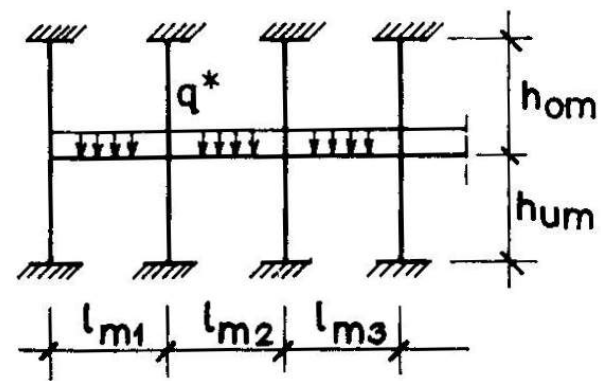
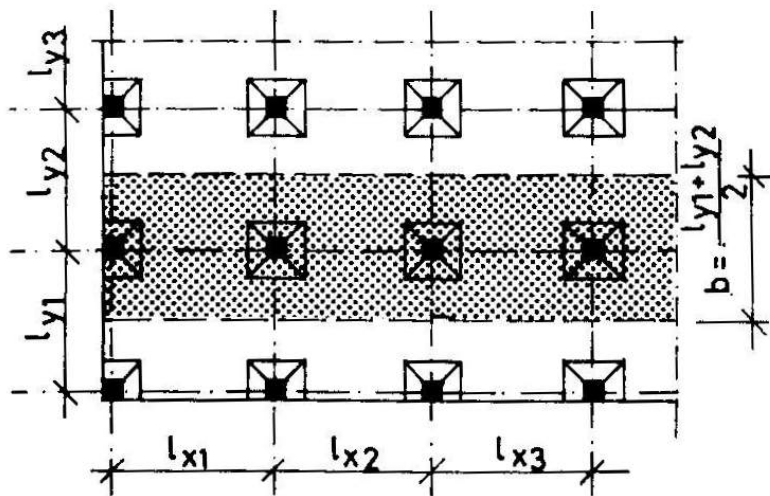
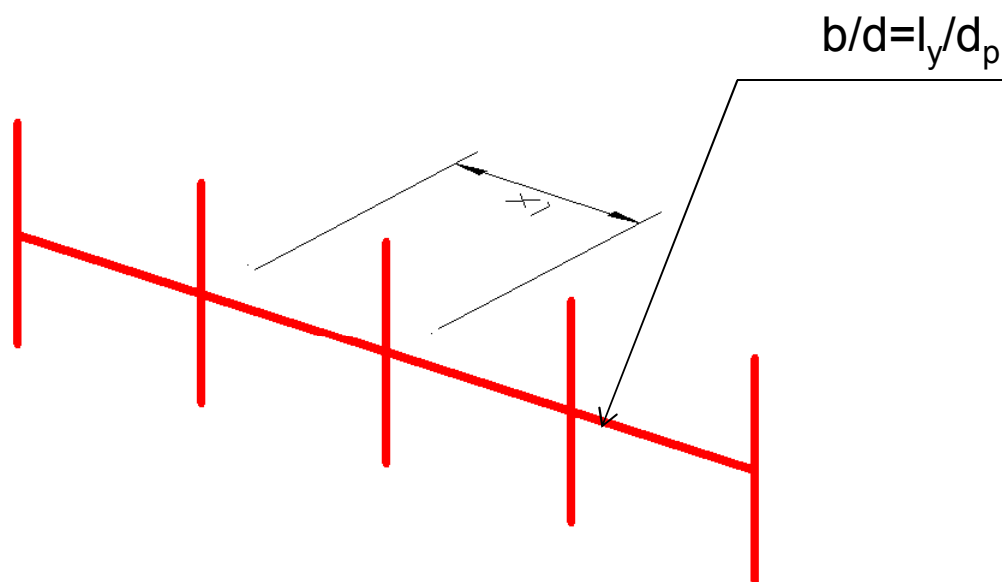


Metoda zamenjujućih okvira

- Metoda podrazumeva da ploča sa stubovima čini kontinualni okvir.
- U propisima mnogih zemalja
- Široka primena (metoda traka)



Kako se formira zamenjujući okvir

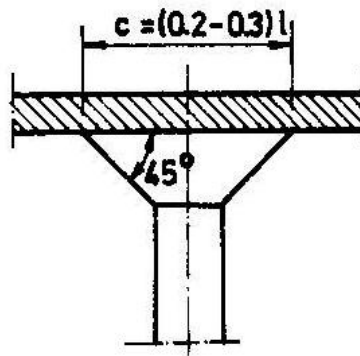
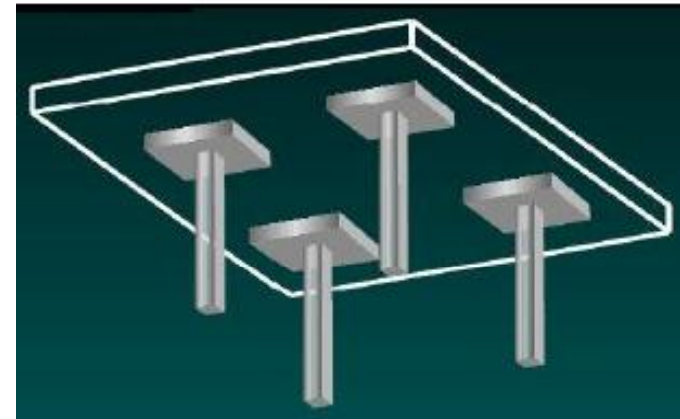


Na mestu oslanjaje ploče na stubove moguće je formirati ojačanja u obliku kapitela, što utiče na:

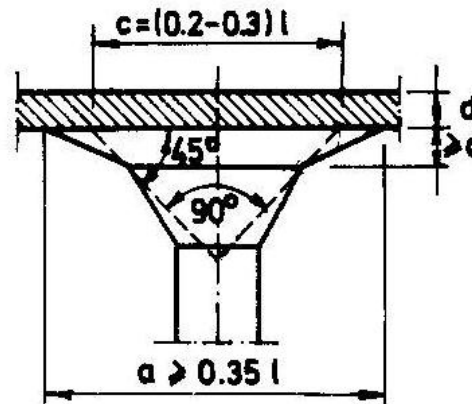
- smanjenje smičućih napona - obezbeđenje ploče od proboja
- smanjenje raspona ploče – povoljniji ugibi
- povećanje poprečnog preseka ploče nad stubom na mestima najvećih negativnih momenata – manja negativna armatura

Tipovi kapitela

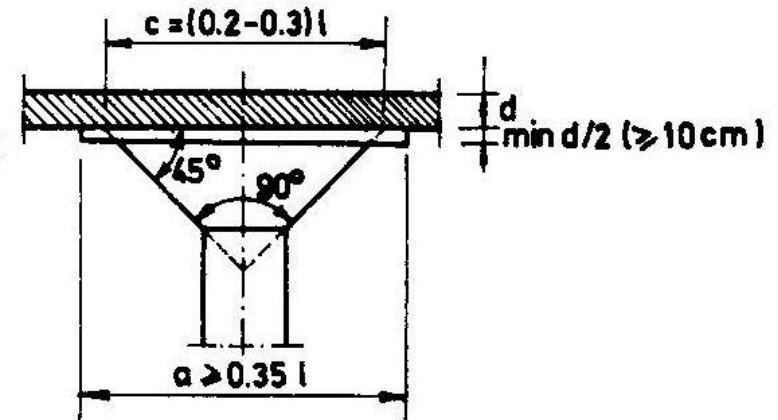
“Drop Panel”



Manja opterećenja

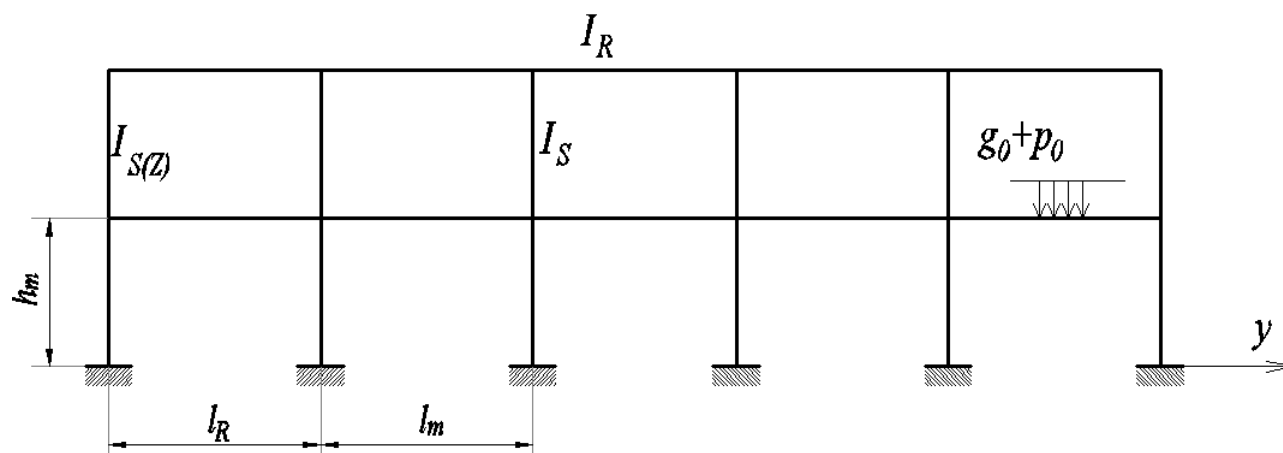


Veća opterećenja



Metoda zamenjujućih okvira

Računski rasponi i visine zamenjujućeg okvira, krutost rige



$$g_0 = g \cdot l_x [kN / m]$$

$$p_0 = p \cdot l_x [kN / m]$$

$$l_m = l_y \left(1 - \frac{2}{3} \frac{c}{l_y} \right)$$

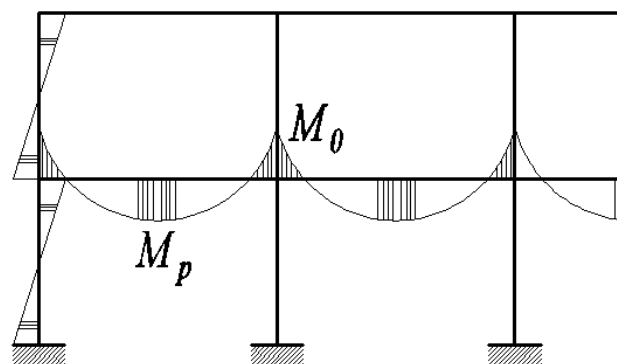
$$l_R = l_y \left(1 - \frac{1}{3} \frac{c}{l_y} \right)$$

