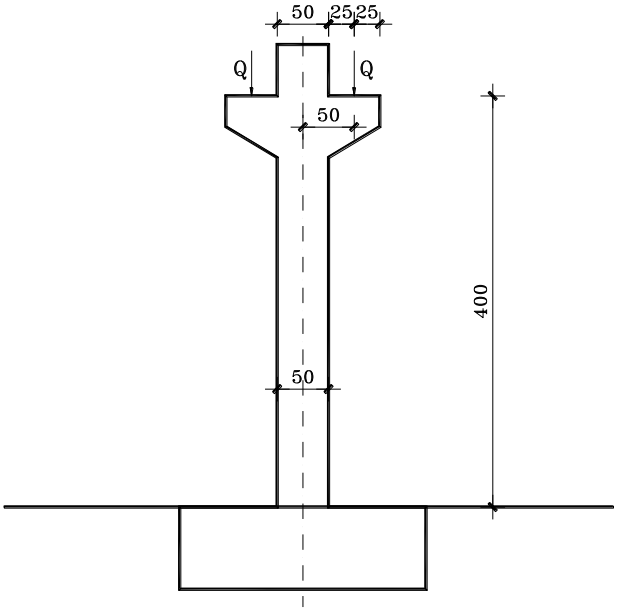
BETONSKE KONSTRUKCIJE

Program 2

Zagreb, 2017.

Ime i prezime

1. Proračun stupa



Gradiva:

Beton: C25/30

Armatura: B500B

Visina stupa: L = 400 cm

Proračun duljine izvijanja stupa (za konzolu $\beta = 2.0$):

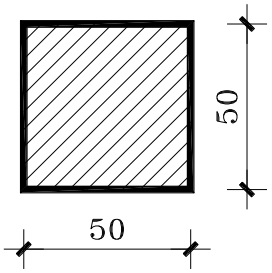
$$L_i = L \cdot \beta = 400 \cdot 2.0 = 800\text{cm}$$

$$\lambda = \frac{L_i}{i_{min}} = \frac{800}{0.289 \cdot 50} = 55.4$$ - vitkost elementa

$$i_{min} = \sqrt{\frac{I}{A_c}}$$ - polumjer tromosti u smjeru manjeg otpora izvijanja

Za pravokutni presjek $i_{min} = 0.289 \cdot b_{min}$

Poprečni presjek:



Visina presjeka: h = 50 cm

Zaštitni sloj betona: c = 3.0 cm

Udaljenost do težišta armature: $d_1 = c+\phi_v+\phi_u/2 = 3.0+0.8+2.2/2 = 4.9\text{cm} \cong 5\text{cm}$

Statička visina presjeka: $d= h - d_1 = 50 – 5.0 = 45$ cm

f_{cd} - računska čvrstoća betona C25/30

$$f_{cd} = \alpha_{cc} \frac{f_{ck}}{\gamma_c} = 1.0 \cdot \frac{25}{1.5} = 16.67 \text{ N/mm}^2 = 1.667 \text{ kN/cm}^2$$

f_{yd} - računska granica popuštanja čelika B500B

$$f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{500}{1.15} = 434.78 \text{ N/mm}^2 = 43.48 \text{ kN/cm}^2$$

1.1. Proračun po teoriji I reda:

Reakcija kranske staze: Q=250kN
Moment na stupu $M_q = Q \times 0.5 = 250 \times 0.5 = 125\text{kNm}$

Računske unutarnje sile:

$$M_{Ed} = 1.5 \cdot M_q = 1.5 \cdot 125 = 187.5\text{kNm}$$

$$N_{Ed} = 1.5 \cdot N_q = 1.5 \cdot 250 = 375\text{kN}$$

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{187.5 \cdot 10^2}{50 \cdot 50^2 \cdot 1.667} = 0.090$$

$$\nu_{Ed} = \frac{N_{Ed}}{b \cdot d \cdot f_{cd}} = \frac{375.0}{50 \cdot 50 \cdot 1.667} = 0.090$$

