

DIMENZIONIRANJE

PLOČA
REBRO

PLOČA

- **Materijal:**

Beton: C30/37 ($f_{ck}/f_{ck,cube}$ valjak/kocka)
(C35/45, C40/50, C45/55 ...)

Čelik: B500B ($f_{yk}/f_{sk}=500/560$)

Visina presjeka: $h = \dots$ [cm]

Zaštitni sloj betona: $c = \dots$ [cm] → 5 cm

Udaljenost do težišta armature: $d_1 = c + \Phi_v + \Phi/2$

Statička visina presjeka: $d = h - d_1$

PLOČA

- Računska čvrstoća betona

$$f_{cd} = \frac{f_{ck}}{\gamma_c} = \frac{30}{1.5} = \dots [N/mm^2] \Rightarrow [kN/cm^2]$$

BETON:

$$\gamma_c = 1.5$$

- Računska čvrstoća čelika

$$f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{500}{1.15} = \dots [N/mm^2] \Rightarrow [kN/cm^2]$$

ČELIK:

$$\gamma_s = 1.15$$

PLOČA-POLJE

- Maksimalni računski moment savijanja u polju:

$$M_{Sd}^{polje} = \dots [kNm] \Rightarrow [kNcm]$$

- Bezdimenzionalni moment savijanja:

$$\mu_{Sd} = \frac{M_{Sd}^{polje}}{b \times d^2 \times f_{cd}} = \dots < \mu_{Rd,max} = 0.252$$

- Za $\mu_{Sd} = \dots \rightarrow$

$$\zeta = \dots (\text{zeta})$$

$$\xi = \dots (\text{ksi})$$

$$\varepsilon_{s1} = \dots \text{‰}$$

$$\varepsilon_{c2} = \dots \text{‰}$$

PLOČA-POLJE

- Potrebna površina armature:

$$A_{s1} = \frac{M_{Sd}^{polje}}{\zeta \times d \times f_{yd}} = \dots [\text{cm}^2 / \text{m}]$$

- Minimalna armatura

$$A_{s,min} = 0.022 \frac{f_{ck,kocke}}{f_{yd}} \times b_t \times d = \dots [\text{cm}^2 / \text{m}]$$

$$A_{s,min} = 0.0015 \times b_t \times d = \dots [\text{cm}^2 / \text{m}]$$

- Maksimalna armatura

$$A_{s,max} = 0.375 \frac{0.85 \times f_{cd}}{f_{yd}} \times b_t \times d = \dots [\text{cm}^2 / \text{m}]$$

PLOČA-POLJE

- Odabrana armatura:

$$A_{s,min} < A_{s1} < A_{s,max}$$

- ODABRANO:

$$9\Phi 28 / 10 \text{ cm} \Rightarrow \text{površina cm}^2 / \text{m}$$

PLOČA-LEŽAJ

- Maksimalni računski moment savijanja u polju:

$$M_{Sd}^{ležaj} = \dots [kNm] \Rightarrow [kNcm]$$

- Smanjenje momenta na ležaju:

$$\Delta M_{Sd} = \frac{R_{Sd} \times e}{8}$$

- Reducirani moment na ležaju:

$$M_{Sd,red} = M_{Sd}^{ležaj} - \Delta M_{Sd} = \dots [kNcm]$$

PLOČA-LEŽAJ

- Bezdimenzionalni moment savijanja:

$$\mu_{Sd} = \frac{M_{Sd,red}^{ležaj}}{b \times d^2 \times f_{cd}} = \dots < \mu_{Rd,max} = 0.252$$

- Za $\mu_{Sd} = \dots \rightarrow \zeta = \dots$ (zeta)

$$\xi = \dots$$
 (ksi)

$$\varepsilon_{s1} = \dots \text{‰}$$

$$\varepsilon_{c2} = \dots \text{‰}$$

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- Potrebna površina armature:

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PLOČA-LEŽAJ

Ležaj na upornjaku dimenzionira se sa 25% momenta u prvom polju.

$$M_{Sd}^{prviležaj} = 0.25 \times M_{Sd}^{polje} = \dots [kNm] \Rightarrow [kNcm]$$

REBRO

- Materijal:

Beton: C30/37 ($f_{ck}/f_{ck,cube}$ valjak/kocka)
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BETON:

$$\gamma_c = 1.5$$

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$$f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{500}{1.15} = \dots [N/mm^2] \Rightarrow [kN/cm^2]$$