$$h_m = h - \frac{c}{2}$$

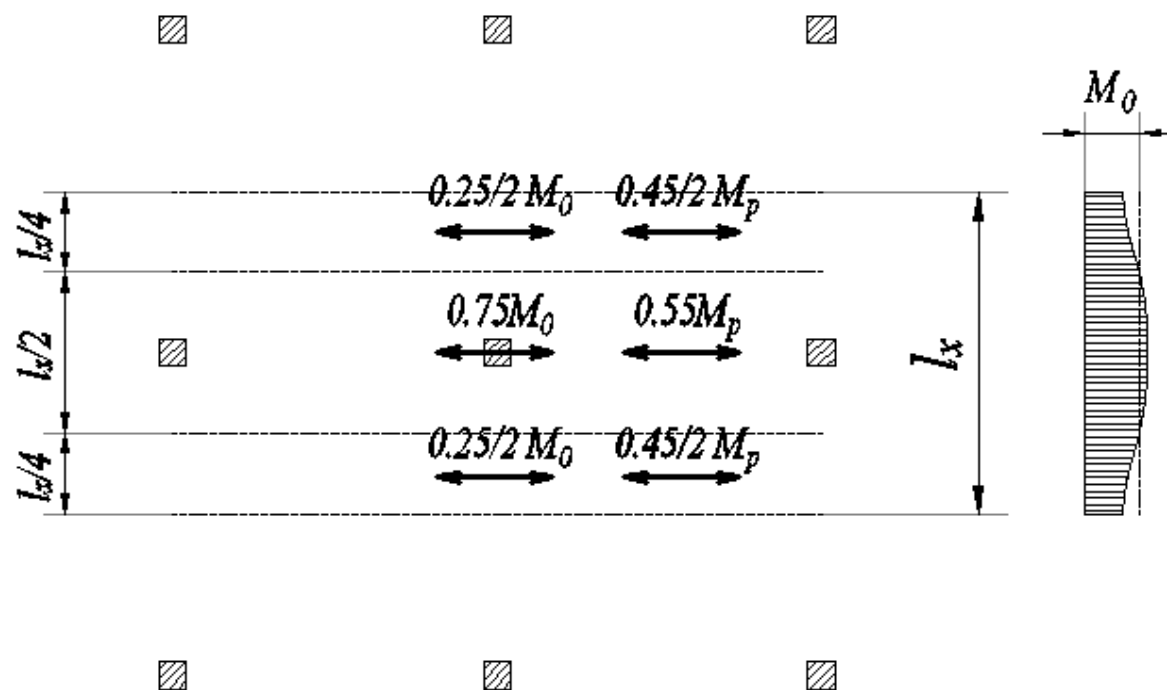
$$I_R = \frac{l_y \cdot d_p^3}{12}$$

l_y – osovinski razmak

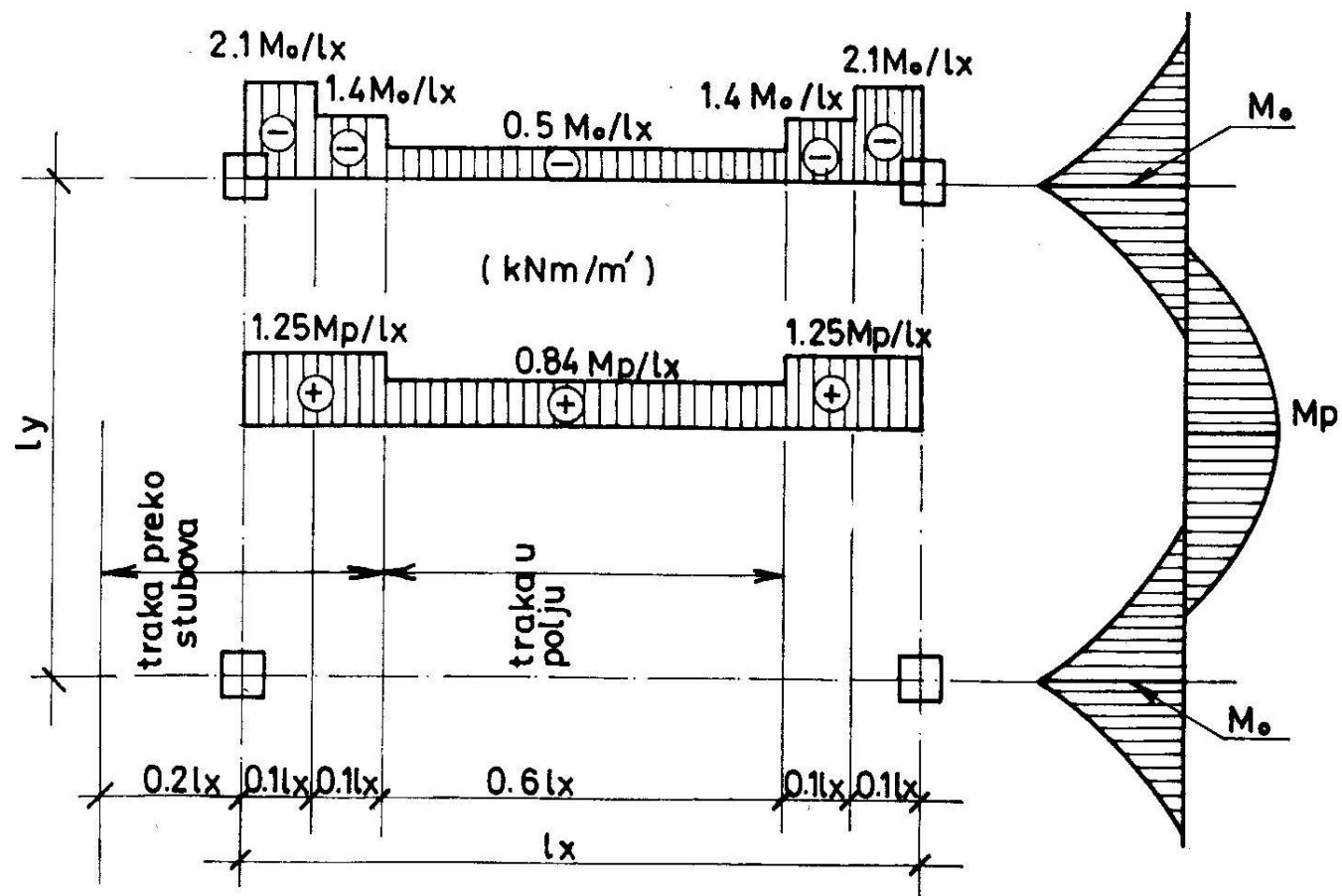
h – spratna visina



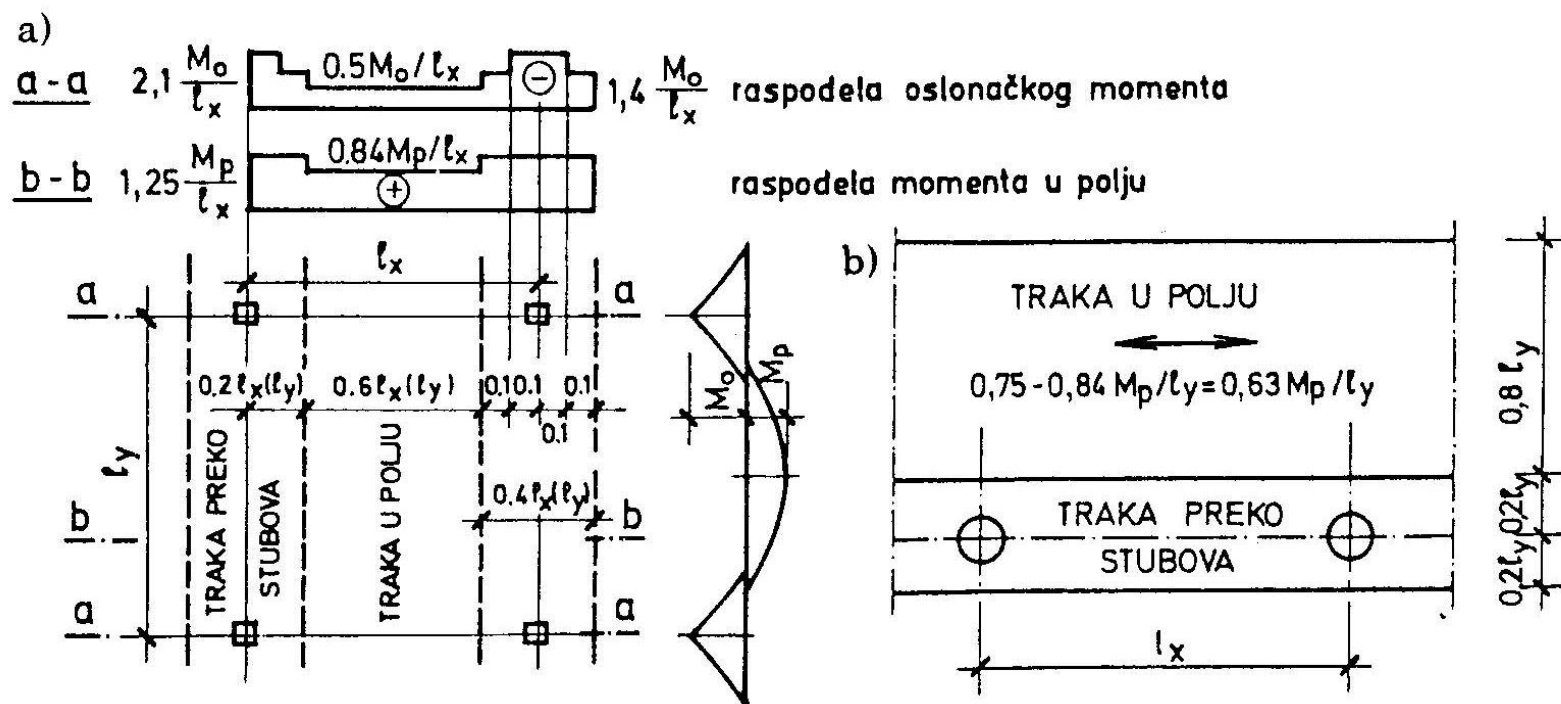
Raspodela momenta po trakama na širini polja L_x
 ("Uputstvo za proračun pečurkastih ploča" 1950.

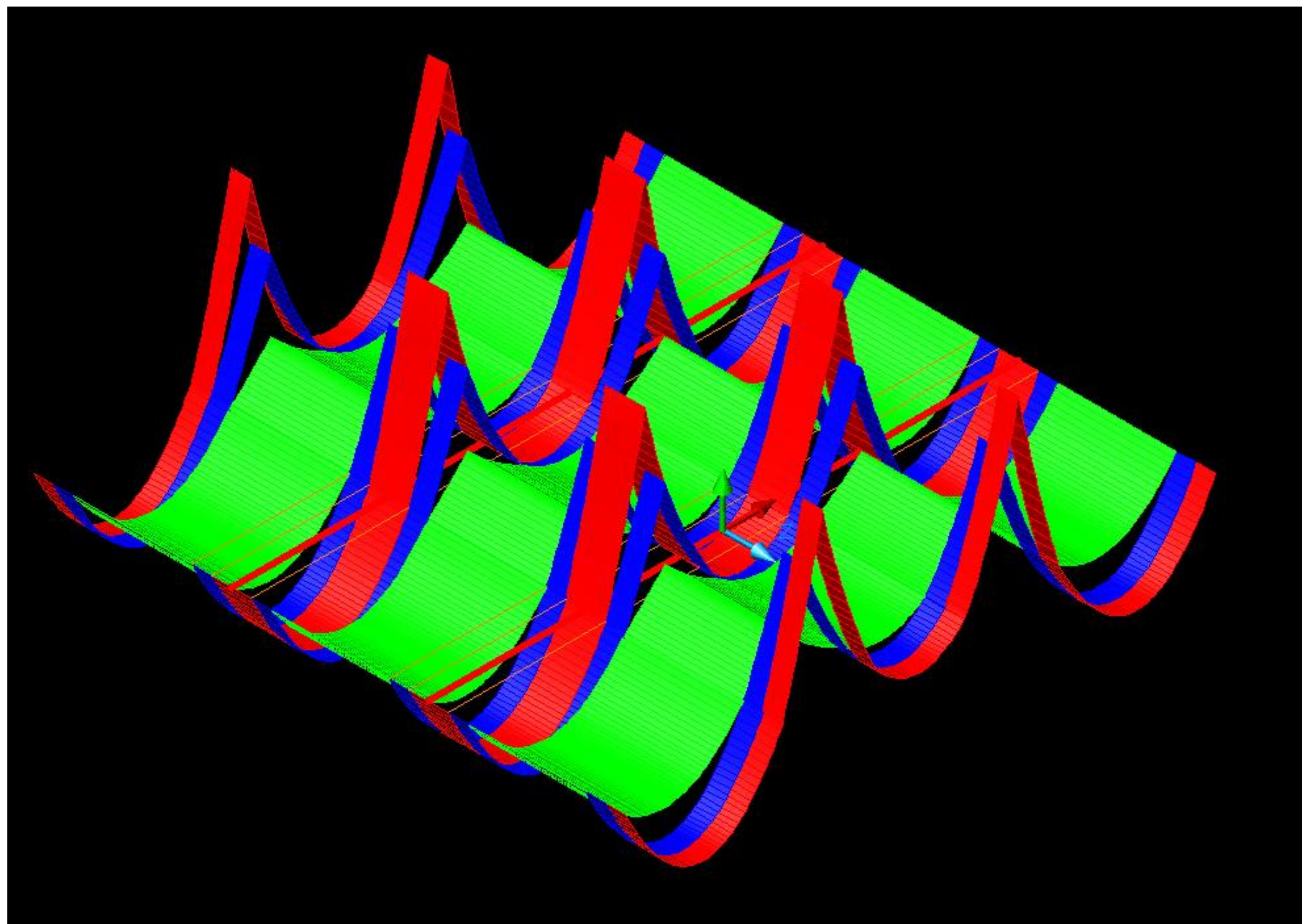


Raspodela momenta po trakama na širini polja L_x DIN



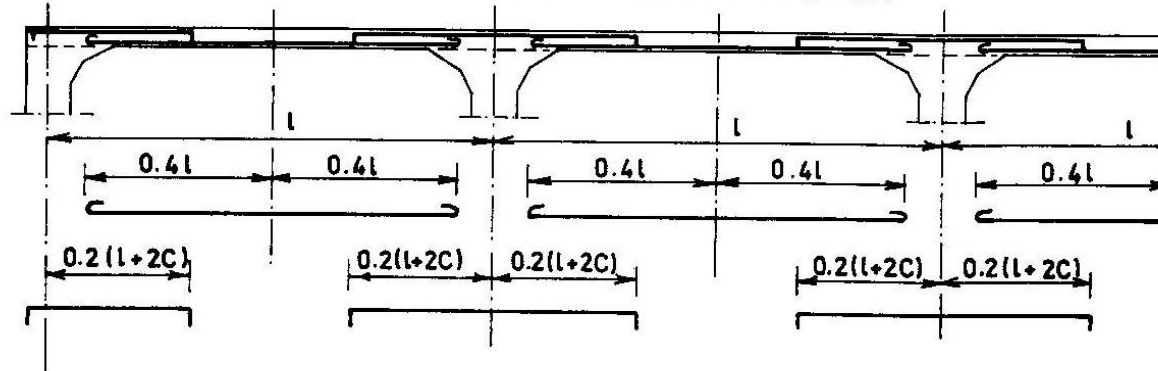
Raspodela momenta po trakama na širini polja l_x BAB 87



