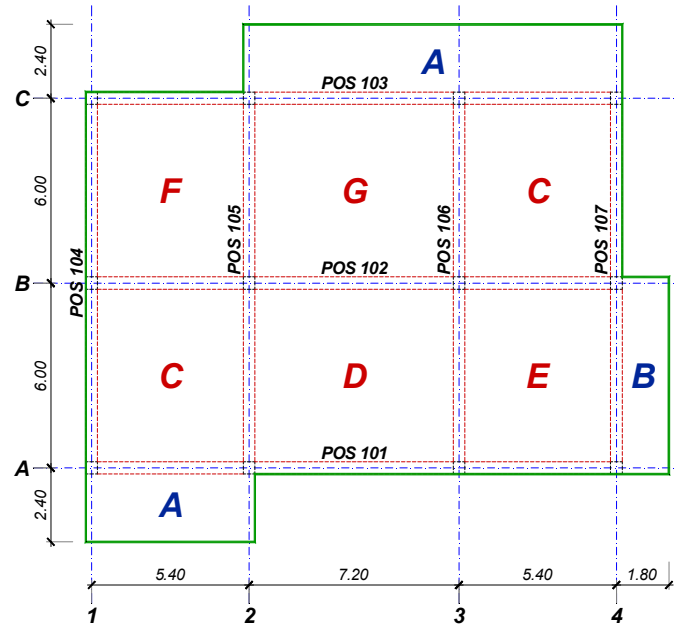


# Svođenje opterećenja na grede

1



2

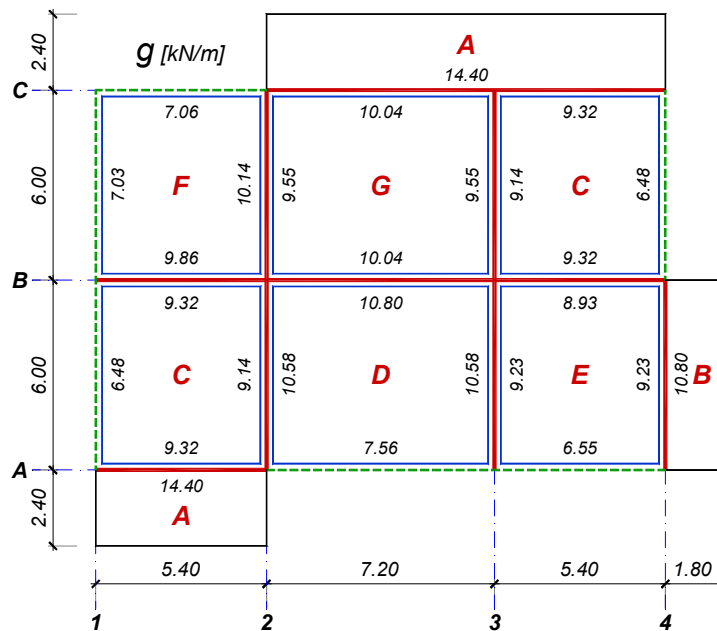
$l_y:l_x$	1,0	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2,0	
	$Q_1$	0,250	0,260	0,272	0,280	0,288	0,296	0,304	0,310	0,316	0,322	0,327
	$Q_2$	0,250	0,240	0,228	0,220	0,212	0,204	0,196	0,190	0,184	0,178	0,173
	$Q_1$	0,220	0,232	0,244	0,254	0,264	0,273	0,281	0,290	0,296	0,302	0,308
	$Q_2$	0,330	0,313	0,298	0,285	0,272	0,262	0,251	0,242	0,234	0,227	0,220
	$Q_1$	0,330	0,346	0,362	0,376	0,387	0,399	0,410	0,418	0,426	0,434	0,442
	$Q_2$	0,230	0,240	0,246	0,252	0,257	0,261	0,264	0,270	0,274	0,276	0,278
	$Q_1$	0,198	0,211	0,223	0,234	0,244	0,254	0,262	0,270	0,278	0,285	0,292
	$Q_2$	0,302	0,289	0,277	0,266	0,256	0,246	0,238	0,230	0,222	0,215	0,208
	$Q_1$	0,302	0,315	0,326	0,334	0,342	0,350	0,356	0,361	0,367	0,372	0,377
	$Q_2$	0,198	0,185	0,174	0,166	0,158	0,150	0,144	0,139	0,133	0,128	0,123
	$Q_1$	0,292	0,313	0,331	0,346	0,360	0,370	0,380	0,390	0,400	0,410	0,419
	$Q_2$	0,208	0,217	0,226	0,233	0,241	0,247	0,252	0,256	0,260	0,263	0,266
	$Q_1$	0,292	0,274	0,257	0,244	0,230	0,221	0,212	0,204	0,196	0,189	0,182
	$Q_2$	0,208	0,196	0,186	0,177	0,169	0,162	0,156	0,150	0,144	0,138	0,133
	$Q_1$	0,262	0,282	0,300	0,316	0,329	0,344	0,354	0,365	0,376	0,386	0,394
	$Q_2$	0,190	0,200	0,210	0,218	0,227	0,234	0,240	0,245	0,250	0,254	0,258
	$Q_1$	0,274	0,285	0,297	0,309	0,318	0,326	0,334	0,341	0,347	0,353	0,358
	$Q_2$	0,190	0,182	0,174	0,165	0,158	0,152	0,146	0,141	0,136	0,131	0,126
	$Q_1$	0,262	0,248	0,232	0,217	0,206	0,196	0,186	0,177	0,170	0,163	0,158
	$Q_2$	0,290	0,266	0,249	0,231	0,202	0,182	0,160	0,138	0,117	0,095	0,073
	$Q_1$	0,290	0,266	0,249	0,231	0,202	0,182	0,160	0,138	0,117	0,095	0,073
	$Q_2$	0,290	0,234	0,221	0,209	0,198	0,188	0,180	0,173	0,167	0,161	0,155

Približno opterećenje osloničke grede  $q = \frac{Q}{l}$

Koeficijent  $\gamma$  za određivanje rezultirajuće reakcije oslonca krutino završeno simetrično ploče, odabirajte na osnovi stranice, opterećenja jednako podijeljeno opterećenjem  $q$  (kN/m<sup>2</sup>)

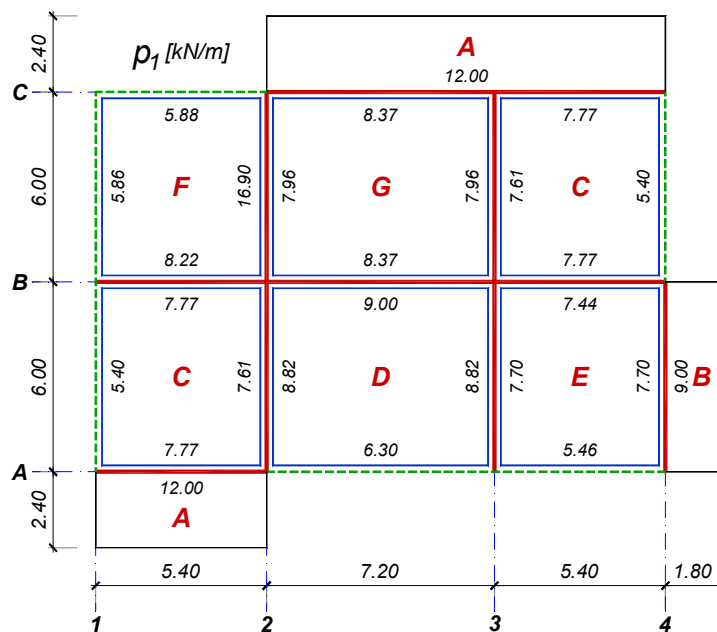
### Stalno opterećenje (bez s.t. gređa POS 101-POS 107)

