Univerzitet u Beogradu – Građevinski fakultet
www.grf.bg.ac.rs

Studijski program: **GRAĐEVINARSTVO**

Modul: **PŽA, HVE, MTI**

Godina/Semestar: **III godina / V semestar**

Naziv predmeta (šifra): **Betonske konstrukcije 1**

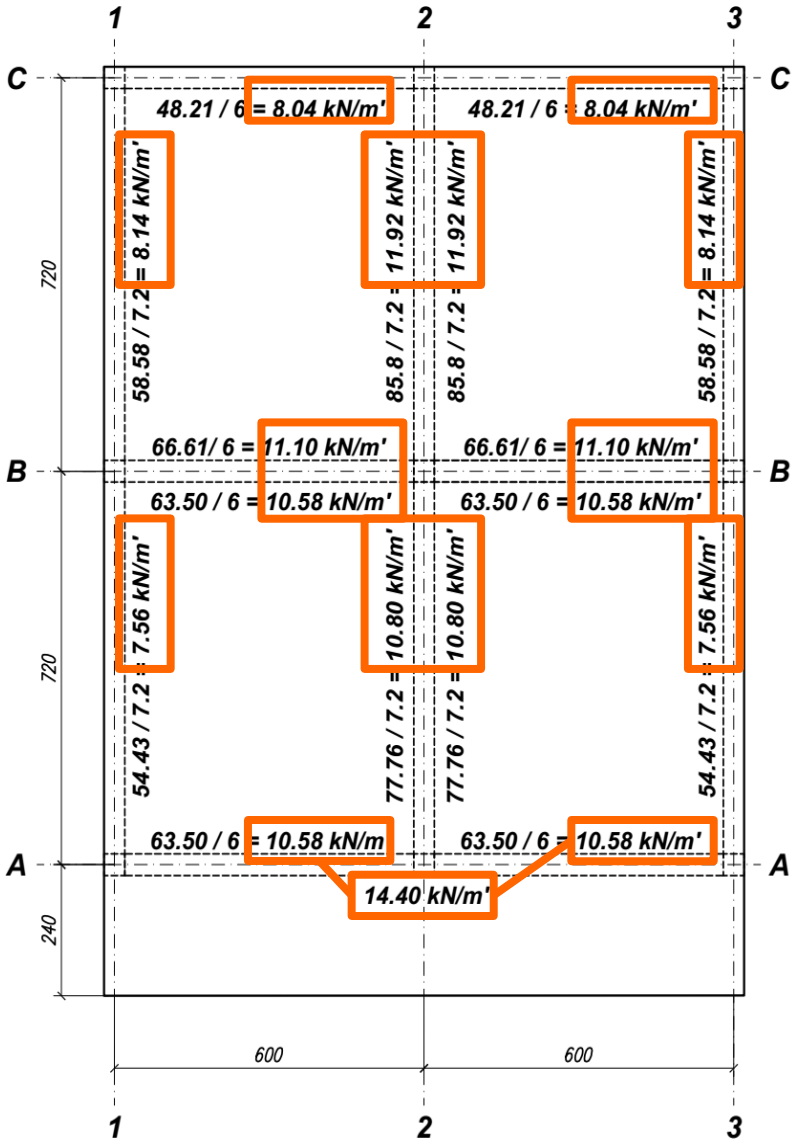
(B2S3BK, B2H3BK, B2M3BK, B1S3BK)