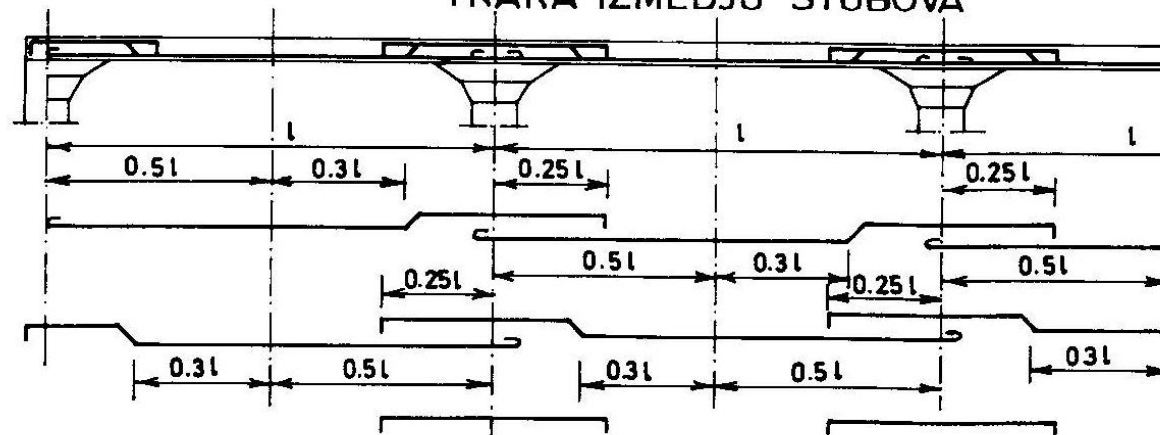


Armiranje pečurkastih ploča

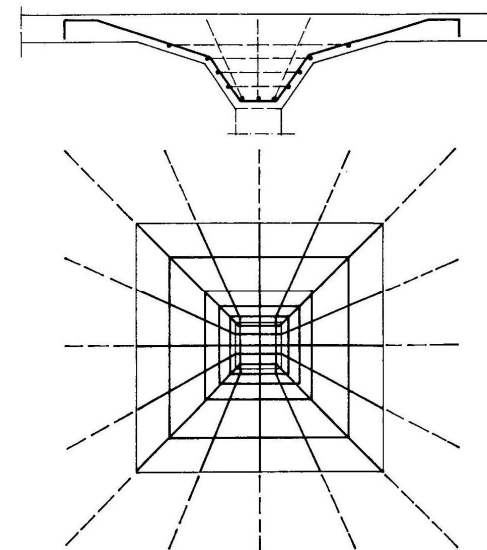
TRAKA IZNAD STUBOVA

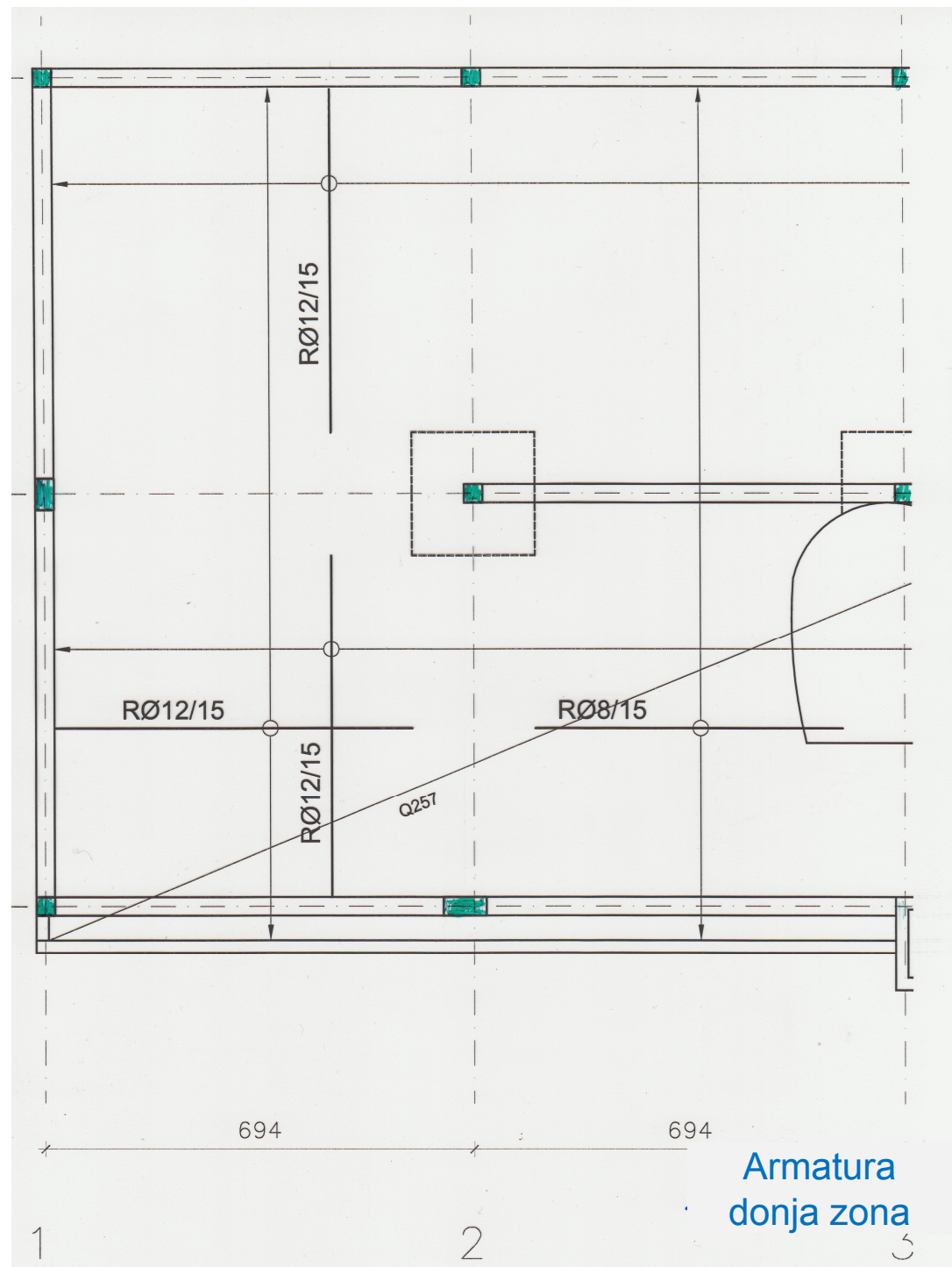


TRAKA IZMEDJU STUBOVA

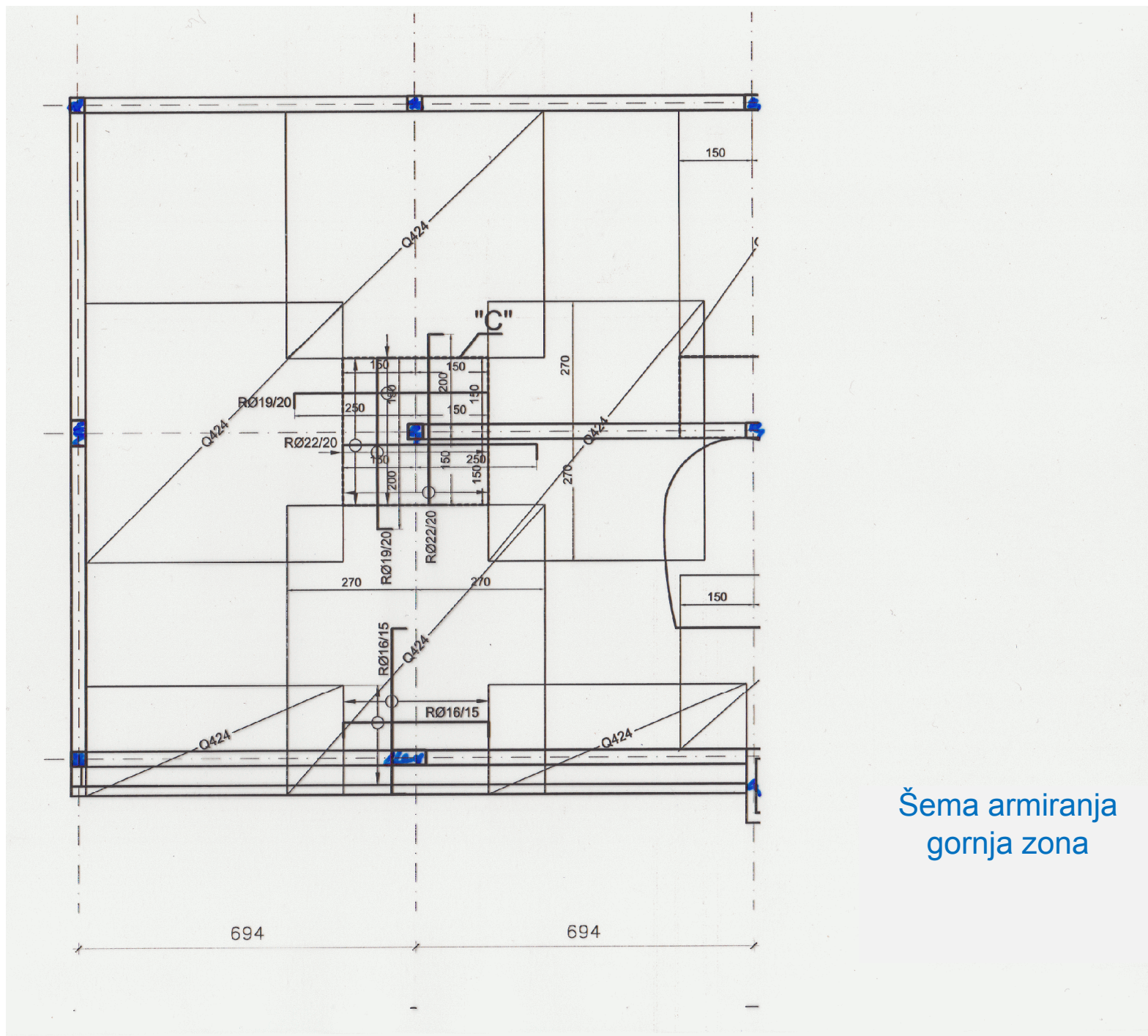


DOPUNSKO GVOŽDJE—PO POTREBI





Armatura
donja zona



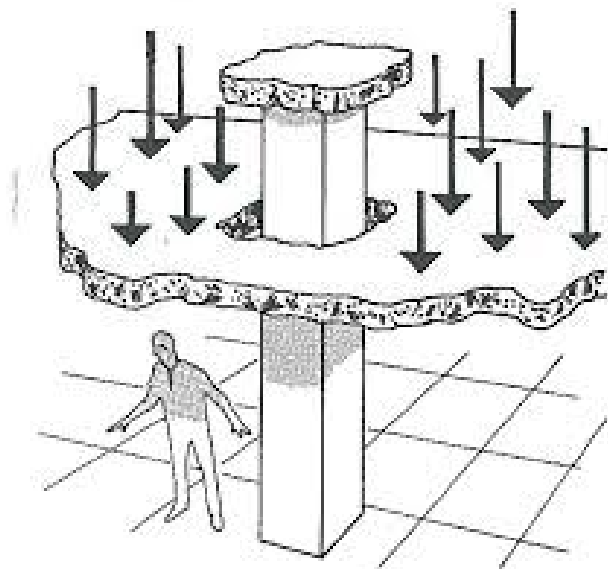
Šema armiranja
gornja zona

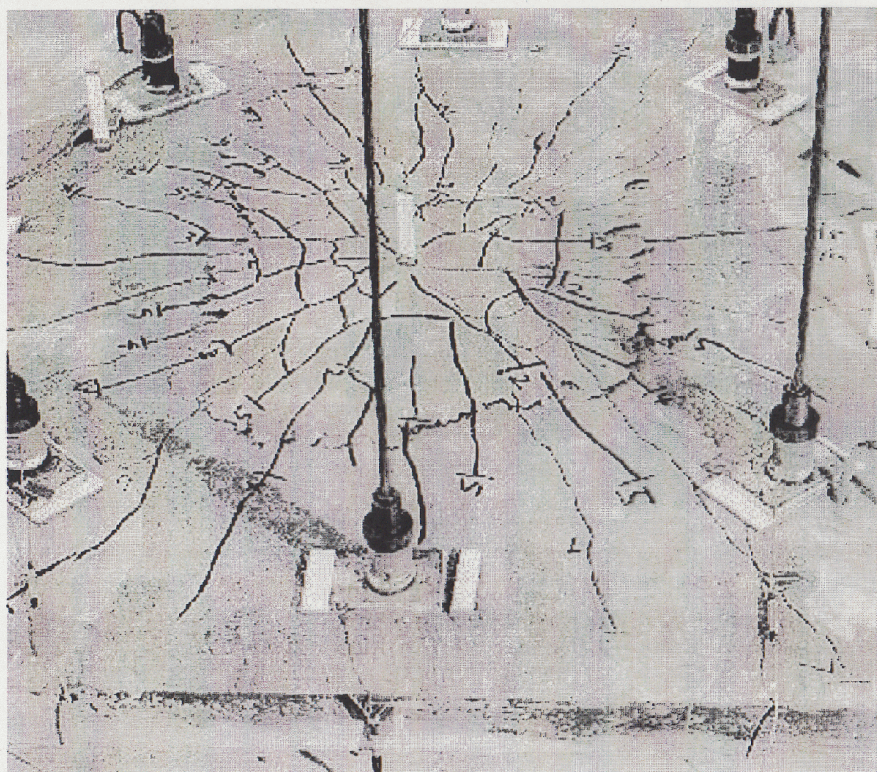


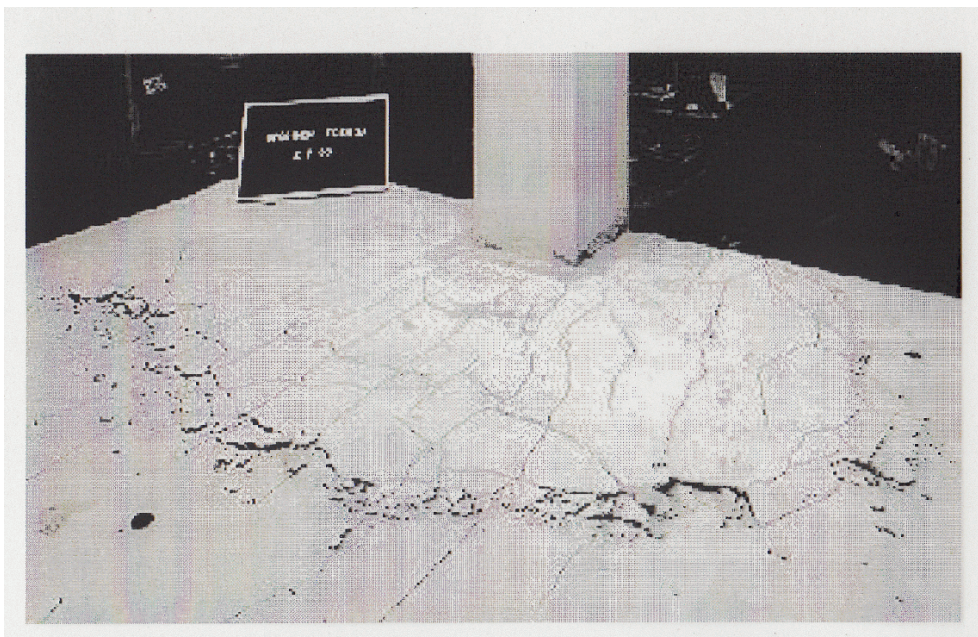
Armiranje ploče



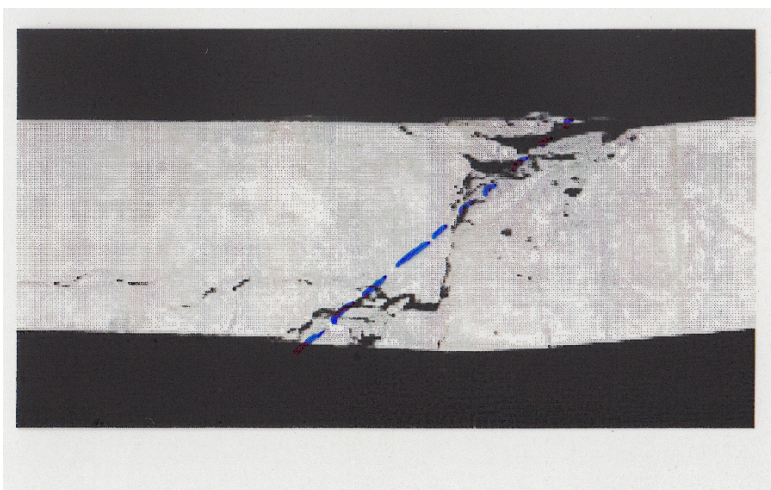
Proračun na probijanje







Probijanje ivičnog stuba



Proračun na probijanje bez ili sa kapitelom

$$\tau = \frac{T_{\max}}{O_{kp} \cdot h_s}$$

$$T_{\max} = q \left(l_x \cdot l_y - \frac{1}{4} d_{kp}^2 \pi \right)$$

$$q = g + p$$

h_s – srednja statička visina za dva usvojena pravca armiranja

$O_{kp} = d_{kp} \cdot \pi$ – obim preseka oko stuba, prečnika d_{kp}

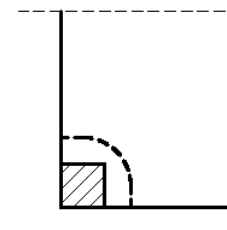
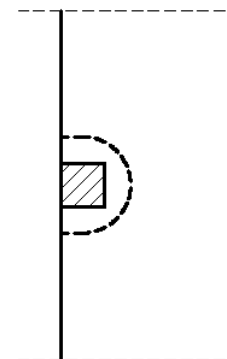
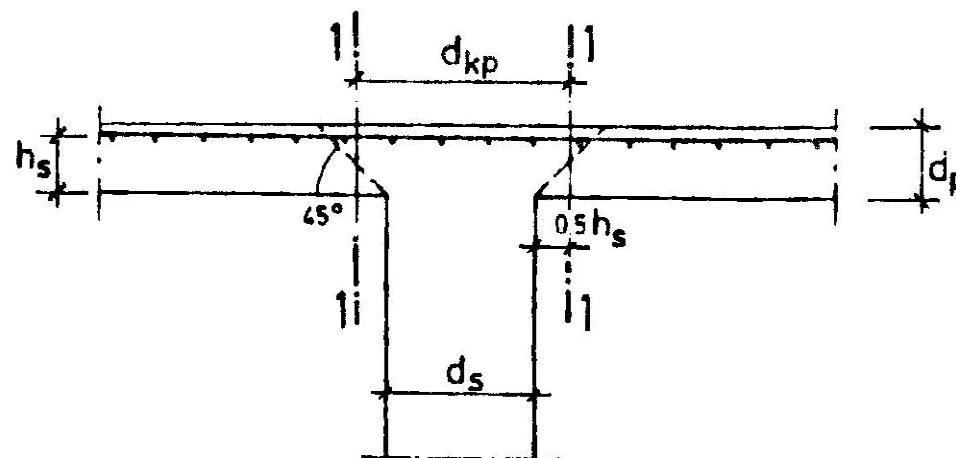
$$d_{kp} = d_s + h_s$$

d_s – prečnik kružnog stuba. Za pravougaoni stub:

$$d_s = 1.13 \sqrt{b \cdot d} \quad \text{Kada je } d > 1.5b, \text{ usvaja se } d = 1.5b.$$

Kod ivičnih stubova se usvaja $0.6 O_{kp}$.

Kod ugaonih stubova se usvaja $0.3 O_{kp}$.



$$\tau \leq \gamma_2 \cdot \tau_b \quad - \text{neophodan uslov.}$$