3



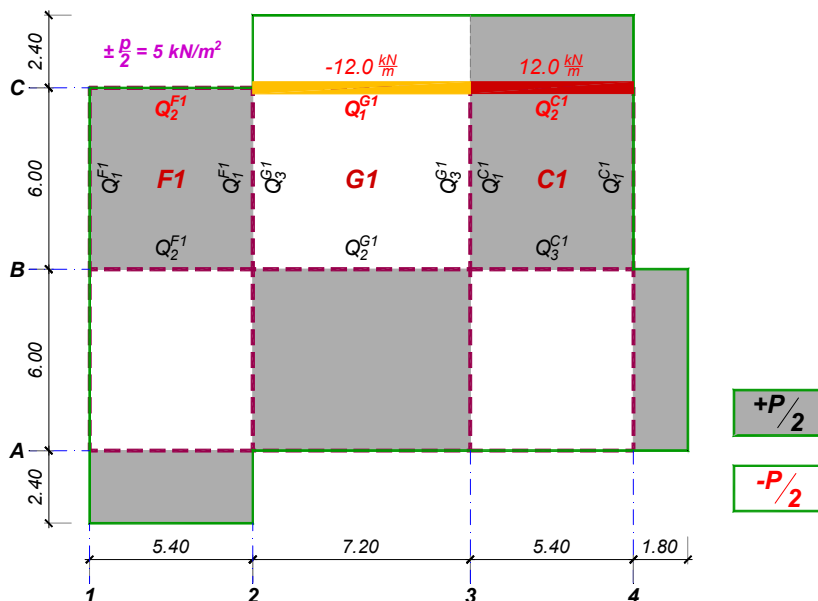
### Povremeno opterećenje $p/2$ po čitavoj ploči

4



## Šema opterećenja - polje 1-2 (polje 3-4)

5



### Ploča F1, $p_2 = +p/2$

$$L_y/L_x = 6.0/5.4 \approx 1.1$$

$$Q_2^{F1} = 0.240 \times \frac{10.0}{2} \times 5.4 \times 6.0 = 38.88 \text{ kN}$$

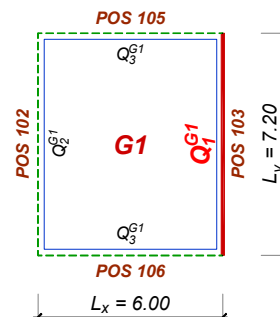
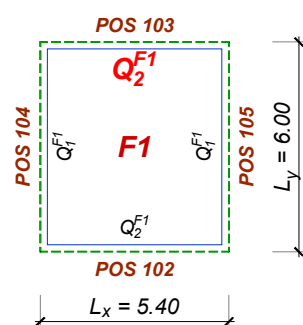
$$p_{2,1}^{103} = \frac{Q_2^{F1}}{L_x} = \frac{38.88}{5.4} = 7.20 \frac{\text{kN}}{\text{m}}$$

### Ploča G1, $p_2 = -p/2$

$$L_y/L_x = 7.2/6.0 = 1.2$$

$$Q_1^{G1} = 0.362 \times \frac{-10.0}{2} \times 6.0 \times 7.2 = -78.19 \text{ kN}$$

$$p_{2,2}^{103} = \frac{Q_1^{G1}}{L_y} = \frac{-78.19}{7.2} = -10.86 \frac{\text{kN}}{\text{m}}$$

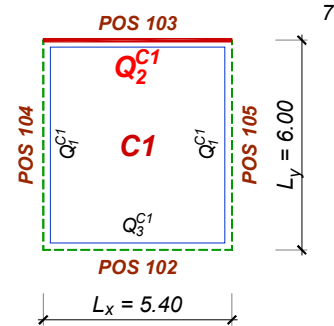


## Ploča C1, $p_2 = +p/2$

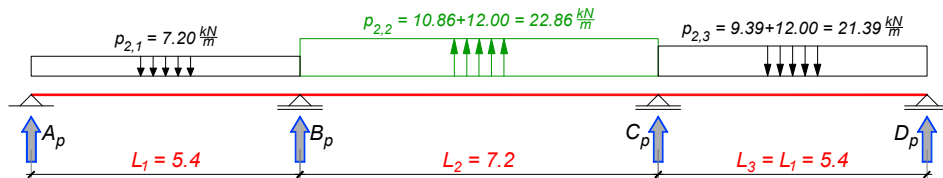
$$L_y/L_x = 6.0/5.4 \approx 1.1$$

$$Q_2^{C1} = 0.313 \times \frac{10.0}{2} \times 5.4 \times 6.0 = 50.71 \text{ kN}$$

$$p_{2,3}^{103} = \frac{Q_2^{C1}}{L_x} = \frac{50.71}{5.4} = 9.39 \frac{\text{kN}}{\text{m}}$$