ČELIK:

$$\gamma_s = 1.15$$

REBRO-POLJE

- Maksimalni računski moment savijanja u polju:

$$M_{Sd}^{polje} = \dots [kNm] \Rightarrow [kNcm]$$

- Bezdimenzionalni moment savijanja:

$$\mu_{Sd} = \frac{M_{Sd}^{polje}}{b_{eff} \times d^2 \times f_{cd}} = \dots < \mu_{Rd,max} = 0.252$$

- Za $\mu_{Sd} = \dots \rightarrow$

$$\zeta = \dots (\text{zeta})$$

$$\xi = \dots (\text{ksi})$$

$$\varepsilon_{s1} = \dots \%$$

$$\varepsilon_{c2} = \dots \%$$

REBRO-POLJE

- Potrebna površina armature:

$$A_{s1} = \frac{M_{Sd}^{polje}}{\zeta \times d \times f_{yd}} = \dots [\text{cm}^2 / \text{m}]$$

- Minimalna armatura

$$A_{s,min} = \left[0.022 + \frac{b_{eff}}{b_w} \left(0.0027 - \frac{b_{eff}}{5000 \times b_w} \right) \times \frac{h_f}{h} \left(8.5 - 17.5 \times \frac{h_f}{h} \right) \right] \times \frac{f_{ck}}{f_{yd}} \times b_w \times d = \dots [\text{cm}^2]$$

- Maksimalna armatura

$$A_{s,max} = \left[0.400 + \left(0.833 \frac{b_{eff}}{b_w} - 0.833 \right) \frac{h_f}{h} \right] \frac{0.85 \times f_{cd}}{f_{yd}} \times b_w \times d = \dots [\text{cm}^2]$$

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$$\mu_{Sd} = \frac{M_{Sd,red}^{ležaj}}{b_w \times d^2 \times f_{cd}} = \dots < \mu_{Rd,max} = 0.252$$

- Za $\mu_{Sd} = \dots \rightarrow \zeta = \dots$ (zeta)

$$\xi = \dots$$
 (ksi)

$$\varepsilon_{s1} = \dots \%$$

$$\varepsilon_{c2} = \dots \%$$

REBRO-LEŽAJ

- Potrebna površina armature:

$$A_{s1} = \frac{M_{Sd,red}^{ležaj}}{\zeta \times d \times f_{yd}} = \dots [\text{cm}^2 / \text{m}]$$

- Minimalna armatura

$$A_{s,min} = \left[0.023 + \left(0.0417 \frac{b_{eff}}{b_w} - 0.0417 \right) \times \frac{h_f}{h} \left(2 - 3.33 \times \frac{h_f}{h} \right) \right] \times \frac{f_{ck}}{f_{yd}} \times b_w \times d = \dots [\text{cm}^2]$$

- Maksimalna armatura

$$A_{s,max} = \left(0.5 - \frac{f_{yk}}{4000} \right) \frac{0.85 \times f_{cd}}{f_{yd}} \times b_w \times d = \dots [\text{cm}^2]$$

REBRO-LEŽAJ

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POPREČNA ARMATURA

- Računska vrijednost poprečne sile

$$V_{Sd} = \dots [kN]$$

$$V_{Sd,1} = V_{Sd} - a \times (\gamma_g \times g + \gamma_q \times q) = \dots [kN]$$

$$a = b / 2 + d$$

b – širina ležaja

$$V_{Rd,1} = [\tau_{Rd} \times k \times (1.2 + 40 \times \rho_1) + 0.15 \times \sigma_{cp}] \times b_w \times d$$

$$\tau_{Rd} = 0.037 [kN / cm^2]$$

$$k = 1.6 - d \geq 1$$

POPREČNA ARMATURA

$$\rho_1 = \frac{A_{S1}}{b \times d}$$

A_{S1} -Pretpostavljena uzdužna armaturakoja prolazi preko ležaja

$$V_{Sd,1} > V_{Rd,1} \Rightarrow \text{Potreban proračun poprečne armature}$$

POPREČNA ARMATURA

• STANDARDNA METODA

Pretpostavljene vilice $\Phi 12$, reznost $m=4$

$$A_{sw} = \dots [\text{cm}^2]$$

$$f_{ywd} = \frac{f_{yk}}{\gamma_s} = \dots [\text{kN} / \text{cm}^2]$$

$$z = 0.9 \times d =$$

Potrebni razmak vilica :

$$s_{w,1} = \frac{A_{sw} \times f_{ywd} \times z}{V_{Sd,1} - V_{Rd,1}} = \dots [\text{cm}]$$