Nastavnik: **Jelena Dragaš**

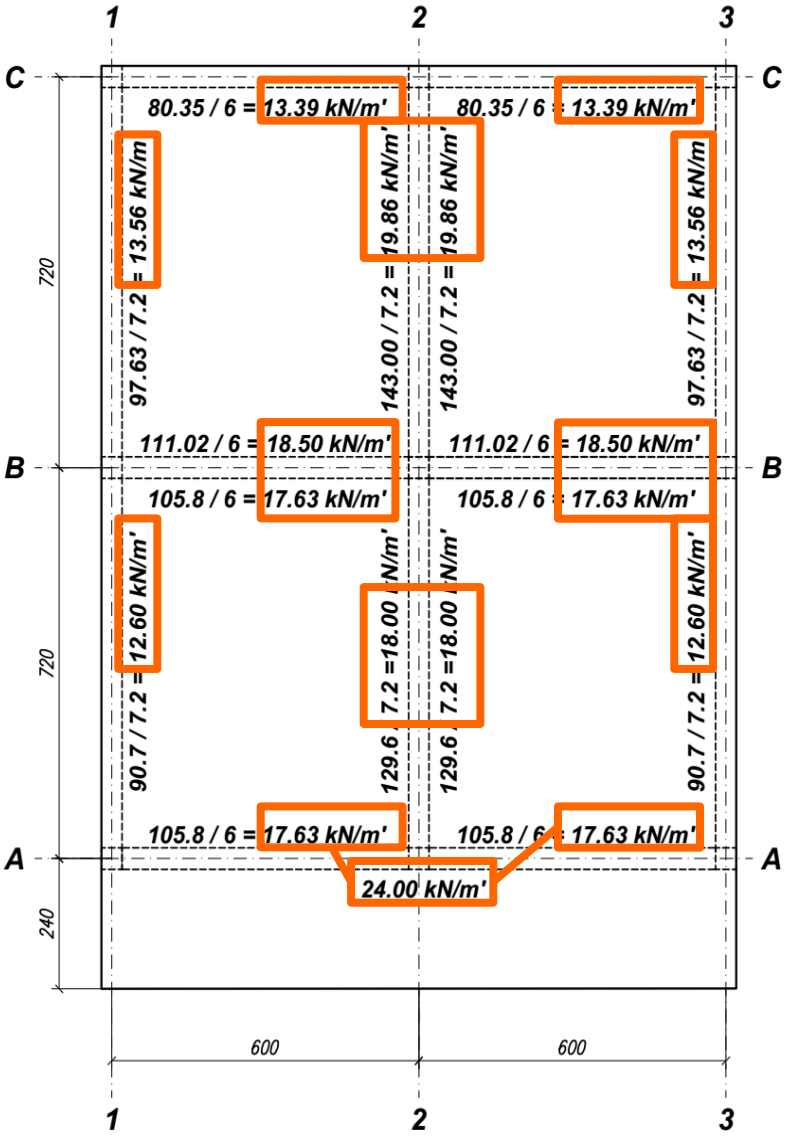
Naslov predavanja: Ramovi i priprema za ispit**.**

Datum : 29.12.2022.

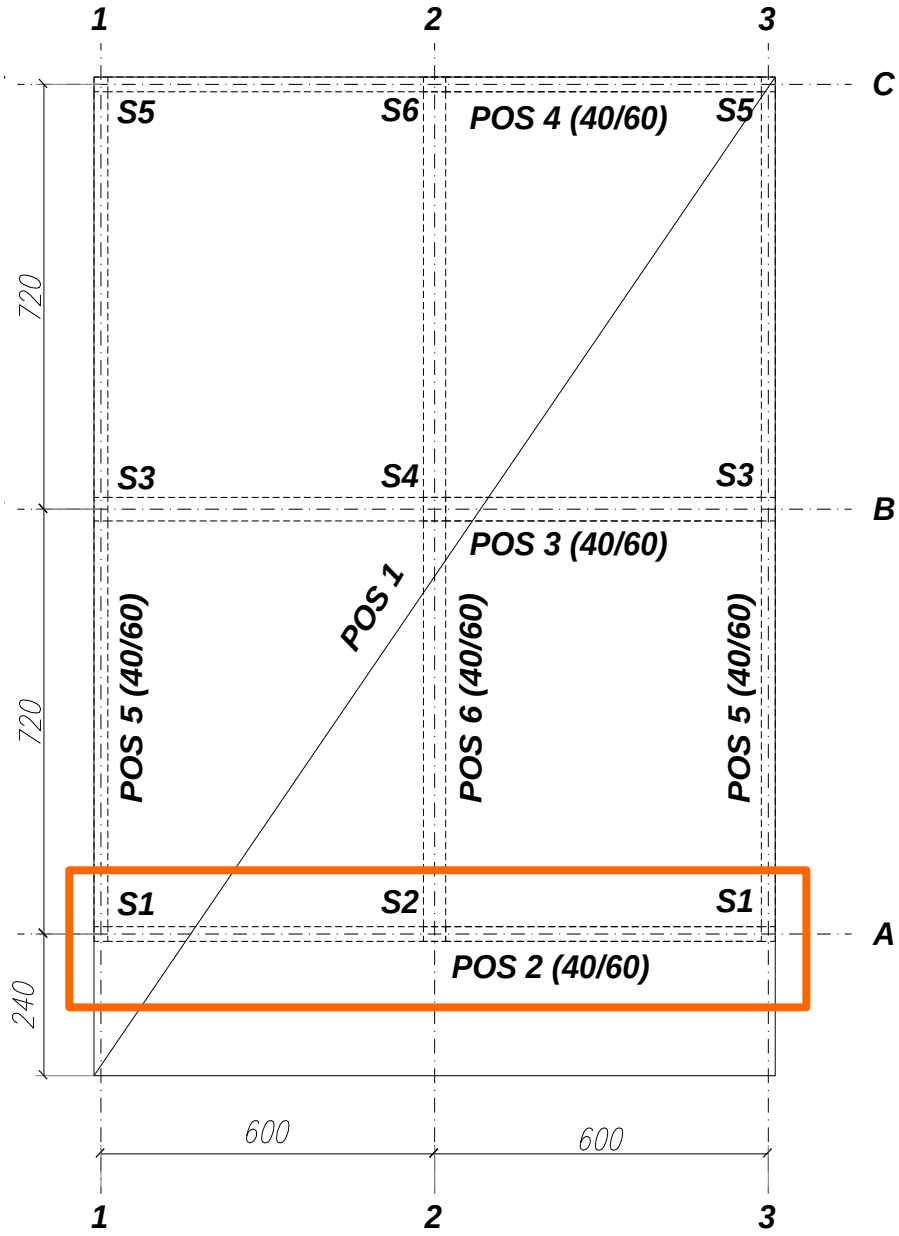
Reakcije ploče - stalno opterećenje g (kN/m')