## Ukupno, $p_2 = \pm p/2$ za maksimalni $M$ u poljima 1-2 i 3-4



## POS 103 (osa C) – analiza opterećenja

8

### stalno opterećenje

$$\text{polje 1-2: } g_1 = 4.5 + 7.06 = 11.56 \text{ kN/m}$$

$$\text{polje 2-3: } g_2 = 4.5 + 10.04 + 14.4 = 28.94 \text{ kN/m}$$

$$\text{polje 3-4: } g_3 = 4.5 + 9.32 + 14.4 = 28.22 \text{ kN/m}$$

### povremeno opterećenje za max. $M_u$ u krajnjim poljima

$$\text{polje 1-2: } p_1 = 11.76/2 + 7.20 = 13.08 \text{ kN/m}$$

$$\text{polje 2-3: } p_2 = 40.74/2 + (-22.86) = -2.49 \text{ kN/m}$$

$$\text{polje 3-4: } p_3 = 39.54/2 + 21.39 = 41.16 \text{ kN/m}$$

$$q_{u1} = 1.6 \times 11.56 + 1.8 \times 13.08 = 42.03 \text{ kN/m}$$

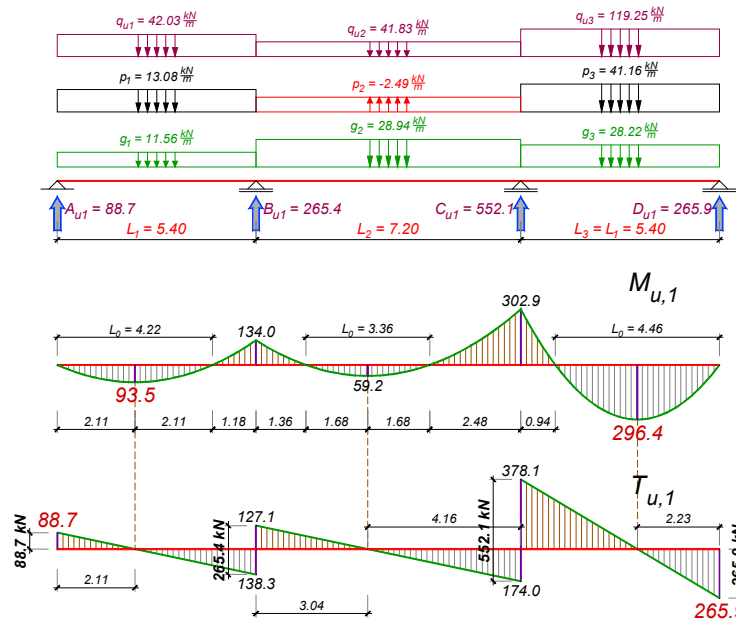
$$q_{u2} = 1.6 \times 28.94 + 1.8 \times (-2.49) = 41.83 \text{ kN/m}$$

$$q_{u3} = 1.6 \times 28.22 + 1.8 \times 41.16 = 119.25 \text{ kN/m}$$

Pri ovoj kombinaciji opterećenja se, pored maksimalnih momenata savijanja u krajnjim poljima, javljaju i maksimalne transverzalne sile na krajnjim osloncima i reakcije oslonaca A i D.

## $P_1$ – max. $M_u$ u krajnjim poljima

9



$M_u = 296.4 \text{ kNm}$  (polje 3-4, donja zona)

10

pretp.  $a_1 = 5 \text{ cm} \Rightarrow b/d/h = 30/60/55 \text{ cm}$

$$L_0 = 4.46 \text{ m} \Rightarrow B = \min. \left\{ \begin{array}{l} 30 + 20 \times 16 = 350 \\ 600/2 + 240 = 540 \\ 30 + 0.25 \times 446 = 141 \end{array} \right\} = 141 \text{ cm}$$

$$k = \frac{55}{\sqrt{\frac{296.4 \times 10^2}{141 \times 2.05}}} = 5.441 \Rightarrow s = 0.087$$

$$\varepsilon_b / \varepsilon_a = 0.952 / 10\%$$

$$\bar{\mu} = 3.484\%$$

$$x = 0.087 \times 55 = 4.8 \text{ cm} < d_p = 16 \text{ cm}$$

$$A_a = 3.484 \times \frac{141 \times 55}{100} \times \frac{2.05}{40} = 13.89 \text{ cm}^2$$

usvojeno: **4RØ22** (15.21 cm<sup>2</sup>)

$M_u = 93.5 \text{ kNm}$  (polje 1-2, donja zona)

11

pretp.  $a_1 = 5 \text{ cm} \Rightarrow b/d/h = 30/60/55 \text{ cm}$

$$L_o = 4.22 \text{ m} \Rightarrow B = \min. \left\{ \begin{array}{l} 30 + 8 \times 16 = 158 \\ 600/2 = 300 \\ 30 + 0.25 \times 422/3 = 65 \end{array} \right\} = 65 \text{ cm}$$

$$k = \frac{55}{\sqrt{\frac{93.5 \times 10^2}{65 \times 2.05}}} = 6.573 \Rightarrow s = 0.071$$

$$\varepsilon_b / \varepsilon_a = 0.765 / 10\text{‰}$$

$$\bar{\mu} = 2.373\%$$

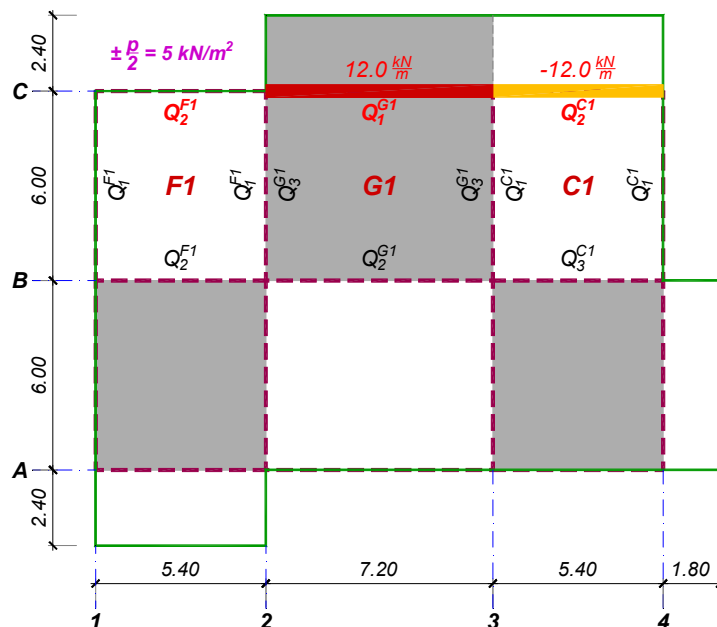
$$x = 0.071 \times 55 = 3.9 \text{ cm} < d_p = 16 \text{ cm}$$

$$A_a = 2.373 \times \frac{65 \times 55}{100} \times \frac{2.05}{40} = 4.36 \text{ cm}^2$$

usvojeno: **3RØ16** ( $6.03 \text{ cm}^2$ )

### Šema opterećenja - polje 2-3

12

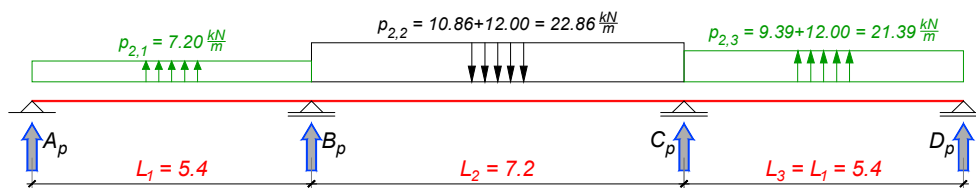


## Šema opterećenja - polje 2-3

13

Šema opterećenja je ista kao za maksimalne momente savijanja u krajnjim poljima, samo što su opterećenja suprotnog znaka. Stoga su i konturni uslovi na pojedinim pločama potpuno isti, pa su i opterećenja za pojedine raspone grede POS 103 istog intenziteta i suprotnog znaka.