POPREČNA ARMATURA

- Metoda slobodnog izbora nagiba tlačnih štapova
 - Za a.b. Elemente bez uzdužne sile nagib tlačnih štapova se uzima $\Theta=39^\circ$

Potrebni razmak vilica :

$$s_{w,1} = \frac{A_{sw} \times f_{ywd} \times z \times \text{ctg}\Theta}{V_{Sd,1}} = \dots [\text{cm}]$$

$$\text{ctg}\Theta = 1.235$$

Mjerodavan je manji razmak vilica

ODABRANA ARMATURA $\Phi 12$, $m=4$ na razmaku $s_{w1}=\dots[\text{cm}]$

POPREČNA ARMATURA

- Minimalna poprečna armatura $\longrightarrow$ max. razmak vilica

Pretpostavljene vilice $\Phi 12$, reznost $m=4$

1. UVJET

$$A_{sw,min} = \rho_{w,min} \times s_w \times b_w$$

$$s_{w,max} = \frac{A_{sw,min}}{\rho_{w,min} \times b_w}$$

$$C25 / 35 - C35 / 45, \text{ za } f_{yk} = 500 \Rightarrow \rho_{w,min} = 0.0011$$

$$C40 / 50 - C50 / 60, \text{ za } f_{yk} = 500 \Rightarrow \rho_{w,min} = 0.0013$$

POPREČNA ARMATURA

2. UVJET

$$V_{Rd2} = 0.5 \times v \times f_{cd} \times b_w \times z$$

$$v = 0.7 - \frac{f_{ck}}{200}$$

b_w – širina rebra

$$z = 0.9 \times d$$

$$\text{za } 0 < V_{Sd,1} \leq 1/5 V_{Rd,2} \Rightarrow s_{w,max} \leq 0.8 \times d \leq 30 \text{ cm}$$

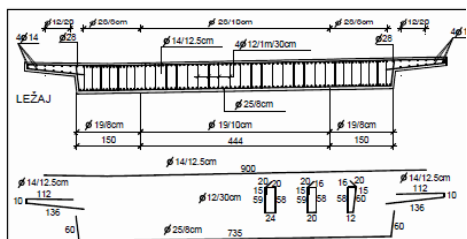
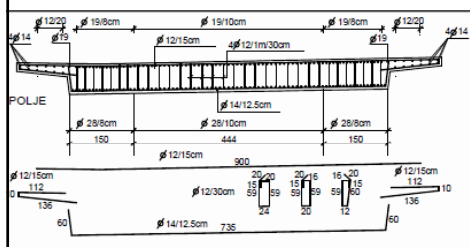
$$\text{za } V_{Rd,2} / 5 < V_{Sd,1} \leq 2 V_{Rd,2} / 3 \Rightarrow s_{w,max} \leq 0.6 \times d \leq 30 \text{ cm}$$

$$\text{za } 2 V_{Rd,2} / 3 < V_{Sd,1} \leq V_{Rd,2} \Rightarrow s_{w,max} \leq 0.3 \times d \leq 20 \text{ cm}$$