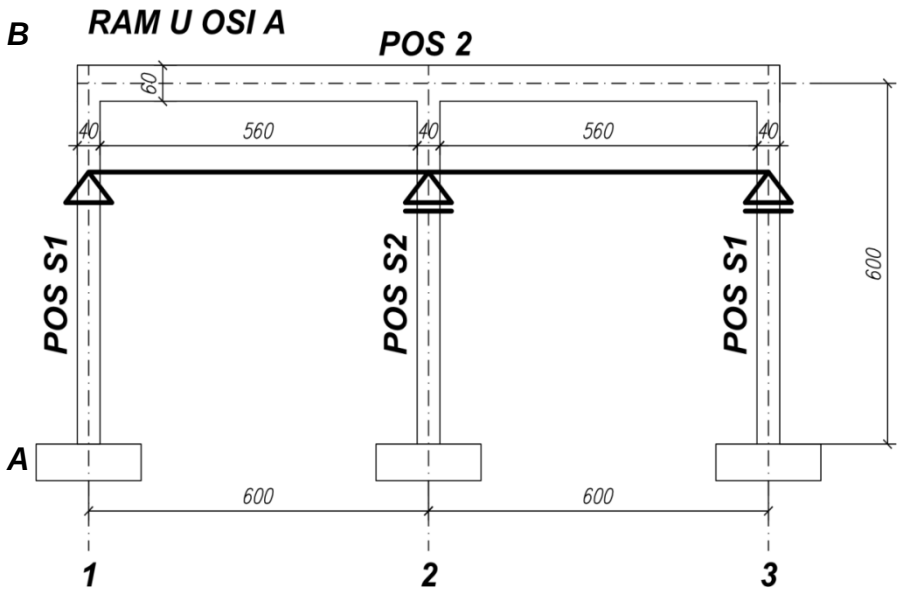


Reakcije ploče - promenljivo opterećenje q (kN/m')