$$\tau \leq \frac{2}{3} \gamma_1 \cdot \tau_a \quad - \text{nije potrebna armatura za osiguranje od proboja}$$

$$\frac{2}{3} \gamma_1 \cdot \tau_a < \tau \leq \gamma_2 \cdot \tau_b \quad - \text{potrebna armatura za osiguranje od proboja}$$

$$\gamma_1 = 1.3 \alpha_a \sqrt{\mu} \quad \gamma_2 = 0.45 \alpha_a \sqrt{\mu}$$

$$\alpha_a = \begin{cases} 1.0 & GA \\ 1.3 & RA \\ 1.4 & MA \end{cases}$$

μ – srednja vrednost procenta armiranja preseka ploče u gornjoj zoni, na širini oslonačke trake od $0.4l_x$ i $0.4l_y$, uz uslov:

$$0.5\% \leq \mu \leq 25 \cdot f_{bk} / \sigma_v \leq 1.5\%$$

Potrebna površina poprečne armature ($45^\circ \leq \alpha \leq 90^\circ$).

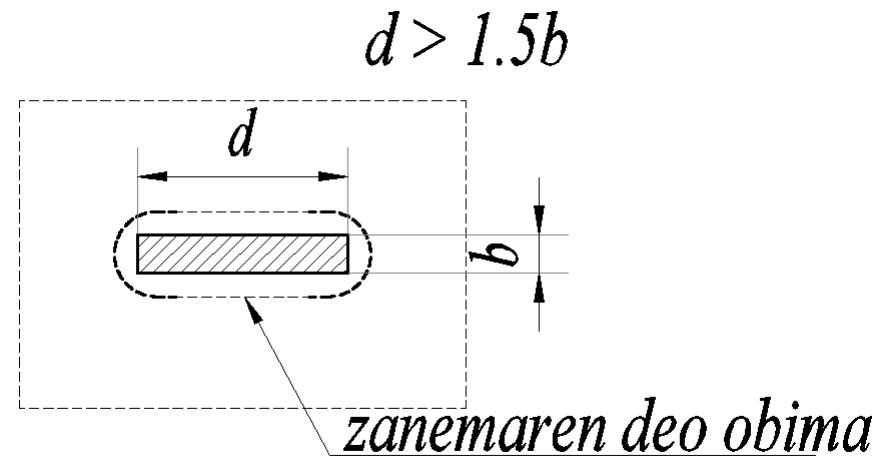
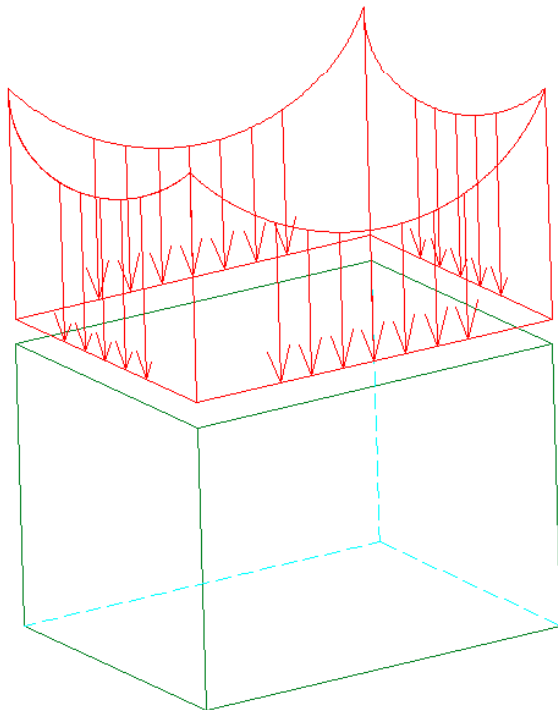
$$A_{ak} = \frac{0.75 T_{\max}}{\sigma_v / 1.8} = 1.35 \frac{T_{\max}}{\sigma_v}$$

	Marka betona (MB)					
	15	20	30	40	50	60
τ_a (MPa)	0,5	0,6	0,8	1,0	1,1	1,2
τ_b (MPa)	1,5	1,8	2,2	2,6	3,0	3,4

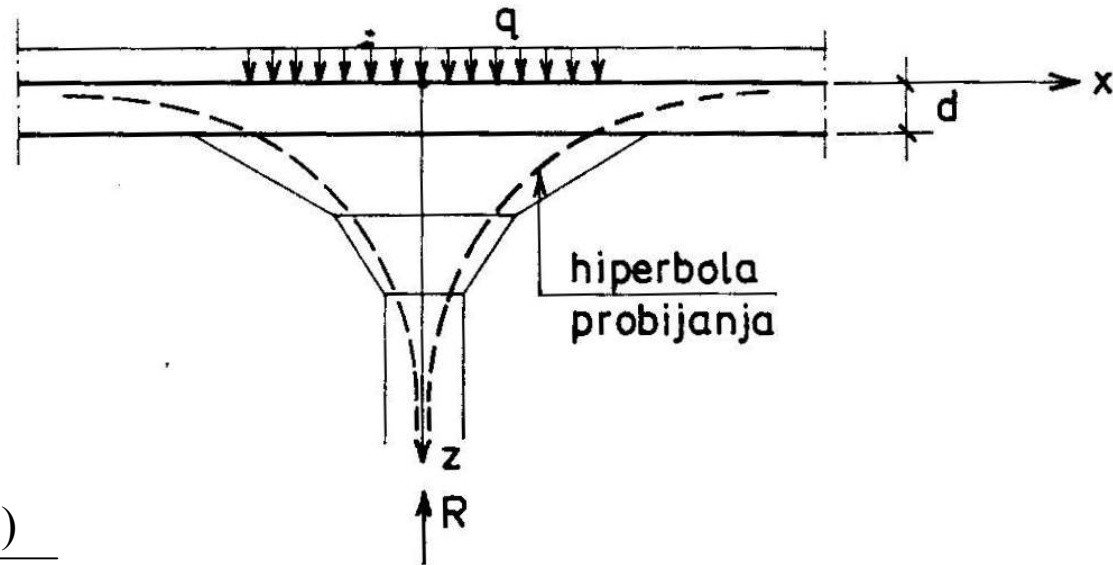
Kada je presek stuba pravougaonik, dimenzija b/d , onda se zamenjujući prečnik kružnog preseka sračunava kao

$$d_s = 1.13\sqrt{bd}$$

Ako je $d > 1.5b$ treba uzeti $d=1.5b$. Razlog za ovo je što se koncentracija smicanja dešava na uglovima, s jedne strane, a sa druge, na bočnim stranama stuba veće dužine ne vlada dvoosno stanje napona pa su dopušteni naponi manji i taj deo se zanemaruje.