**Ukupno,  $p_2 = \pm p/2$  za maksimalni  $M$  u polju 2-3**



## POS 103 (osa C) – analiza opterećenja

14

### stalno opterećenje

$$\text{polje 1-2: } g_1 = 4.5 + 7.06 = 11.56 \text{ kN/m}$$

$$\text{polje 2-3: } g_2 = 4.5 + 10.04 + 14.4 = 28.94 \text{ kN/m}$$

$$\text{polje 3-4: } g_3 = 4.5 + 9.32 + 14.4 = 28.22 \text{ kN/m}$$

### povremeno opterećenje za max. $M_u$ u srednjem polju

$$\text{polje 1-2: } p_1 = 11.76/2 + (-7.20) = -1.32 \text{ kN/m}$$

$$\text{polje 2-3: } p_2 = 40.74/2 + 22.86 = 43.23 \text{ kN/m}$$

$$\text{polje 3-4: } p_3 = 39.54/2 + (-21.39) = -1.62 \text{ kN/m}$$

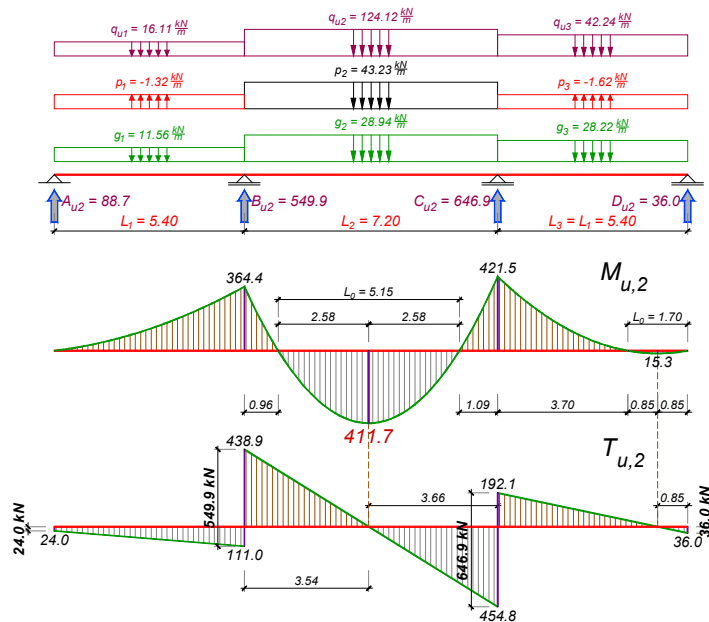
$$q_{u1} = 1.6 \times 11.56 + 1.8 \times (-1.32) = 16.11 \text{ kN/m}$$

$$q_{u2} = 1.6 \times 28.94 + 1.8 \times 43.23 = 124.12 \text{ kN/m}$$

$$q_{u3} = 1.6 \times 28.22 + 1.8 \times (-1.62) = 42.24 \text{ kN/m}$$

## $P_2$ – max. $M_u$ u srednjem polju

15



$M_u = 411.7 \text{ kNm}$  (polje 2-3, donja zona)

16

pretp.  $a_1 = 7 \text{ cm} \Rightarrow b/d/h = 30/60/53 \text{ cm}$

$$L_0 = 5.15 \text{ m} \Rightarrow B = \min. \left\{ \begin{array}{l} 30 + 20 \times 16 = 350 \\ 600/2 + 240 = 540 \\ 30 + 0.25 \times 515 = 159 \end{array} \right\} = 159 \text{ cm}$$

$$k = \frac{53}{\sqrt{\frac{411.7 \times 10^2}{159 \times 2.05}}} = 4.713 \Rightarrow s = 0.102$$

$$\varepsilon_b / \varepsilon_a = 1.132 / 10\%$$

$$\bar{\mu} = 4.670\%$$

$$x = 0.102 \times 53 = 5.4 \text{ cm} < d_p = 16 \text{ cm}$$

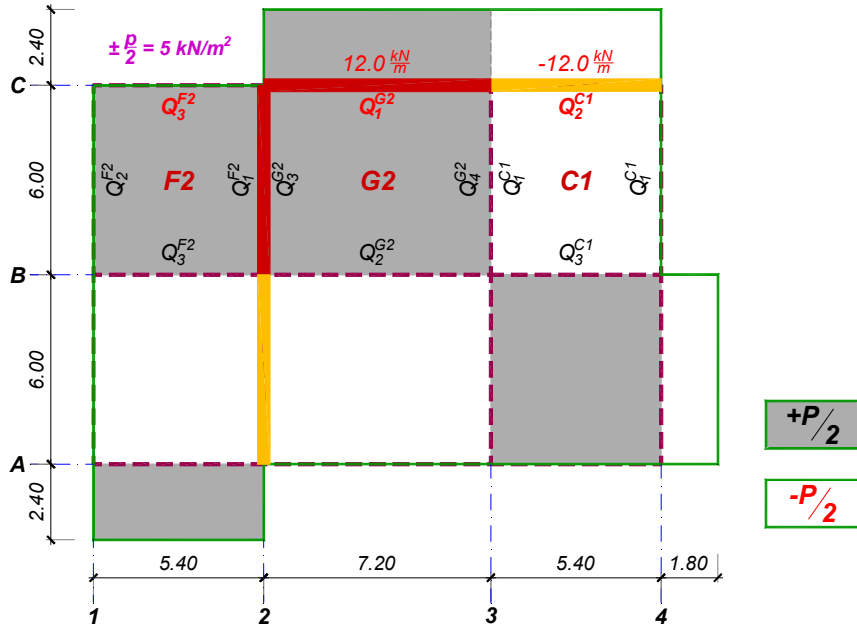
$$A_a = 4.670 \times \frac{159 \times 53}{100} \times \frac{2.05}{40} = 20.14 \text{ cm}^2$$

usvojeno: **6RØ22** (22.81 cm<sup>2</sup>)



## Šema opterećenja – oslonac u osi 2

17



### Ploča F2, $p_2 = +p/2$

$$\frac{L_y}{L_x} = \frac{6.0}{5.4} \approx 1.1$$

$$Q_3^{F2} = 0.207 \times \frac{10.0}{2} \times 5.4 \times 6.0 = 33.53 \text{ kN}$$

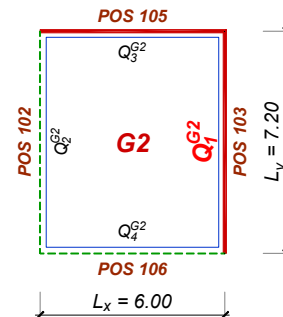
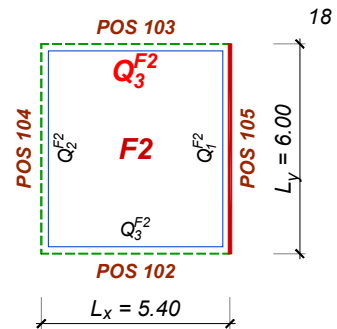
$$p_{2,1}^{103} = \frac{Q_3^{F2}}{L_x} = \frac{33.53}{5.4} = 6.21 \frac{\text{kN}}{\text{m}}$$

### Ploča G2, $p_2 = +p/2$

$$\frac{L_y}{L_x} = \frac{7.2}{6.0} = 1.2$$

$$Q_1^{G2} = 0.331 \times \frac{10.0}{2} \times 6.0 \times 7.2 = 71.50 \text{ kN}$$

$$p_{2,2}^{103} = \frac{Q_1^{G2}}{L_y} = \frac{71.50}{7.2} = 9.93 \frac{\text{kN}}{\text{m}}$$