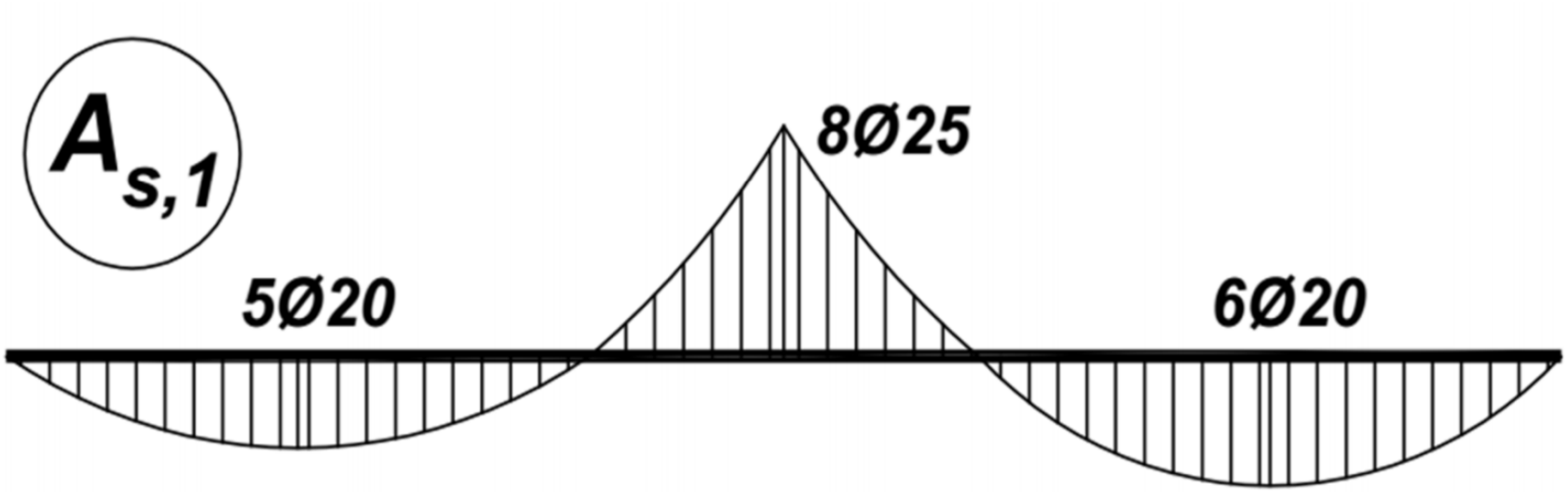


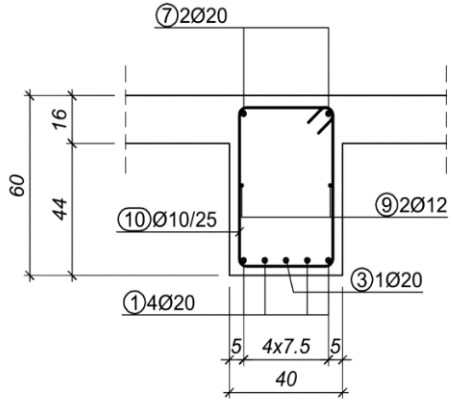
Statički sistem greda

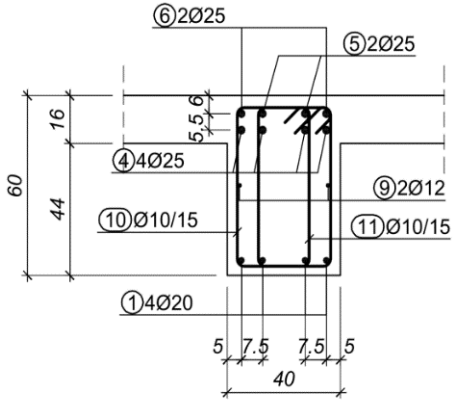


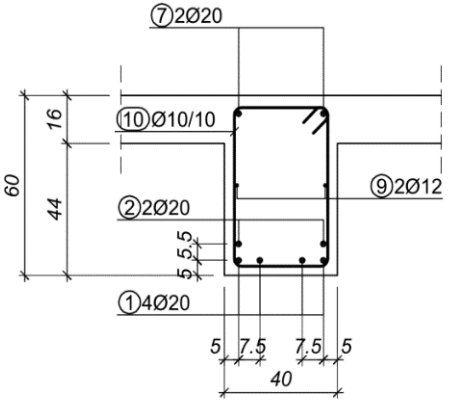


Usvojena armatura

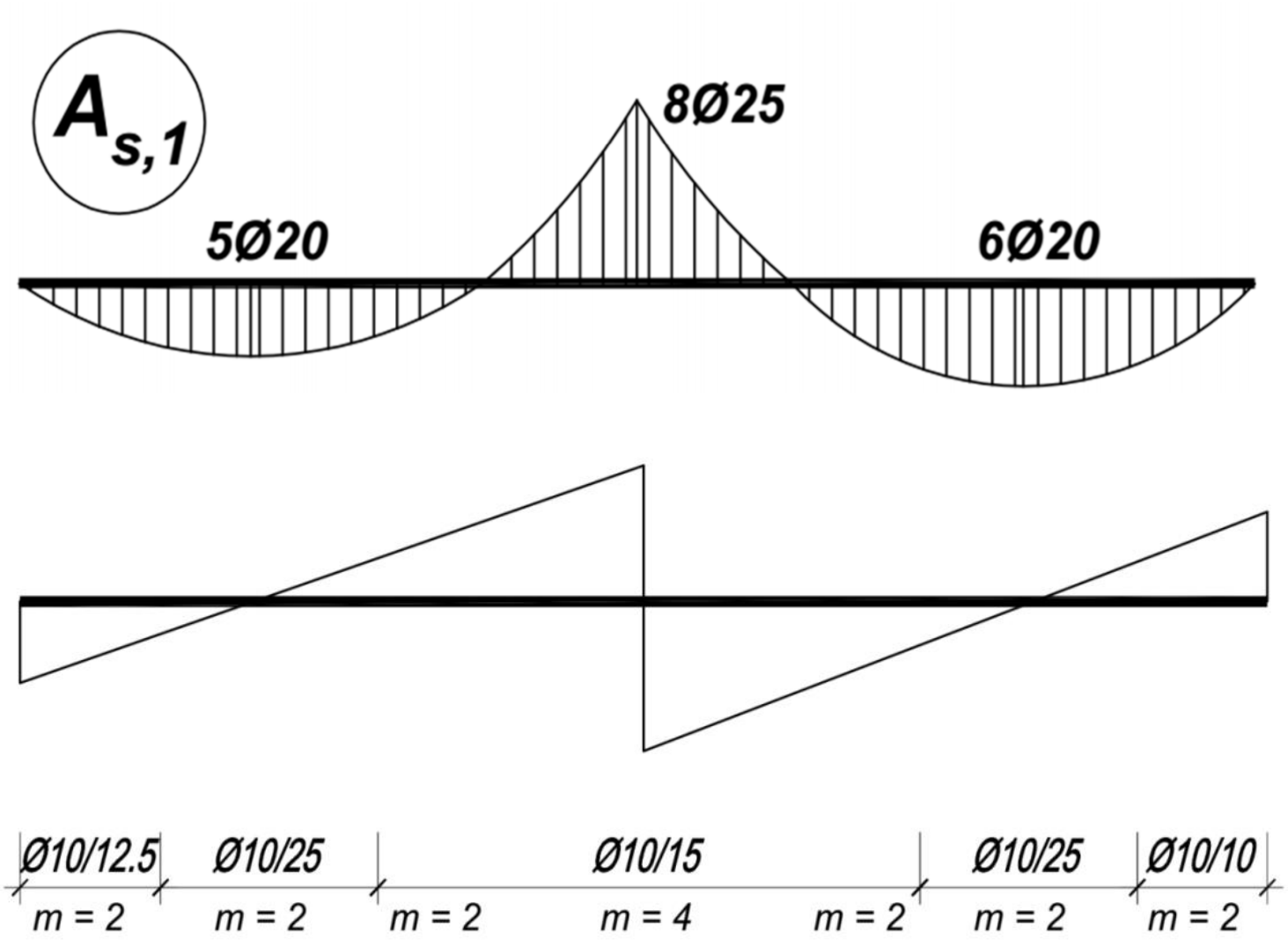


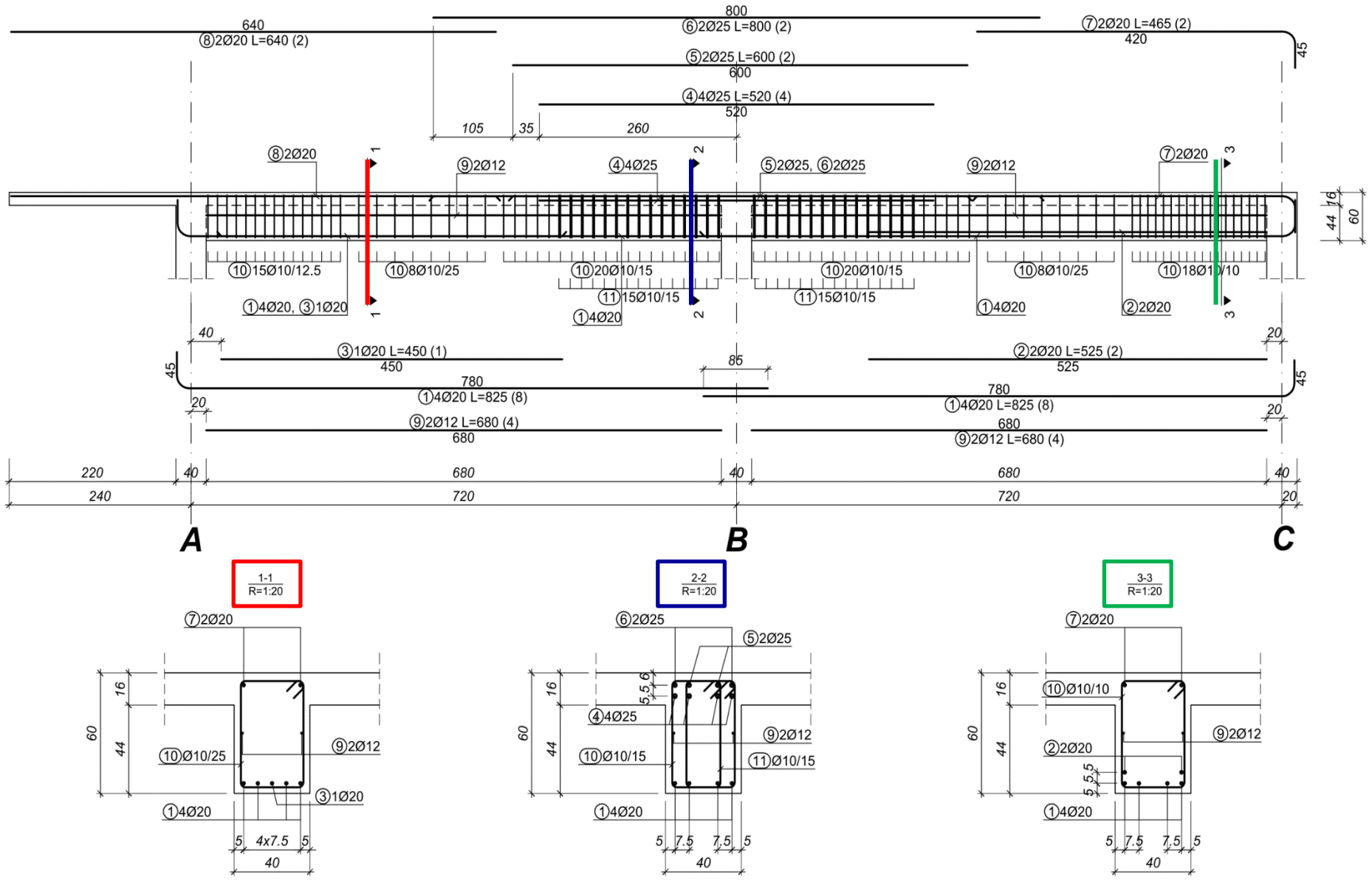