Hiperbola probijanja



$$\tau = \frac{Q(x)}{O \cdot z_x} = \frac{Q(x)}{2\pi \cdot x \cdot z_x}$$

$$Q(x) = ql_x \cdot l_y - qx^2\pi \quad \searrow \quad 0$$

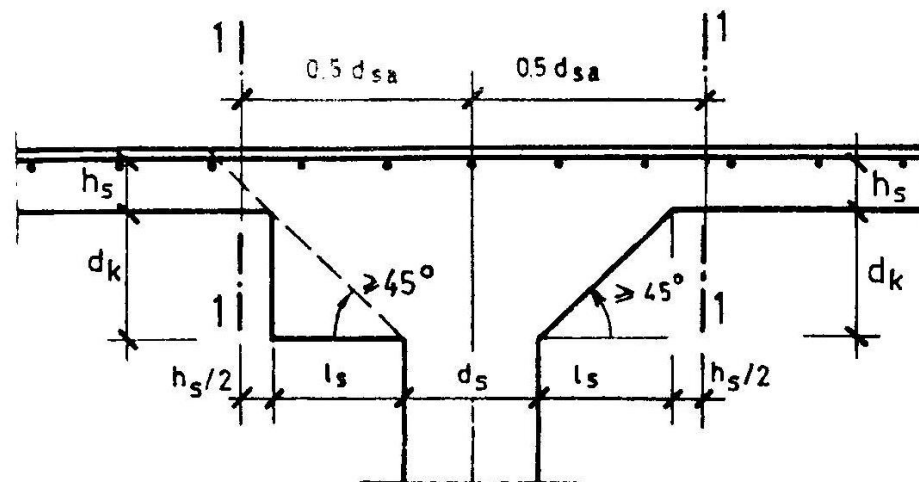
$$\Rightarrow Q(x) = R_{g+p} \Rightarrow \tau = \frac{R_{g+p}}{2\pi \cdot x \cdot z_x}$$

Iz uslova $\tau \leq \tau_a$, sledi:

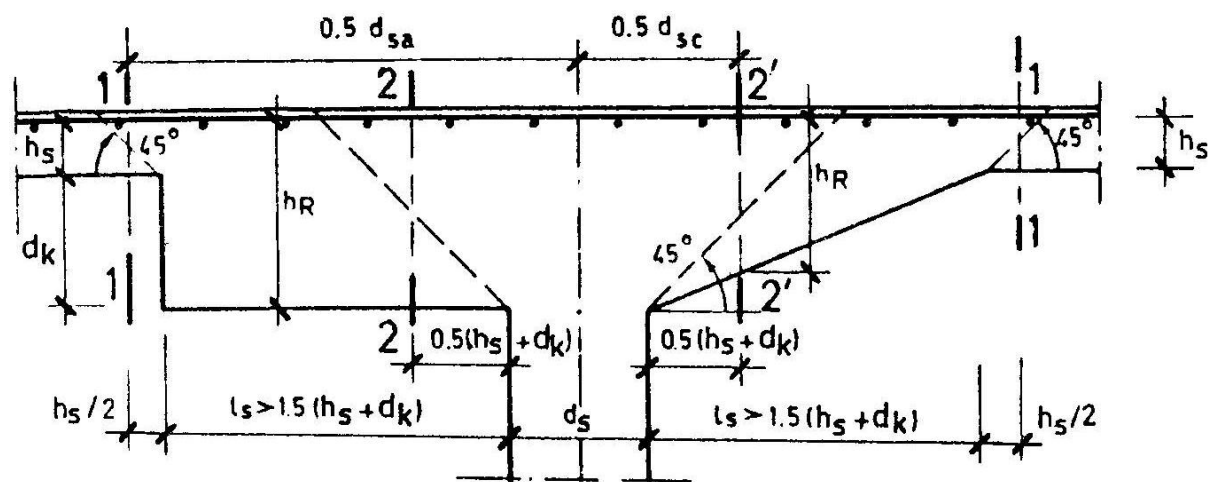
$$z_x \geq \frac{q \cdot l_x \cdot l_y}{2\pi \cdot x \cdot \tau_a}$$

Kritični preseci

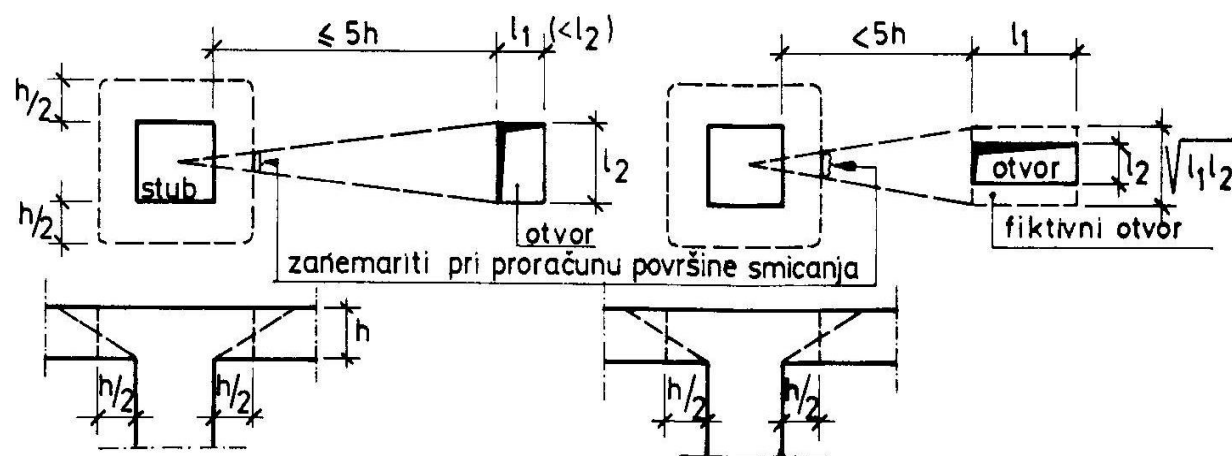
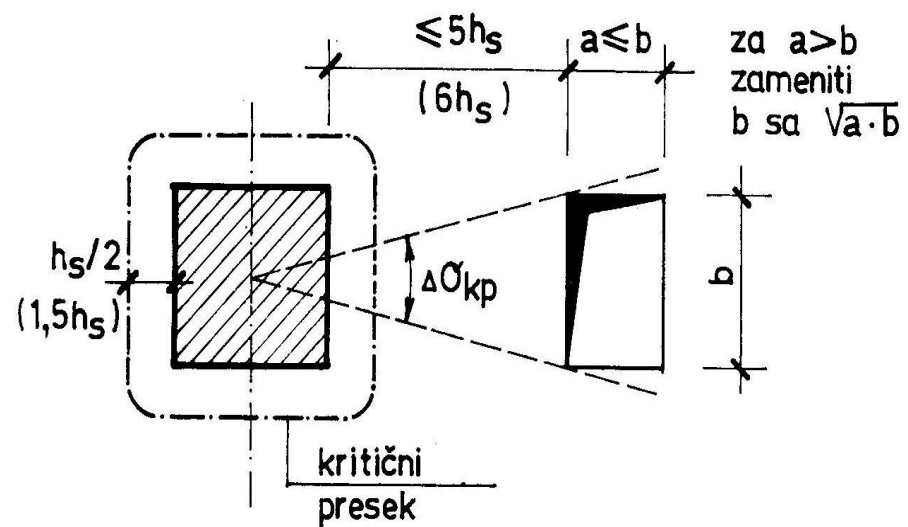
$$l_s \leq d_k$$



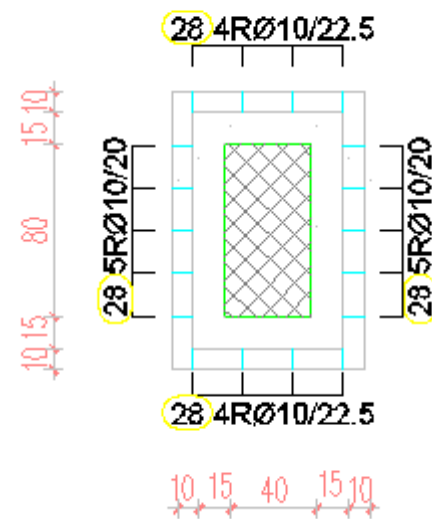
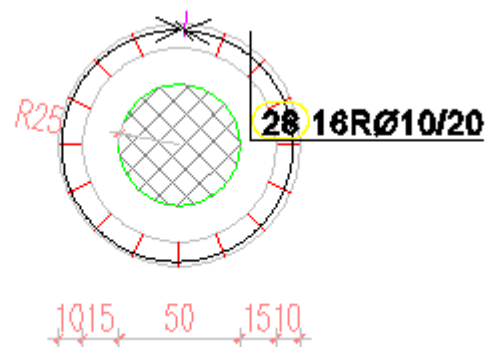
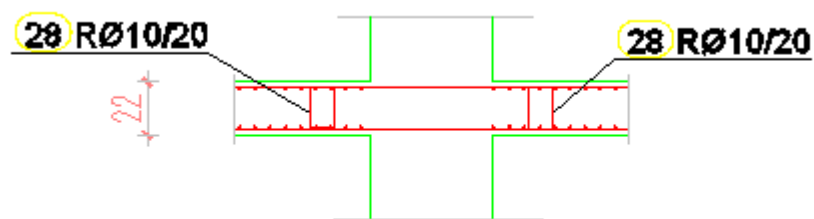
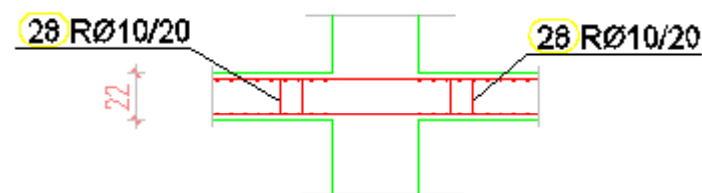
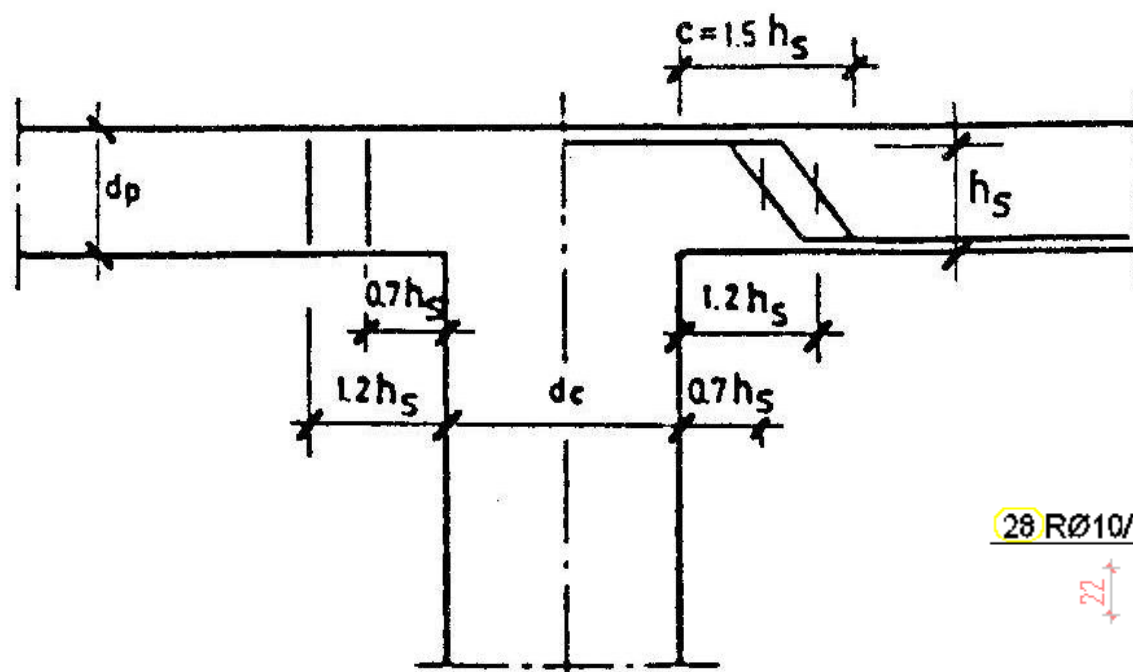
$$l_s \geq 1.5(h_s + d_k)$$