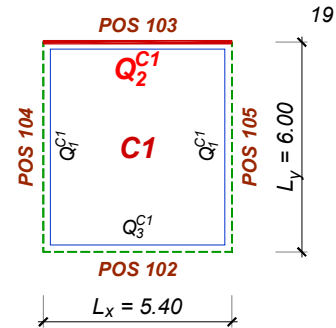


## Ploča C1, $p_2 = -p/2$

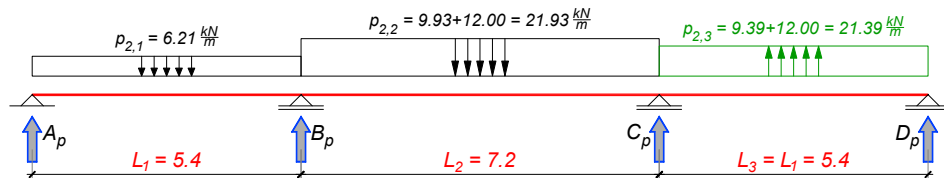
$$L_y/L_x = 6.0/5.4 \approx 1.1$$

$$Q_2^{F1} = 0.313 \times \frac{-10.0}{2} \times 5.4 \times 6.0 = -50.71 \text{ kN}$$

$$p_{2,3}^{103} = \frac{Q_2^{C1}}{L_x} = \frac{-50.71}{5.4} = -9.39 \frac{\text{kN}}{\text{m}}$$



## Ukupno, $p_2 = \pm p/2$ za maksimalni $M$ na osloncu 2



## POS 103 (osa C) – analiza opterećenja

20

### stalno opterećenje

polje 1-2:  $g_1 = 4.5 + 7.06 = 11.56 \text{ kN/m}$

polje 2-3:  $g_2 = 4.5 + 10.04 + 14.4 = 28.94 \text{ kN/m}$

polje 3-4:  $g_3 = 4.5 + 9.32 + 14.4 = 28.22 \text{ kN/m}$

### povremeno opterećenje za max. $M_u$ nad osloncem 2

polje 1-2:  $p_1 = 11.76/2 + 6.21 = 12.09 \text{ kN/m}$

polje 2-3:  $p_2 = 40.74/2 + 21.93 = 42.30 \text{ kN/m}$

polje 3-4:  $p_3 = 39.54/2 + (-21.39) = -1.62 \text{ kN/m}$

$$q_{u1} = 1.6 \times 11.56 + 1.8 \times 12.09 = 40.25 \text{ kN/m}$$

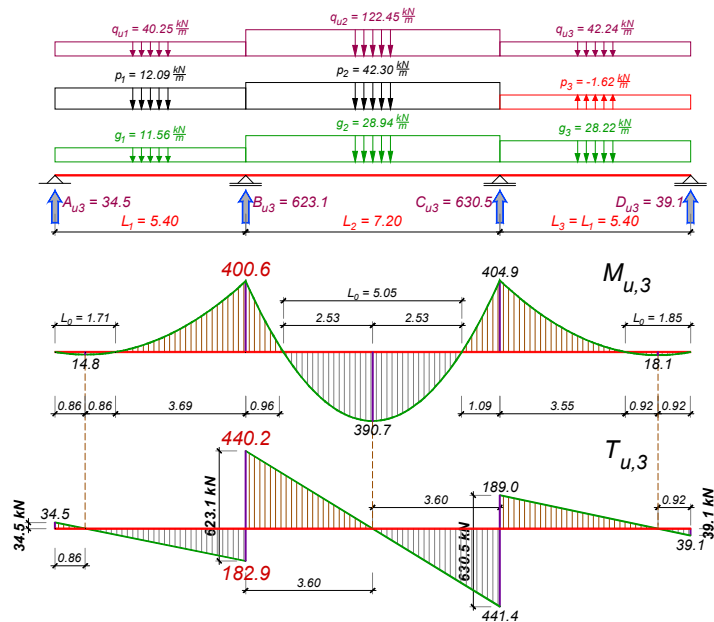
$$q_{u2} = 1.6 \times 28.94 + 1.8 \times 42.30 = 122.45 \text{ kN/m}$$

$$q_{u3} = 1.6 \times 28.22 + 1.8 \times (-1.62) = 42.24 \text{ kN/m}$$

Pri ovoj kombinaciji opterećenja se, pored maksimalnog momenta savijanja nad osloncem 2, javljaju i maksimalne transverzalne sile u presecima levo i desno od tog oslonca, kao i maksimalna sila u osloncu 2.

## $P_3$ – max. $M_u$ nad osloncem 2

21



## POS 103 – dimenzionisanje

22

$M_{u,max} = 400.6 \text{ kNm}$  (osa 2, gornja zona)

MB 30  $\Rightarrow f_B = 20.5 \text{ MPa} = 2.05 \text{ kN/cm}^2$

RA 400/500  $\Rightarrow \sigma_v = 400 \text{ MPa} = 40 \text{ kN/cm}^2$

pretp.  $a_1 = 7 \text{ cm}$   $\Rightarrow b/d/h = 30/60/53 \text{ cm}$

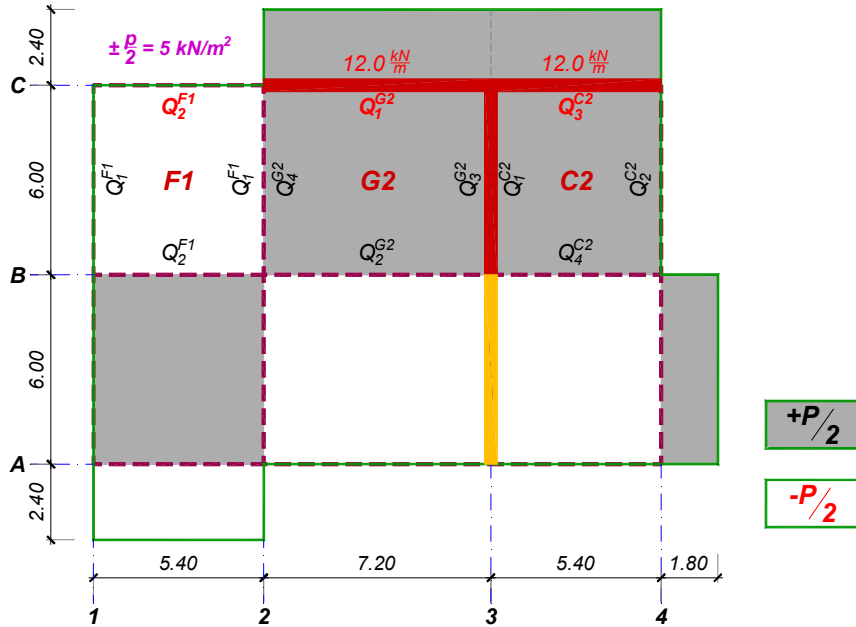
$$k = \frac{53}{\sqrt{\frac{400.6 \times 10^2}{30 \times 2.05}}} = 2.077 \Rightarrow \frac{\varepsilon_b}{\varepsilon_a} = 3.5 / 7.029\% \\ \mu = 26.909\%$$

$$A_a = 26.909 \times \frac{30 \times 53}{100} \times \frac{2.05}{40} = 21.93 \text{ cm}^2$$

usvojeno: **2RØ16 + 4RØ25** (23.66 cm<sup>2</sup>)