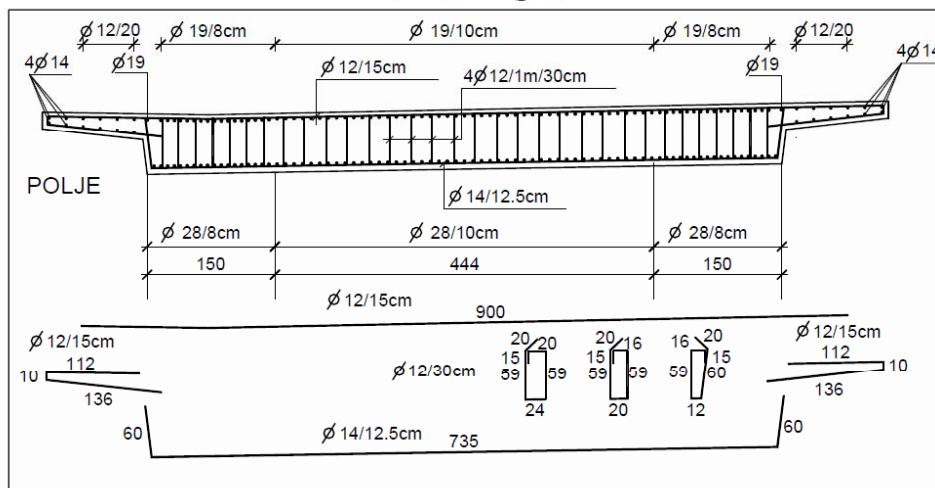
Odabran max. razmak vilica

Armatura pločastog presjeka

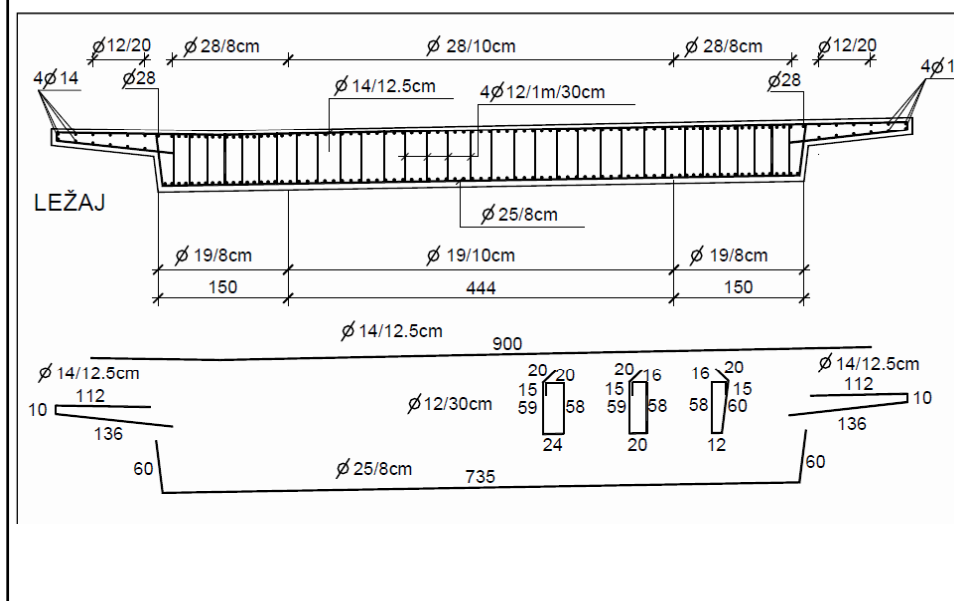
- ☐ Izračunata armatura za središnji trak širine 1 m
- ☐ Rubne dijelove ploče širine 0,2 L_y ojačavamo s 10 do 20% više glavne armature, u skladu s naprijed navedenim pretpostavkama
- ☐ U poprečnom smjeru pokrivamo dijagrame unutarnjih sila za skrivene grede, a potom preostale dijelove ploče armiramo s 20% vrijednosti glavne uzdužne armature



Skica armature ploče u polju

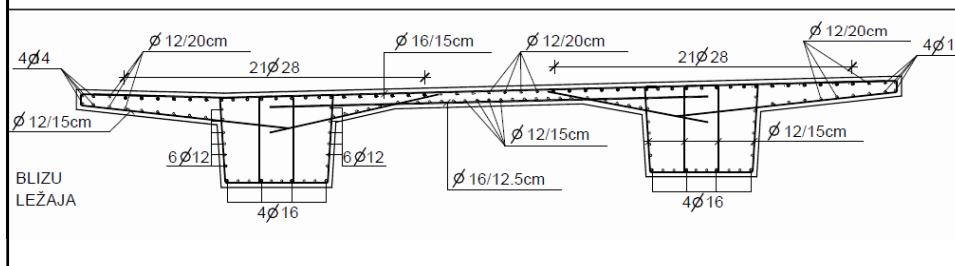


Skica armature ploče u blizini ležaja



Armatura rebrastog presjeka

- ❑ Izračunata armatura za jedno rebro
 - ❑ sva armatura udvostručuje i za drugo rebro
- ❑ Glavna armatura
 - ❑ u polju stavljamo, ako je potrebno, u dva reda vodeći računa o pravilnim razmacima šipaka
 - ❑ nad ležajem raspoređujemo po sudjelujućoj širini vodeći računa da su deblji profili u kutovima vilica, a tanji prema krajevima sudjelujuće širine ploče



Skica armature rebrastog presjeka u polju

