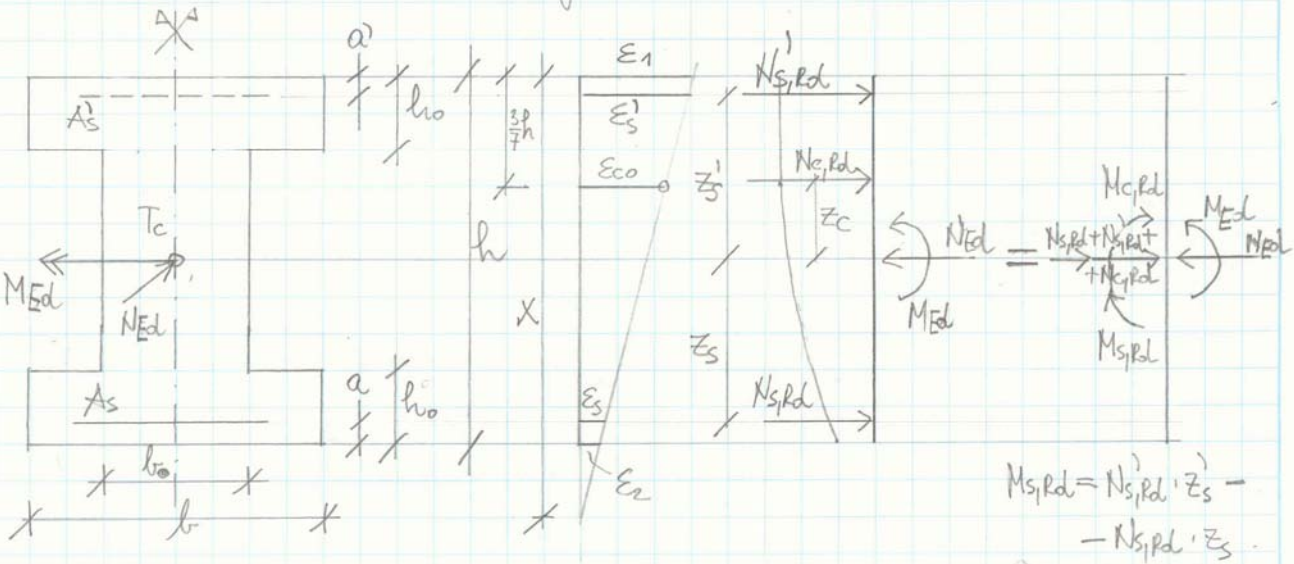
b) I prerez: znane so dimenzije prereza, pri izbranih (predpisanih) deformacijah določamo prerez armature



Podatki:

obremenitev kot pri točki a)

$N_{Ed} = 6825\ kN$ (tlak)

$M_{Ed} = 279\ kNm$

C 40/45 → $\alpha f_{cd} = 2{,}67\ kN/m^2$

RA 400/500 → $f_{yd} = 34{,}8\ kN/cm^2$
(S400)

$b = 60\ cm$
$b_0 = 30\ cm$
$h_0 = 18\ cm$
$h = 60\ cm$
$a = a' = 4{,}5\ cm$

Prerez je podan. Če predpišemo še deformacije nam za rešitev 2 enačb ostanete kot neznanki A_s in A'_s. (μ in ξ)

$z_s = z'_s = 0{,}255\ m$

$\rightarrow \delta = 4{,}5/60 = 0{,}075 \cong 0{,}07$; $b_0 = \frac{30}{60} = 0{,}50$; $h_0 = \frac{18}{60} = 0{,}3$

$A_c = 60 \cdot 60 - 30 \cdot 24 = 2880\ cm^2$

Najprej izračunamo normirano osno silo in upogibni moment težišča.

$$N_{Ed} = A_c \alpha f_{cd} \cdot \nu_d \rightarrow \nu_d = \frac{N_{Ed}}{A_c \alpha f_{cd}} = \frac{6825}{2880 \cdot 2{,}67} = 0{,}8876$$

$$M_{Ed} = A_c \alpha f_{cd} \cdot h \cdot \mu_d \rightarrow \mu_d = \frac{M_{Ed}}{A_c \alpha f_{cd} \cdot h} = \frac{279 \cdot 100}{2880 \cdot 2{,}67 \cdot 60} = 0{,}0605$$

$$\mu_d = \underbrace{\mu_{cd}}_{\text{beton}} + \underbrace{\mu_{sd} \frac{f_{yd}}{\alpha f_{cd}}}_{\text{armature}} \quad ; \quad \mu_d = \underbrace{\mu_{cd}}_{\text{beton}} + \underbrace{\mu_{sd} \cdot \frac{f_{yd}}{\alpha f_{cd}}}_{\text{armature}} \quad (*)$$

Izbira deformacij: Izbrali bomo tožilne deformacije, da bo ν_{cd} in μ_{cd} manjše od ν_d in μ_d $\left(\begin{matrix}\nu_{cd} \leq \nu_d \\ \mu_{cd} \leq \mu_d\end{matrix}\right)$
sicer A_s in A_s' < 0 (negativno) →
→ nesprejemljiva rešitev! ($\nu_{sd} < 0$ in/ali $\mu_{sd} < 0$)

Izberem $-\varepsilon_1 / -\varepsilon_2 = 3{,}20 / 0{,}40$ ‰

$\left.\begin{matrix}\nu_{cd} = 0{,}8558 \\ \mu_{cd} = 0{,}0533\end{matrix}\right\}$ Tab. 9 str. 218

delež, ki ga moramo preseči z armaturo iz enačbe (*)

$$\nu_{sd} = (\nu_d - \nu_{cd}) \frac{\alpha f_{cd}}{f_{yd}} = (0{,}8876 - 0{,}8558) \cdot \frac{2{,}67}{34{,}8} = \underline{0{,}0024}$$

$$\mu_{sd} = (\mu_d - \mu_{cd}) \cdot \frac{\alpha f_{cd}}{f_{yd}} = (0{,}0605 - 0{,}0533) \frac{2{,}67}{34{,}8} = \underline{0{,}0006}$$