## Šema opterećenja – oslonac u osi 3

23



### Ploča F1, $p_2 = -p/2$

$$L_y/L_x = 6.0/5.4 \approx 1.1$$

$$Q_2^{F1} = 0.24 \times \frac{-10.0}{2} \times 5.4 \times 6.0 = -38.88 \text{ kN}$$

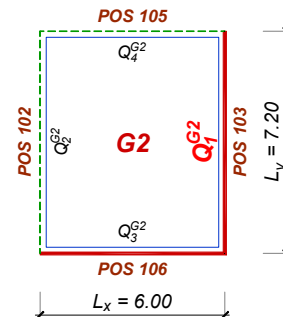
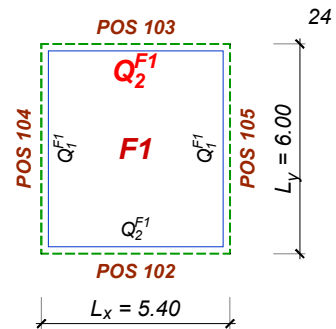
$$p_{2,1}^{103} = \frac{Q_2^{F1}}{L_x} = \frac{-38.88}{5.4} = -7.20 \frac{\text{kN}}{\text{m}}$$

### Ploča G2, $p_2 = +p/2$

$$L_y/L_x = 7.2/6.0 = 1.2$$

$$Q_1^{G2} = 0.331 \times \frac{10.0}{2} \times 6.0 \times 7.2 = 71.50 \text{ kN}$$

$$p_{2,2}^{103} = \frac{Q_1^{G2}}{L_y} = \frac{71.50}{7.2} = 9.93 \frac{\text{kN}}{\text{m}}$$

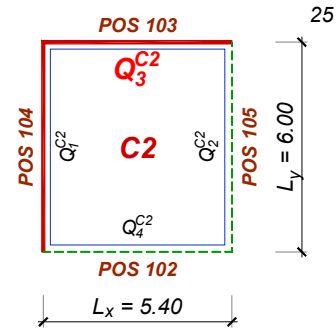


## Ploča C2, $p_2 = +p/2$

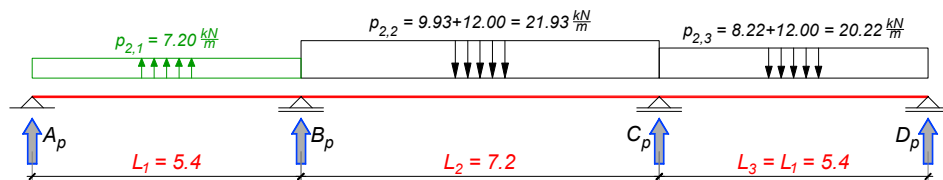
$$L_y/L_x = 6.0/5.4 \approx 1.1$$

$$Q_3^{C2} = 0.274 \times \frac{10.0}{2} \times 5.4 \times 6.0 = 44.39 \text{ kN}$$

$$p_{2,3}^{103} = \frac{Q_3^{C2}}{L_x} = \frac{44.39}{5.4} = 8.22 \frac{\text{kN}}{\text{m}}$$



## Ukupno, $p_2 = \pm p/2$ za maksimalni $M$ na osloncu 3



## POS 103 (osa C) – analiza opterećenja

26

### stalno opterećenje

polje 1-2:  $g_1 = 4.5 + 7.06 = 11.56 \text{ kN/m}$

polje 2-3:  $g_2 = 4.5 + 10.04 + 14.4 = 28.94 \text{ kN/m}$

polje 3-4:  $g_3 = 4.5 + 9.32 + 14.4 = 28.22 \text{ kN/m}$

### povremeno opterećenje za max. $M_u$ nad osloncem 3

polje 1-2:  $p_1 = 11.76/2 + (-7.20) = -1.32 \text{ kN/m}$

polje 2-3:  $p_2 = 40.74/2 + 21.93 = 42.30 \text{ kN/m}$

polje 3-4:  $p_3 = 39.54/2 + 20.22 = 39.99 \text{ kN/m}$

$$q_{u1} = 1.6 \times 11.56 + 1.8 \times (-1.32) = 16.11 \text{ kN/m}$$

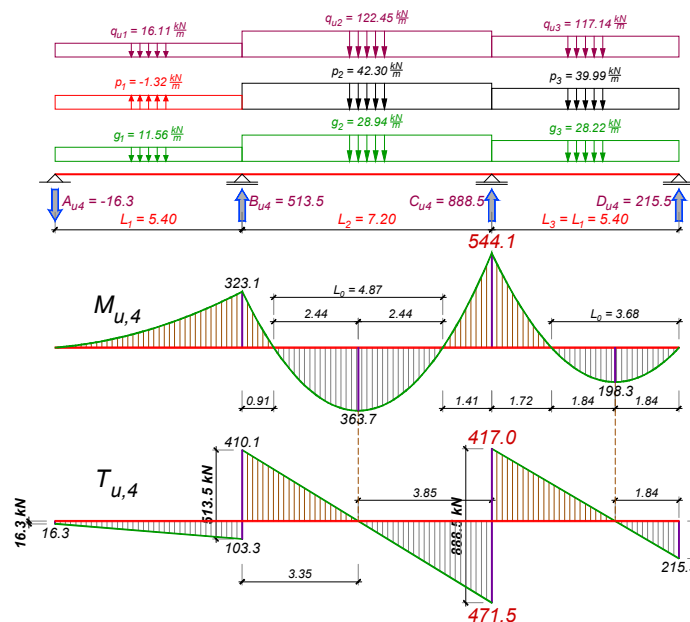
$$q_{u2} = 1.6 \times 28.94 + 1.8 \times 42.30 = 122.45 \text{ kN/m}$$

$$q_{u3} = 1.6 \times 28.22 + 1.8 \times 39.99 = 117.14 \text{ kN/m}$$

Pri ovoj kombinaciji opterećenja se, pored maksimalnog momenta savijanja nad osloncem 3, javljaju i maksimalne transverzalne sile u presecima levo i desno od tog oslonca, kao i maksimalna sila u osloncu 3.