Dijagrami interakcije za:

$\beta = A_{s2} / A_{s1} = 1.0$ - simetrična armatura

$d_1 / h = d_2 / h = 0.1$

Čelik: B500B

Očitano $\omega = 0.10$ - mehanički koef. armiranja

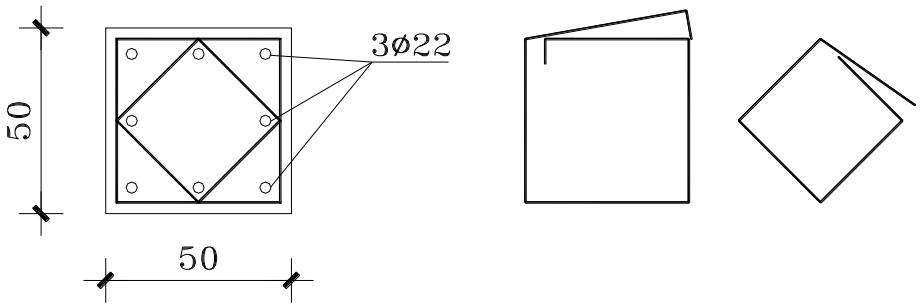
Potrebna površina armature:

$$A_{s1} = \omega \cdot \frac{f_{cd}}{f_{yd}} \cdot b \cdot h = 0.1 \cdot \frac{1.667}{43.48} \cdot 50 \cdot 50 = 9.58\text{cm}^2$$

$$A_{s2} = \beta \cdot A_{s1} = 1 \cdot 9.58 = 9.58\text{cm}^2$$

ODABRANO: 3ϕ22 ($A_{s1,od}$ = 11.40 cm^2) s jedne strane

Ukupna armatura: A_s = **3ϕ22+3ϕ22+2ϕ22= 8ϕ22** =30.41cm^2



Minimalna armatura:

1) $A_{s,min} = 0.15 \cdot \frac{N_{Ed}}{f_{yd}} = 0.15 \cdot \frac{375}{43.48} = 1.29 cm^2$
2) $A_{s,min} = \frac{0.3}{100} \cdot A_c = 0.003 \cdot 50 \cdot 50 = 7.5 cm^2$
3) $A_{s,min} = 4\phi 12 = 4.52 cm^2$
4) $A_{s,min} = \frac{1}{100} \cdot A_c = 0.01 \cdot 50 \cdot 50 = 25 cm^2$ ili ($8\phi 12 = 7.54 cm^2$) ako stup preuzima sile potresa.

Maksimalna armatura:

$A_{s,max} = \frac{4}{100} \cdot A_c = 0.04 \cdot 50 \cdot 50 = 100.0 cm^2$

$A_{s,max} = \frac{8}{100} \cdot A_c = 0.08 \cdot 50 \cdot 50 = 200.0 cm^2$ (na mjestu preklopa armature)

Razmak spona: " e_w":

1) $e_w = 12\phi_{s,min} = 12 \times 2.2 = 26.4$ cm
2) $e_w = b = 50$ cm
3) $e_w = 30$ cm
4) $e_w = 10$ cm ako stup preuzima sile potresa (za veliku duktilnost H)
5) $e_w = 15$ cm ako stup preuzima sile potresa (za srednju duktilnost M)
6) $e_w = 20$ cm ako stup preuzima sile potresa (za malu duktilnost L)

ODABRANO: spone ϕ8/15 cm

U blizini ležaja spone se progušćuju na razmak " $0.6 \times e_w$ " tj. s = 9.0 cm, na duljini:

1) $a = 1.5 \cdot b = 1.5 \cdot 50 = 75 cm$
2) $a = \frac{1}{6} \cdot L = \frac{1}{6} \cdot 425 = 70.83 cm$
3) $a = 50 cm$
4) a= duljina preklopa uzdužne armature ($60 \times \phi_u$)