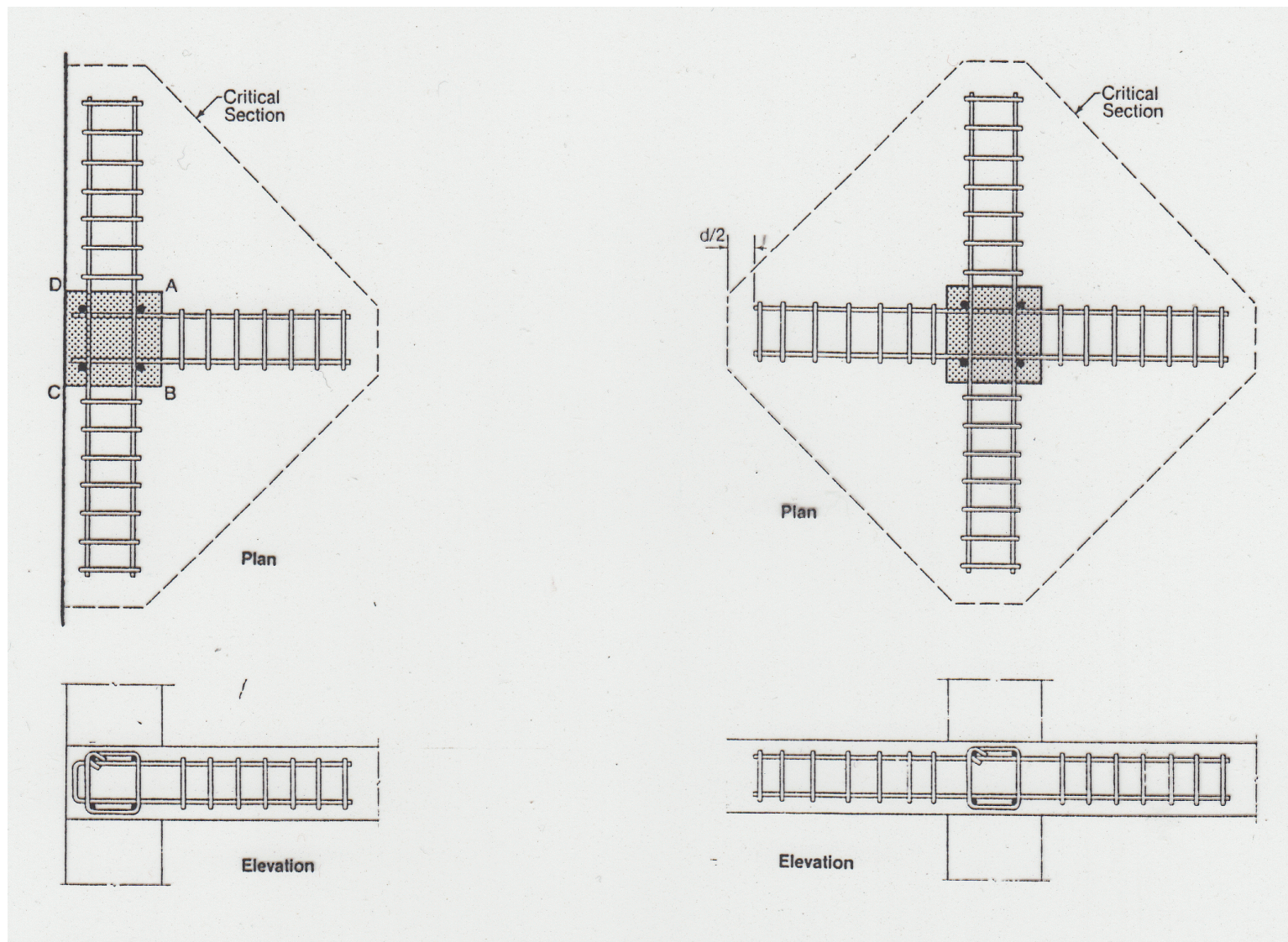
Uticaj otvora u ploči

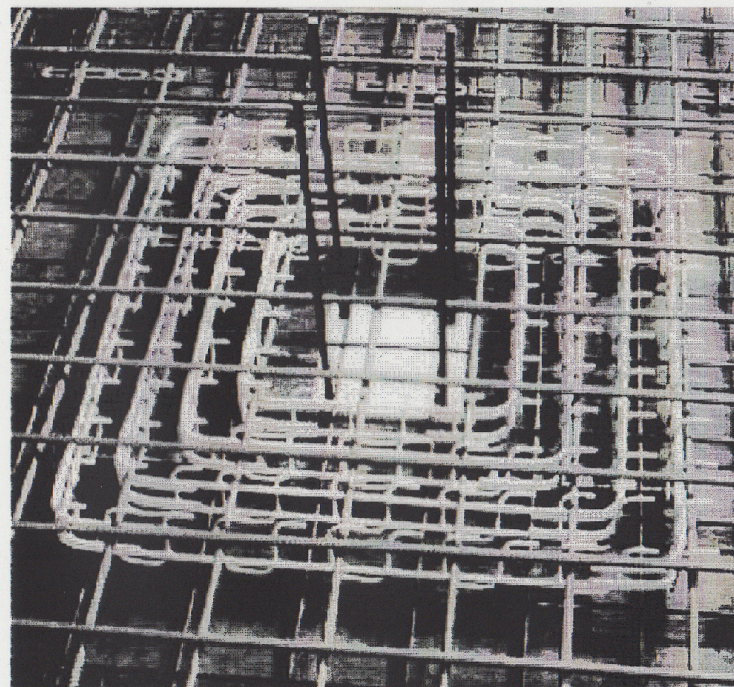
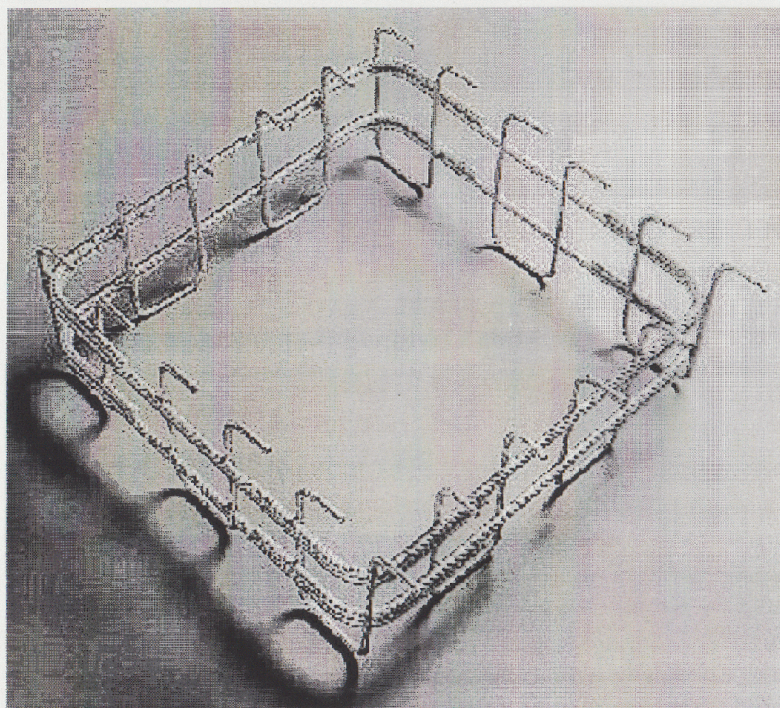


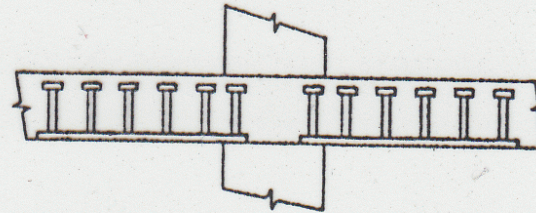
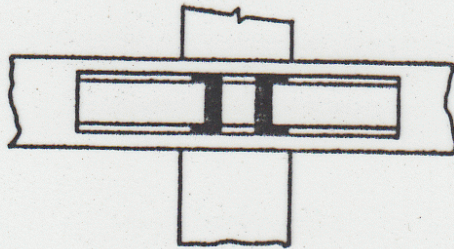
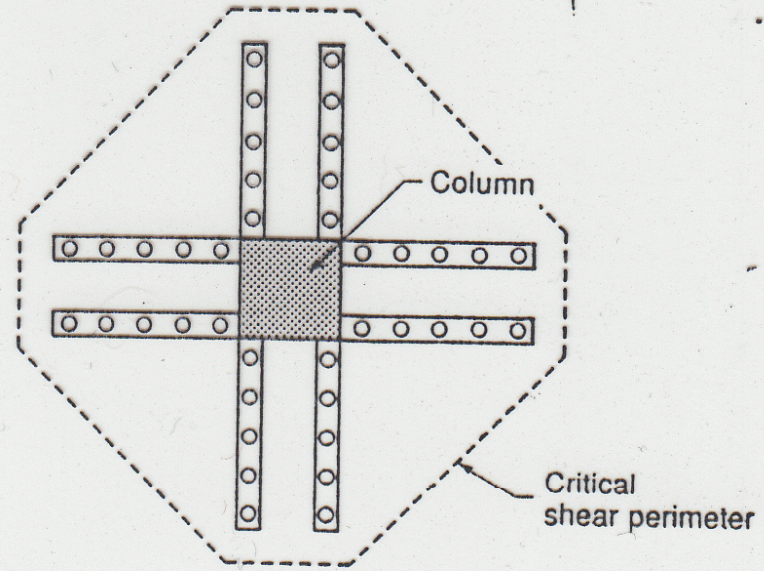
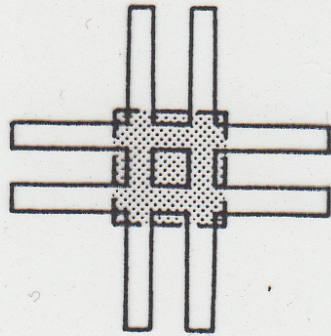
Položaj armature za osiguranje od proboja

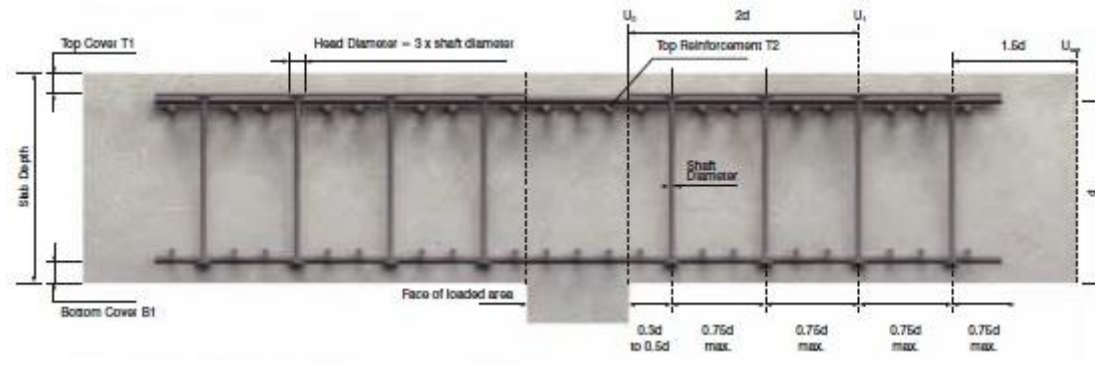
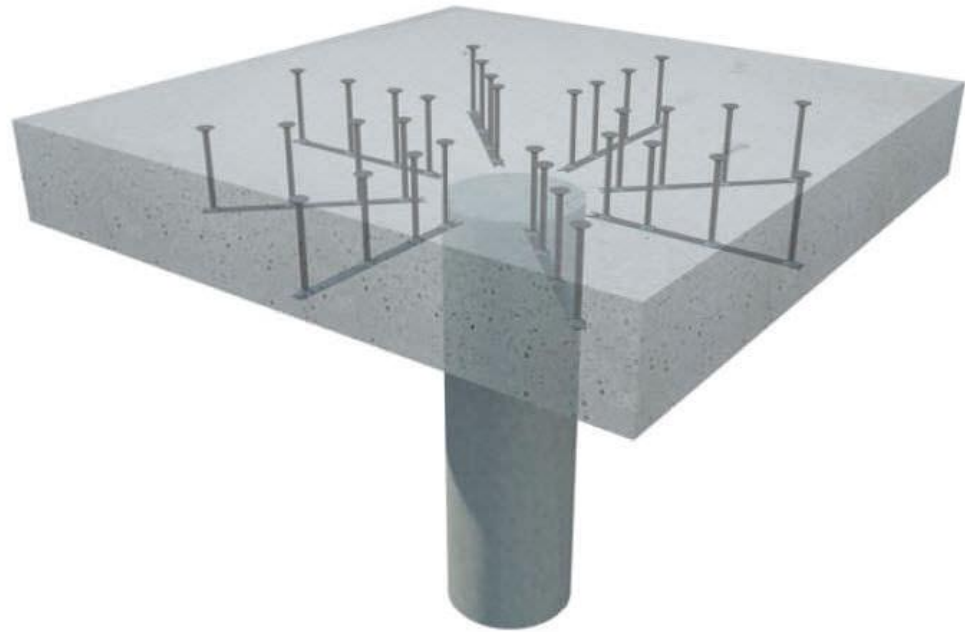


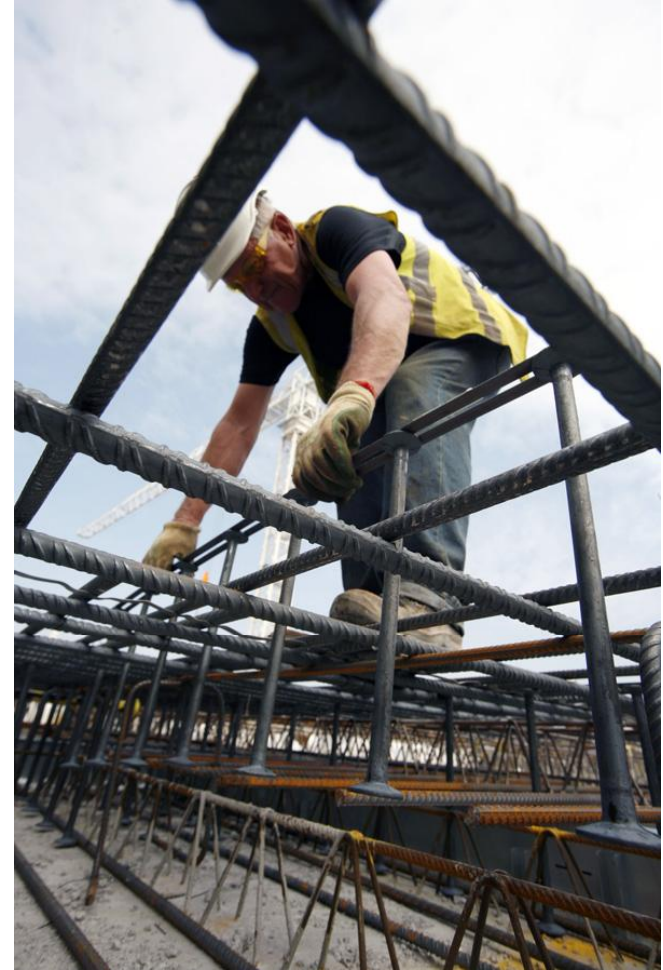
Alternativni vidovi osiguranja od proboja