## $P_4$ – max. $M_u$ nad osloncem 3

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## POS 103 – dimenzionisanje

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$M_{u,max} = 544.1 \text{ kNm}$  (osa 3, gornja zona)

MB 30  $\Rightarrow f_B = 20.5 \text{ MPa} = 2.05 \text{ kN/cm}^2$

RA 400/500  $\Rightarrow \sigma_v = 400 \text{ MPa} = 40 \text{ kN/cm}^2$

pretp.  $a_1 = 7 \text{ cm} \Rightarrow b/d/h = 30/60/53 \text{ cm}$

$$k = \frac{53}{\sqrt{\frac{544.1 \times 10^2}{30 \times 2.05}}} = 1.782 \Rightarrow \frac{\varepsilon_b}{\varepsilon_a} = 3.5 / 3.669\text{‰}$$

$$\mu = 39.520\%$$

$$A_a = 39.520 \times \frac{30 \times 53}{100} \times \frac{2.05}{40} = 32.20 \text{ cm}^2$$

usvojeno: **2RØ16 + 6RØ25** (33.47 cm<sup>2</sup>)

$T_{u,max} = 471.5 \text{ kN}$  (presek u osi 3, levo)

MB 30  $\Rightarrow \tau_r = 1.1 \text{ MPa} = 0.11 \text{ kN/cm}^2$

usv.  $z = 0.9 \times h = 0.9 \times 53 = 47.7 \text{ cm}$

$$\tau_n^{C,I} = \frac{471.5}{30 \times 47.7} = 0.329 \text{ kN/cm}^2 \left\{ \begin{array}{l} > \tau_r = 0.11 \text{ kN/cm}^2 \\ < 3\tau_r = 0.33 \text{ kN/cm}^2 \end{array} \right.$$

$$\lambda = L_{0,T} \times \left( 1 - \frac{\tau_r}{\tau_n} \right) = 385.1 \times \left( 1 - \frac{0.11}{0.329} \right) = 256.5 \text{ cm}$$

$$\tau_{Ru} = 1.5 \times (0.329 - 0.11) = 0.329 \text{ kN/cm}^2$$

usvojeno:  $m=2$  ;  $\alpha = 90^\circ$  ;  $\theta = 45^\circ$

$$e_u = \frac{2 \times a_u^{(1)}}{30 \times 0.329} \times 40 = 8.10 \times a_u^{(1)}$$

$$UR\emptyset 10 + UR\emptyset 8 \Rightarrow e_u = 8.10 \times (0.785 + 0.503) = 10.4 \text{ cm}$$

usvojeno: **UR $\emptyset$ 10/10 + UR $\emptyset$ 8/10** ( $m=2$ )

$$\tau_{u,u}^{(2)} = \frac{2 \times 0.785}{30 \times 10} \times 40 = 0.209 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda_2 = \lambda \times \left( 1 - \frac{\tau_{u,u}^{(2)}}{\tau_{Ru}} \right)$$

$$\lambda_2 = 256.5 \times \left( 1 - \frac{0.209}{0.329} \right) = 93.3 \text{ cm}$$

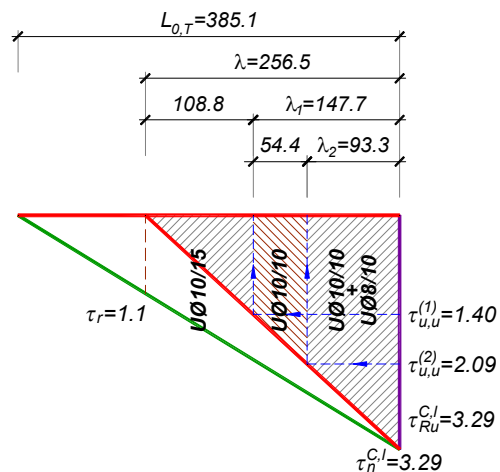
$$\tau_{u,u}^{(1)} = \frac{2 \times 0.785}{30 \times 15} \times 40 = 0.140 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda_1 = 256.5 \times \left( 1 - \frac{0.140}{0.329} \right) = 147.7 \text{ cm}$$

na  $\lambda_2 = 93.3 \text{ cm}$ : **UR $\emptyset$ 10/10 + UR $\emptyset$ 8/10**

na  $\lambda_1 - \lambda_2 = 54.4 \text{ cm}$ : **UR $\emptyset$ 10/10**

na  $\lambda - \lambda_1 = 108.8 \text{ cm}$ : **UR $\emptyset$ 10/15**



$T_u = 417 \text{ kN}$  (presek u osi 3, desno)

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$$\tau_n^{C,d} = \frac{417}{30 \times 47.7} = 0.291 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda = 356 \times \left(1 - \frac{0.11}{0.291}\right) = 221.6 \text{ cm}$$

$$\tau_{Ru} = 1.5 \times (0.291 - 0.11) = 0.272 \text{ kN/cm}^2$$

$$e_u = \frac{2 \times a_u^{(1)}}{30 \times 0.272} \times 40 = 9.80 \times a_u^{(1)}$$

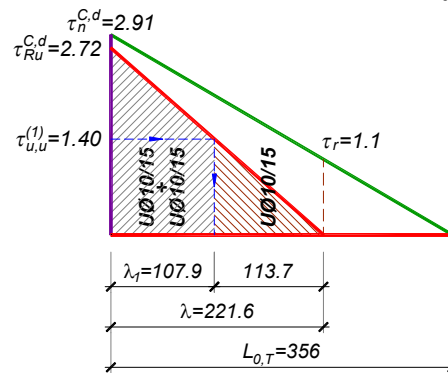
$$\text{Ø}10 : a_u^{(1)} = 0.785 \text{ cm}^2 \Rightarrow e_u = 9.80 \times 0.785 = 7.7 \text{ cm}$$

usvojeno: **2URØ10/15**

$$\tau_{u,u}^{(1)} = \frac{2 \times 0.785}{30 \times 15} \times 40 = 0.140 \frac{\text{kN}}{\text{cm}^2} \Rightarrow \lambda_1 = 221.6 \times \left(1 - \frac{0.140}{0.272}\right) = 107.9 \text{ cm}$$

na  $\lambda_1 = 107.9 \text{ cm}$ : **URØ10/15 + URØ10/15**

na  $\lambda - \lambda_1 = 113.7 \text{ cm}$ : **URØ10/15**



$T_u = 440.2 \text{ kN}$  (presek u osi 2, desno)

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$$\tau_n^{B,d} = \frac{440.2}{30 \times 47.7} = 0.308 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda = 359.5 \times \left(1 - \frac{0.11}{0.308}\right) = 231 \text{ cm}$$

$$\tau_{Ru} = 1.5 \times (0.308 - 0.11) = 0.296 \text{ kN/cm}^2$$

usvojeno:  $m=2$  ;  $\alpha = 90^\circ$  ;  $\theta = 45^\circ$

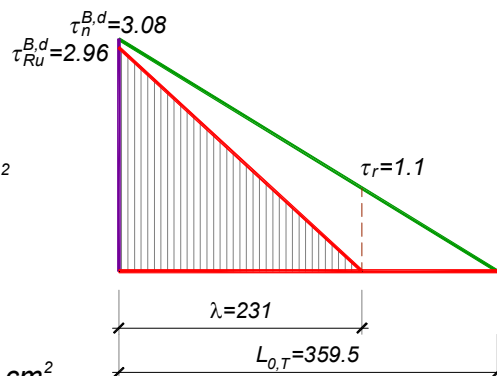
$$\frac{a_u^{(1)}}{e_u} = \frac{b \times \tau_{Ru}}{m \times \sigma_v} = \frac{30 \times 0.296}{2 \times 40} = 0.111$$

$$\frac{a_u^{(1)}}{e_{u1}} + \frac{a_u^{(2)}}{e_{u2}} = \frac{b \times \tau_{Ru}}{m \times \sigma_v} = \frac{30 \times 0.296}{2 \times 40} = 0.111 \frac{\text{cm}^2}{\text{cm}}$$