→ v tab. 10b str. 224 poiščem ν_{sd} in μ_{sd} -ju pripadajoči μ' in k pri $\underline{-\varepsilon_1 / -\varepsilon_2 = 3{,}20 / 0{,}40}$ ‰

→ ne najdemo para k in μ', ki bi točno odgovarjal paru ν_{sd} in μ_{sd}. Iz preglede rešitev po stolpcu ugotovimo, da bi moral biti $\mu' < 0{,}3$ ‰, kar pa ni v tabeli!
Sicer če najdemo par k in μ'

$A_s' = \mu' \cdot A_c$ – _____ cm^2 (μ' je v %)

$A_s = \frac{A_s'}{k}$ = _____ cm^2

Armaturo določimo analitično (glej sliko):

Ravnotežni pogoj

1) $\Sigma N = 0$ $\quad N_{sd} = N_{c,Rd} + N_{s,Rd}' + N_{s,Rd}$

2) $\Sigma M = 0$ $\quad M_{sd} = M_{c,Rd} + N_{s,Rd}' \cdot z_s' - N_{s,Rd} \cdot z_s$ $\Big)$ (*)

$$\left.\begin{aligned} N_{Ed} &= A_c \alpha f_{cd} \cdot \mu_d \\ M_{Ed} &= A_c \cdot h \cdot \alpha f_{cd} \cdot \mu_d \end{aligned}\right\} \rightarrow$$

$N_{c,Rd} = A_c \cdot \alpha f_{cd} \cdot \mu_{cd}$

$= 2880 \cdot 2{,}67 \cdot 0{,}8558 = \underline{6580{,}8\ kN}$

$M_{c,Rd} = A_c \cdot \alpha f_{cd} \cdot h \cdot \mu_{cd}$

$= 2880 \cdot 2{,}67\ 60 \cdot 0{,}0533/_{100} = \underline{245{,}9\ kNm}$

(*) $N_{s,Rd}' + N_{s,Rd} = N_{sd} - N_{c,Rd}$

$N_{s,Rd}' \cdot z_s' + N_{s,Rd} \cdot z_s = M_{sd} - M_{c,Rd}$

$$\begin{bmatrix} 1 & 1 \\ z_s' & z_s \end{bmatrix} \begin{Bmatrix} N_{s,Rd}' \\ N_{s,Rd} \end{Bmatrix} = \begin{Bmatrix} N_{sd} - N_{c,Rd} \\ M_{sd} - M_{c,Rd} \end{Bmatrix} \rightarrow \begin{matrix} N_{s,Rd}' = \\ N_{s,Rd} = \end{matrix}$$

$$N_{s,Rd}' = \frac{M_{sd} - M_{c,Rd} + (N_{sd} - N_{c,Rd}) \cdot z_s}{(z_s + z_s')} = \frac{279 - 245{,}9 + (6825 - 6580{,}8) 0{,}255}{2 \cdot 0{,}255} =$$

$= \underline{184{,}6\ kN}$

1. R. Pogoj $\rightarrow$ $N_{s,Rd} = N_{sd} - N_{c,Rd} - N_{s,Rd}' = 6825 - 6580{,}8 - 184{,}6 = \underline{59{,}6\ kN}$

Sili poznamo $\rightarrow A_s, A_s'$

$|\varepsilon_s'| > \varepsilon_{yd} = 1{,}74‰ \rightarrow \sigma_s' = f_{yd} = 34{,}8\ kN/cm^2$

$A_s' = \frac{N_{s,Rd}'}{\sigma_s'} = \frac{184{,}6}{34{,}8} = \underline{5{,}3\ cm^2}$

$\varepsilon_s = \frac{kx - 1 + \delta}{kx - 3/7} \cdot \varepsilon_{c0} = \frac{1{,}143 - 1 + 0{,}075}{1{,}143 - 3/7} \cdot (-2) = -0{,}61‰$

$\frac{-3{,}20}{3{,}20 - (-0{,}40)} = 1{,}143$

$\varepsilon_1 / \varepsilon_2$

odčitamo na strani 135 ali 91

FGG

$$|\sigma_s| = |\varepsilon_s| \cdot E_s = 0{,}61 \cdot 10^{-3} \cdot 20 \cdot 10^3 = 12{,}2\ kN/cm^2$$

$$A_s = \frac{N_{s,Rd}}{\sigma_s} = \frac{59{,}6\ kN}{12{,}2\ kN/cm^2} = \underline{\underline{4{,}9\ cm^2}}$$

Pogledamo: $k_1 = \frac{A_s'}{A_s} = \frac{5{,}3}{4{,}9} = 1{,}08$

$$\rho' = \frac{A_s'}{A_c} = \frac{5{,}3}{2880} = 0{,}0018 \quad (= 0{,}18\,\%)$$

MINIMALNA ARMATURA; STEBRI: $A_{s,min} = max\left(\frac{0{,}10\,N_{Ed}}{f_{yd}};\ 0{,}002\,A_c\right)$

$A_{s,max} = 0{,}04\,A_c$

NOSILCI, PLOŠČE: $A_{s,min} = max\left(0{,}26\,\frac{f_{ctm}}{f_{yk}}\,b_t \cdot d;\ 0{,}0013\,b_t \cdot d\right)$