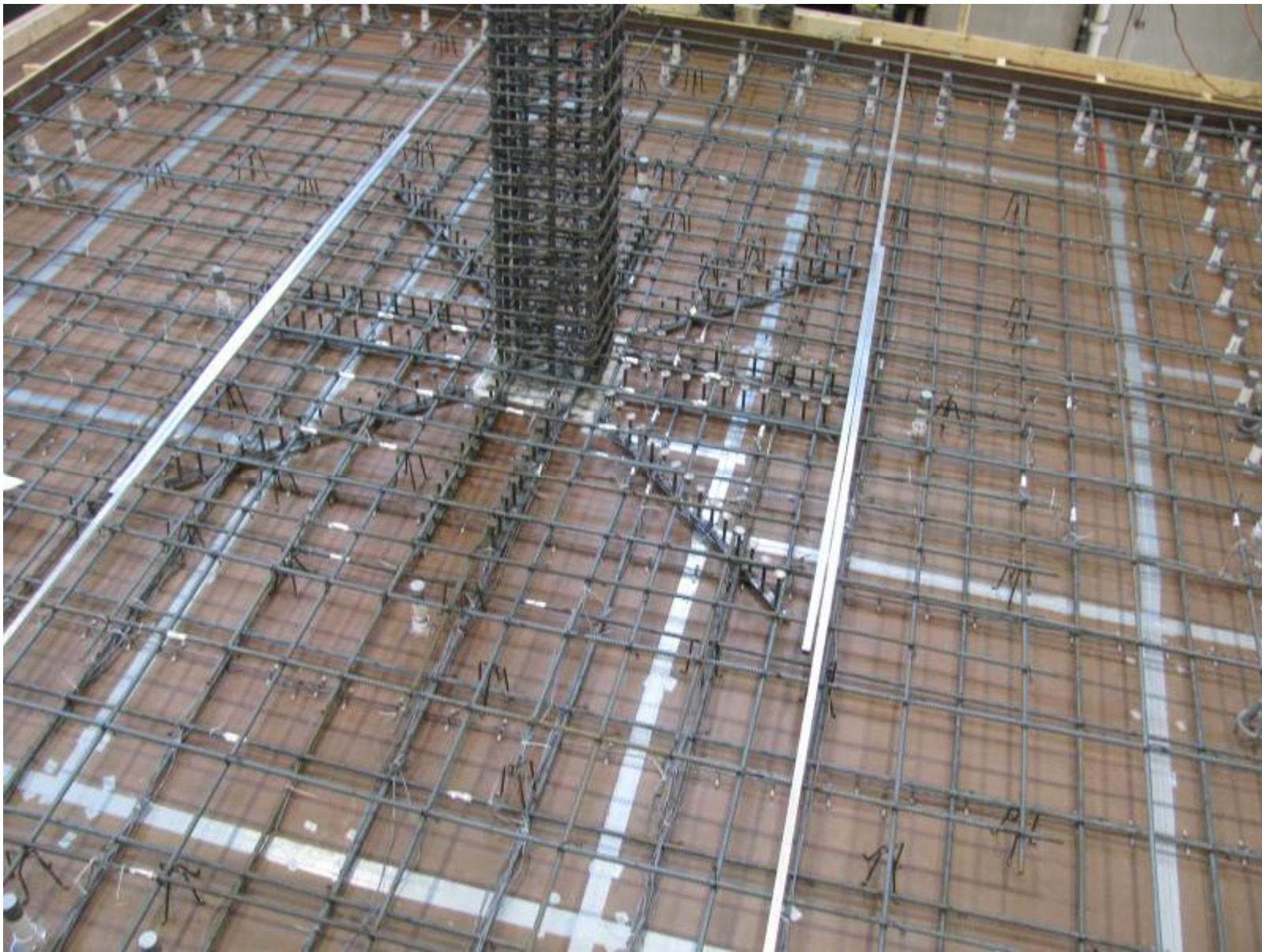




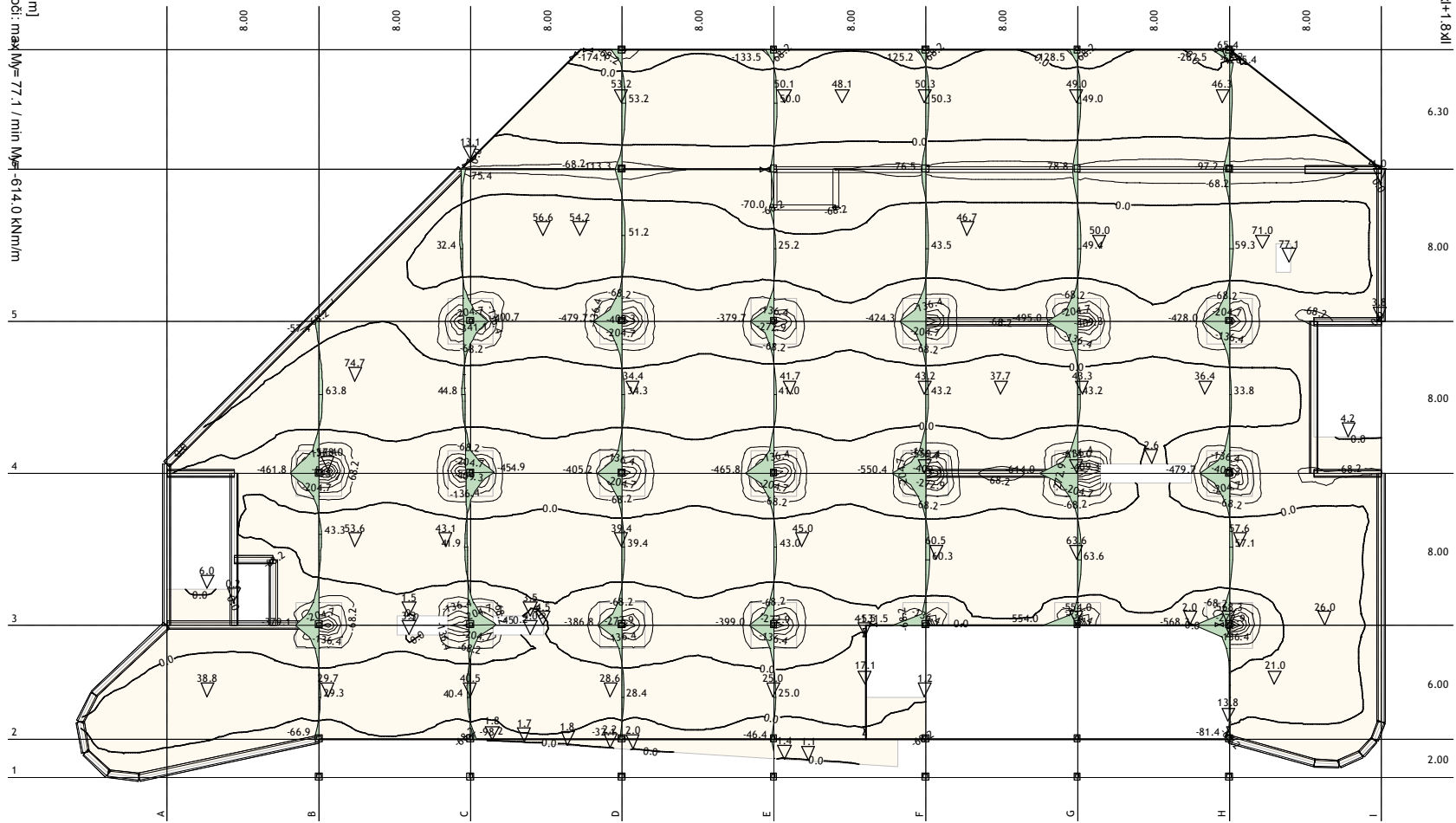








Opt. 4: 1.6x+1.8xI



Nivo: [5.76 m]
Uticaji u ploči: max $M_y = 77.1$ / min $M_y = -614.0$ kNm/m

Metodarno opterećenje: 1.68kN+1.80kN
PBAB 87, MB 30, RA 400/500, a=2.00 cm

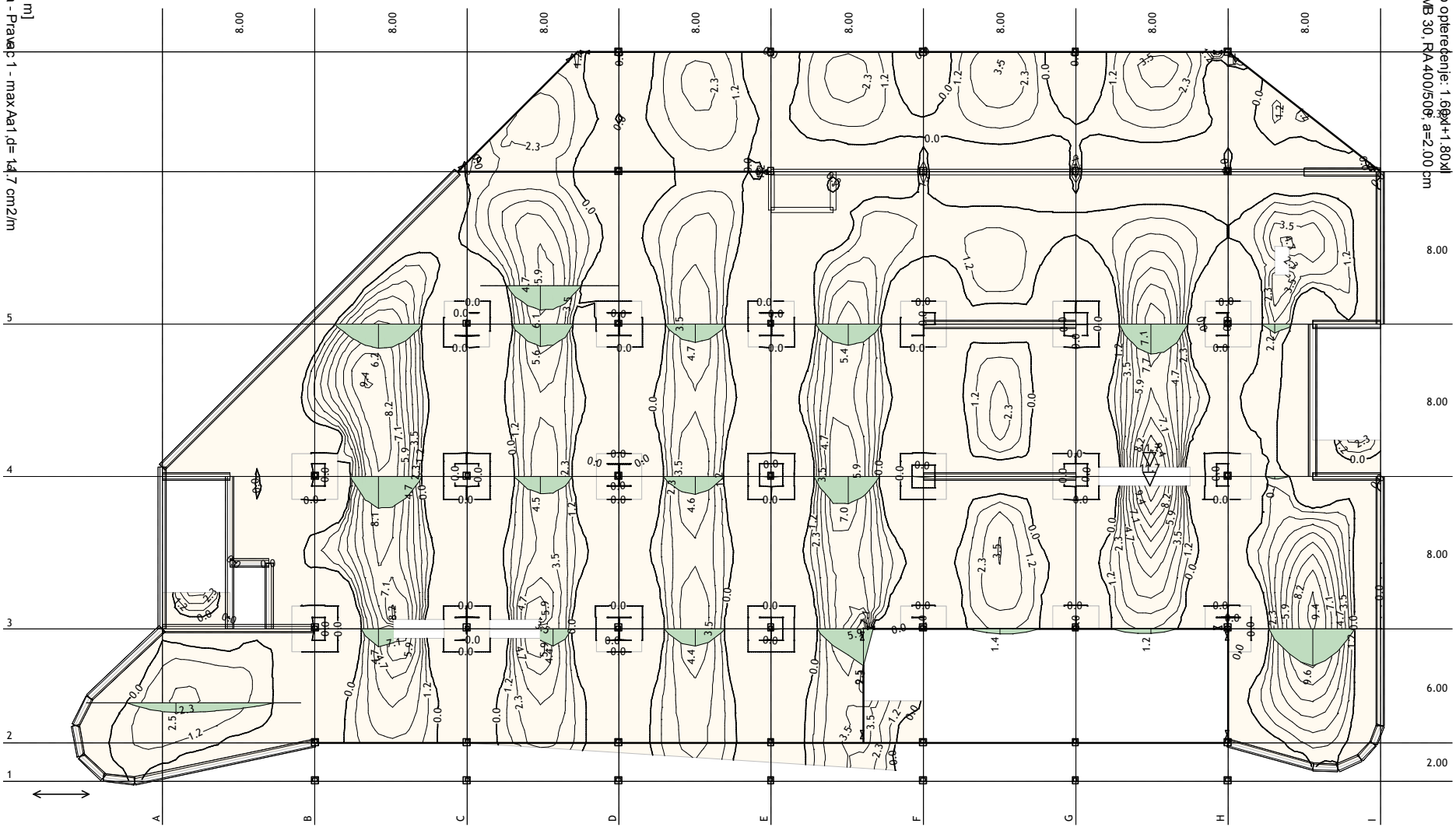
8.00

8.00

8.00

6.00

2.00



00.8

00.8

00.8

00.8

00.8

00.8

00.8

00.8

Nivo: [5.76 m]
Aa - d.20na - Præap 1 - max Aa1, d= 14, 7 cm2/m

Merodano opteređenje: 1.60x1.80x1
PBAB 87, MB 30, RA 400/500, a=2.00 cm

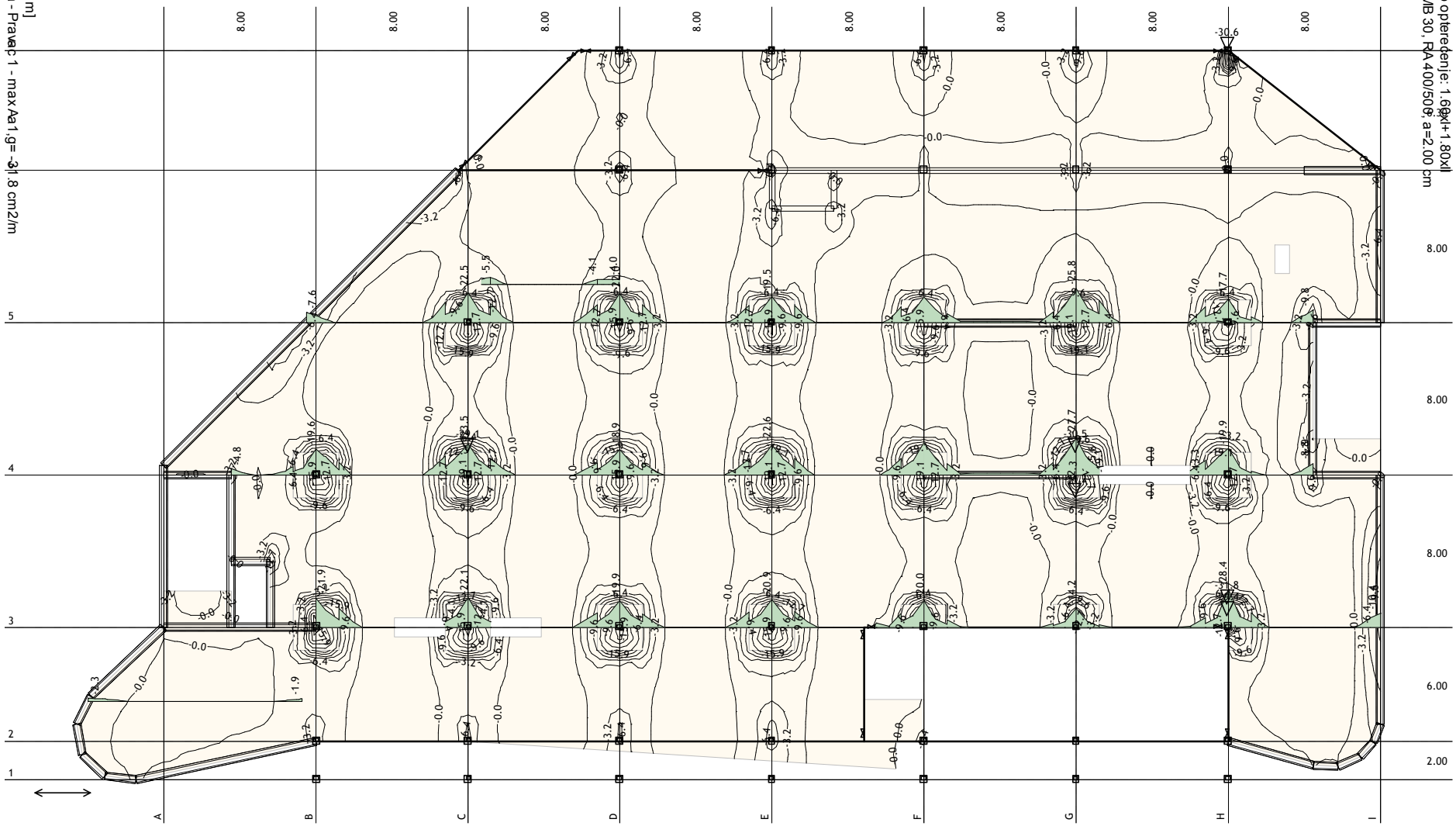
8.00

8.00