Usvajanjem uzengije URØ10/10, potrebno je još:

$$\frac{a_u^{(2)}}{e_{u2}} = \frac{b \times \tau_{Ru}}{m \times \sigma_v} - \frac{a_u^{(1)}}{e_{u1}} = 0.111 - \frac{0.785}{10} = 0.033 \Rightarrow e_{u2} = \frac{a_u^{(2)}}{0.033} = \frac{0.785}{0.033} = 24.0 \text{ cm}$$

usvojeno: **URØ10/10 + URØ10/20 (m=2)**





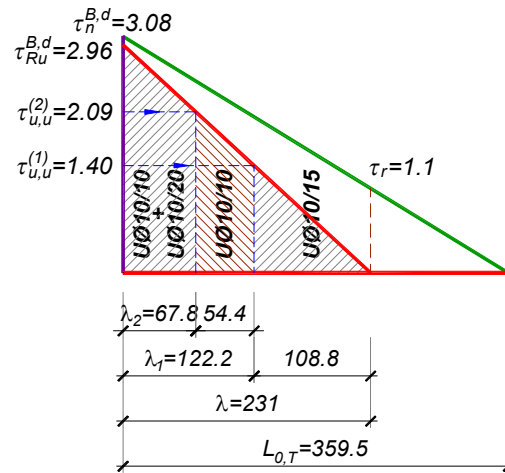
$$\tau_{u,u}^{(2)} = \frac{2 \times 0.785}{30 \times 10} \times 40 = 0.209 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda_2 = \lambda \times \left( 1 - \frac{\tau_{u,u}^{(2)}}{\tau_{Ru}} \right)$$

$$\lambda_2 = 231 \times \left( 1 - \frac{0.209}{0.296} \right) = 67.8 \text{ cm}$$

$$\tau_{u,u}^{(1)} = \frac{2 \times 0.785}{30 \times 15} \times 40 = 0.140 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda_1 = 231 \times \left( 1 - \frac{0.140}{0.296} \right) = 122.2 \text{ cm}$$



na  $\lambda_2 = 67.8 \text{ cm}$ : **URØ10/10 + URØ10/20**

na  $\lambda_1 - \lambda_2 = 54.4 \text{ cm}$ : **URØ10/10**

na  $\lambda - \lambda_1 = 108.8 \text{ cm}$ : **URØ10/15**

**$T_u = 182.9 \text{ kN}$**  (preseki u osi 2, levo)

$$\tau_n^{B,I} = \frac{182.9}{30 \times 47.7} = 0.128 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda = 454.3 \times \left( 1 - \frac{0.11}{0.128} \right) = 63.2 \text{ cm}$$

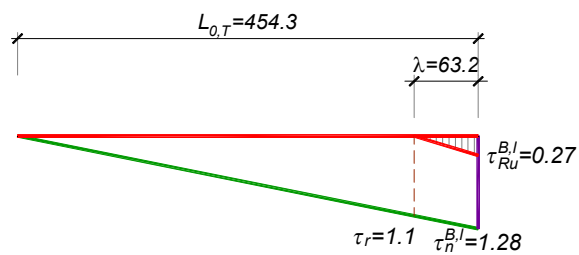
$$\tau_{Ru} = \frac{3}{2} \times (0.128 - 0.11) = 0.027 \frac{\text{kN}}{\text{cm}^2}$$

$$e_u = \frac{2 \times a_u^{(1)}}{30 \times 0.027} \times 40 = 99.95 \times a_u^{(1)}$$

$$\mu_{uz} = \frac{m \times a_u^{(1)}}{b \times e_u} \geq \mu_{uz, \min} = 0.2\% \Rightarrow e_u = \frac{m \times a_u^{(1)}}{b \times 0.2\%} = \frac{2 \times a_u^{(1)}}{30 \times 0.2\%} = 33.3 \times a_u^{(1)}$$

$$\text{Ø8: } a_u^{(1)} = 0.503 \text{ cm}^2 \Rightarrow e_u = 33.3 \times 0.503 = 16.7 \text{ cm}$$

usvojeno: **URØ8/15 (m=2)**



$T_u = 182.9 \text{ kN}$  (presek u osi 1)

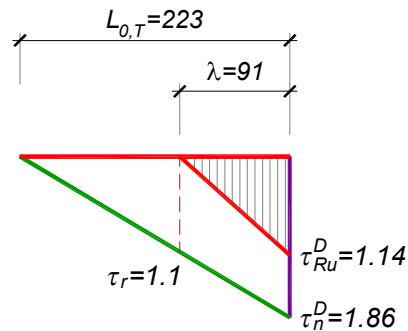
35

$$\tau_n^D = \frac{265.9}{30 \times 47.7} = 0.186 \frac{\text{kN}}{\text{cm}^2}$$

$$\lambda = 223 \times \left(1 - \frac{0.11}{0.186}\right) = 91.0 \text{ cm}$$

$$\tau_{Ru} = \frac{3}{2} \times (0.186 - 0.11) = 0.114 \frac{\text{kN}}{\text{cm}^2}$$

$$e_u = \frac{2 \times a_u^{(1)}}{30 \times 0.114} \times 40 = 23.45 \times a_u^{(1)} = 23.45 \times 0.785 = 18.4 \text{ cm}$$



usvojeno: **URØ10/15 (m=2)**

$$\Delta A_a = \frac{182.9}{2 \times 40} = 3.32 \text{ cm}^2$$

usvojeno: **2RØ22 (7.60 cm<sup>2</sup>)**

## POS 103 – poređenje uticaja

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Granične vrednosti momenata savijanja i transverzalnih sila u karakterističnim presecima (delovima nosača) grede POS 103 za slučaj da opterećenje  $p=10 \text{ kN/m}^2$  deluje na čitavoj ploči ili da se nalazi u najnepovoljnijem položaju za razmatrani uticaj:

	$M_u^{1-2}$	$M_u^2$	$M_u^{2-3}$	$M_u^3$	$M_u^{3-4}$	
$g, p_{\text{tot}}$	21.4	355.5	338.2	523.2	202.8	
$g, p_{\text{max}}$	93.5	400.6	411.7	544.1	296.4	
	336%	13%	22%	4%	46%	
	$T_u^A$	$T_u^{B,l}$	$T_u^{B,d}$	$T_u^{C,l}$	$T_u^{C,d}$	$T_u^D$
$g, p_{\text{tot}}$	41.2	172.9	407.4	454.0	411.0	217.2
$g, p_{\text{max}}$	88.7	182.9	440.2	471.5	417.0	265.9
	115%	6%	8%	4%	1%	22%