8.00

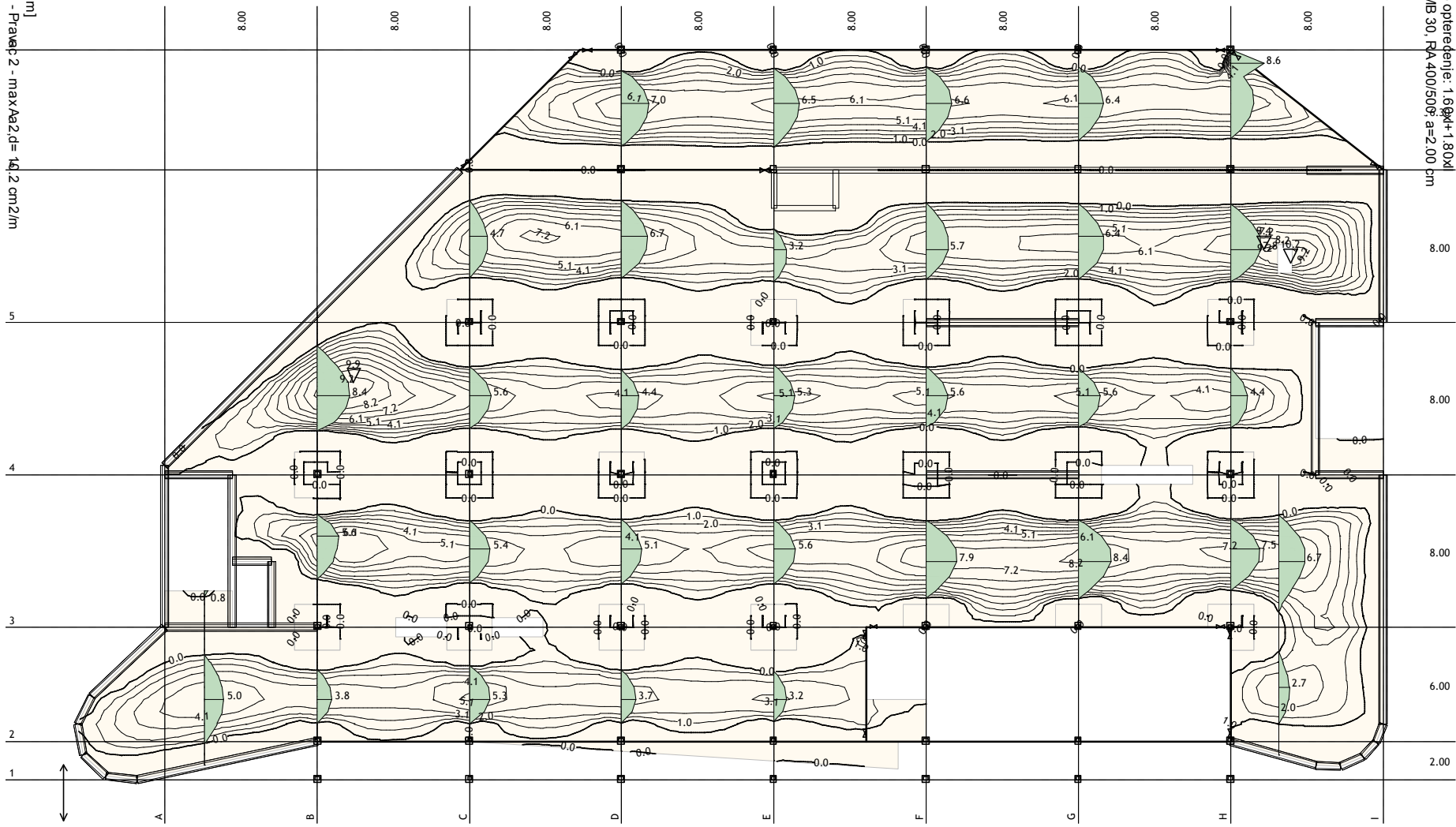
6.00

2.00



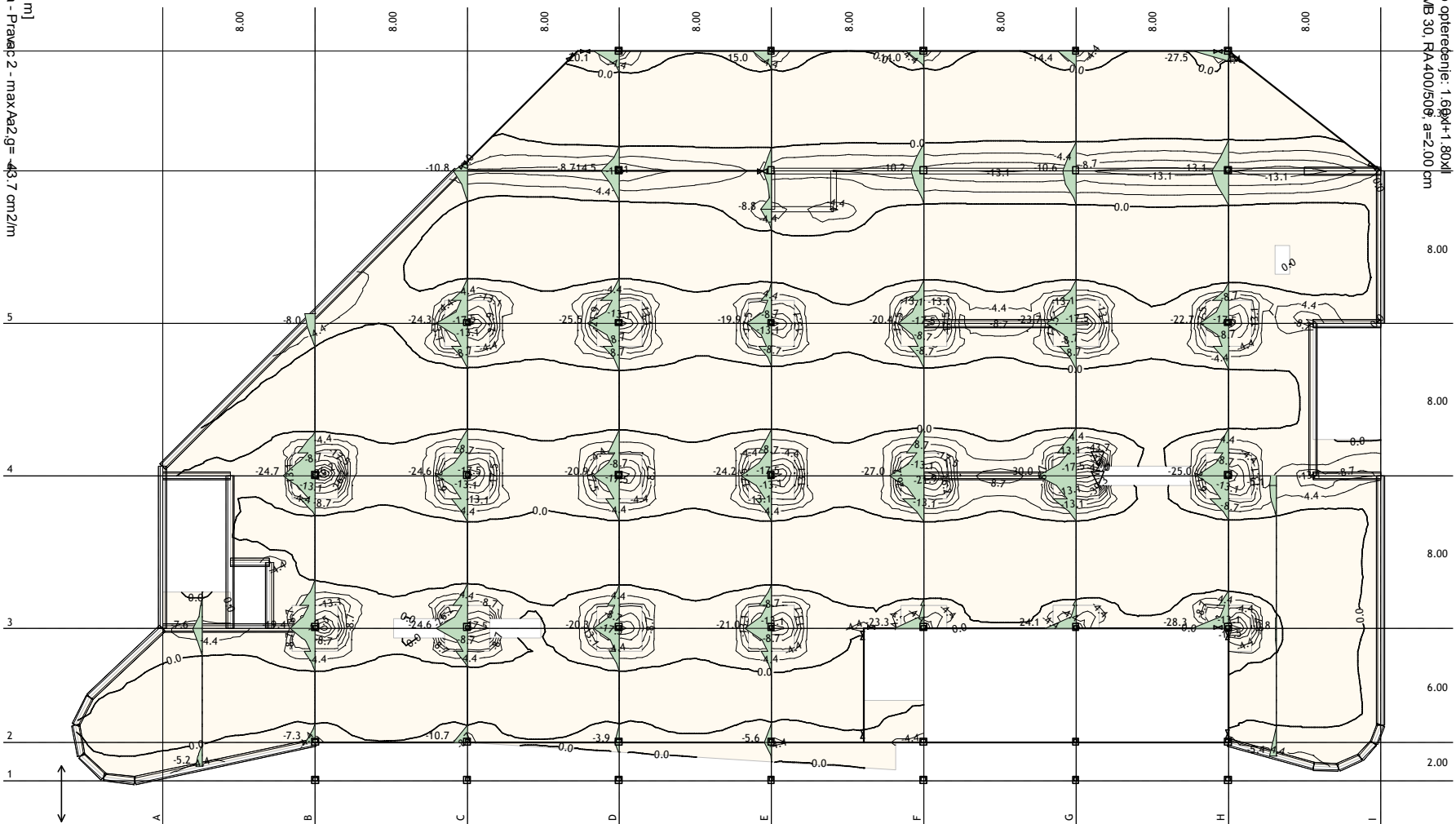
Nivo: [5.76 m]
Aa - g.zona - Pravač 1 - max Aa1, g= -3.1 8 cm2/m

Merodano opteređenje: 1.6kN+1.80kN
PBAB 87, MB 30, RA 400/500, a=2.00 cm

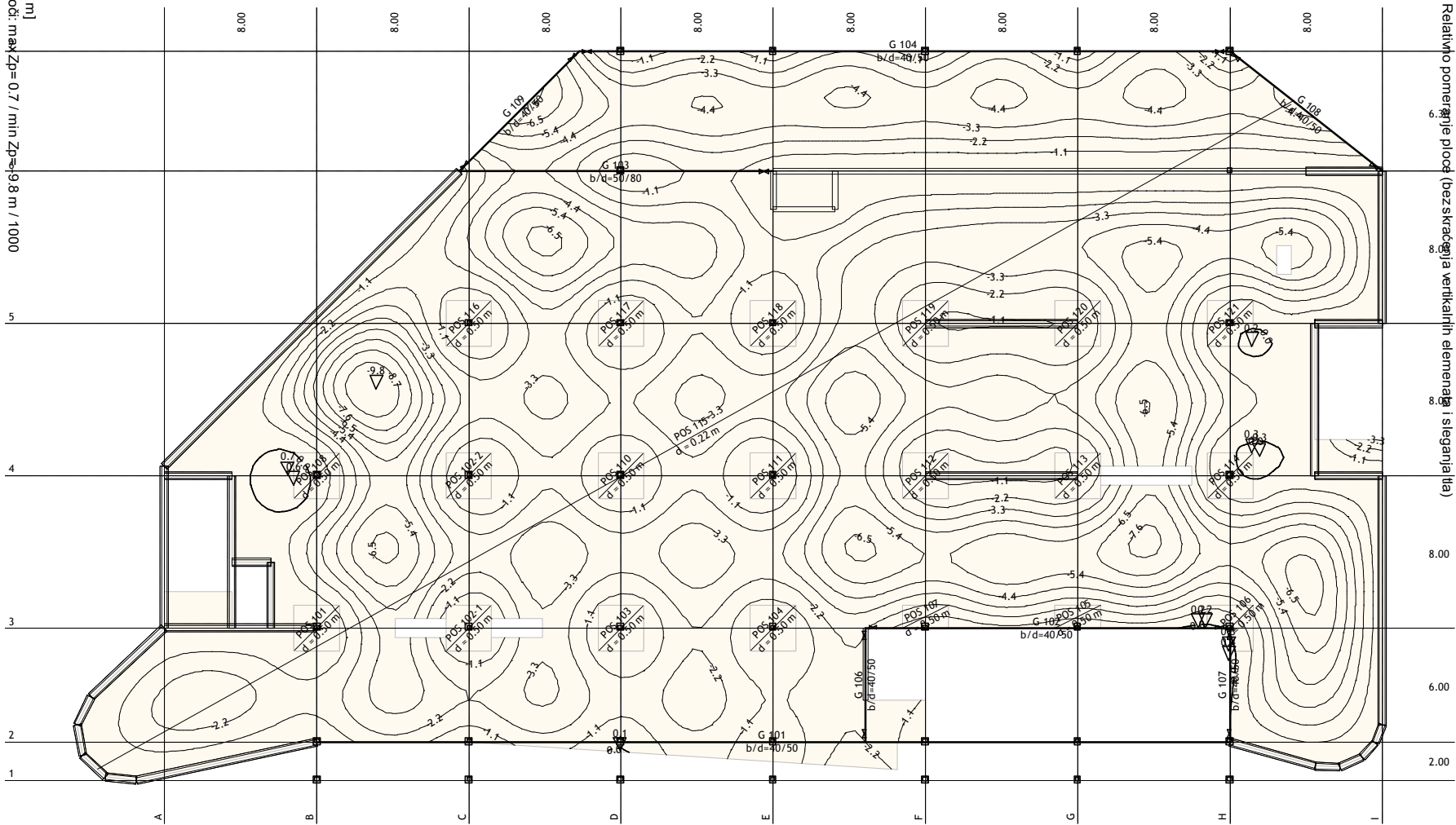


Nivo: [5.76 m]
Aa - d zona - P₁ aap 2 - max Aa2, d = 14.2 cm²/m

Merodano opterećenje: 1.68x1.80x1
PBAB 87, MB 30, RA 400/508, a=2.00 cm



Opt. 3-I-II, Relativno pomeranje ploče (bez skraćivanja vertikalnih elemenata i sleganja tla)



Nivo: [5.76 m]
Ulicaj u ploči: max Zp=0.7 / min Zp≈9.8 m / 1000