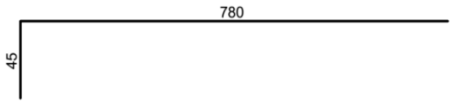
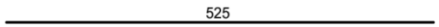
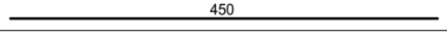
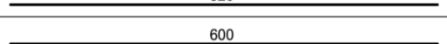
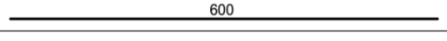
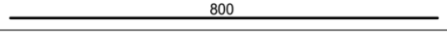
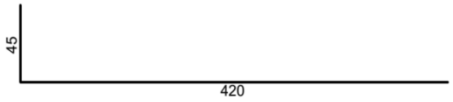
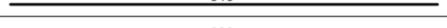
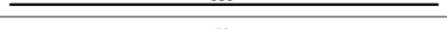
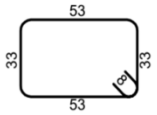
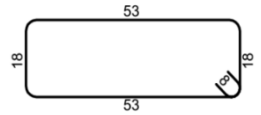


Usvojena armatura




640
⑧2Ø20 L=640 (2)
800
⑥2Ø25 L=800 (2)
⑦2Ø20 L=465 (2)
420
45
⑤2Ø25 L=600 (2)
600
④4Ø25 L=520 (4)
520
105
35
260
⑧2Ø20
⑨2Ø12
④4Ø25
⑤2Ø25, ⑥2Ø25
⑨2Ø12
⑦2Ø20
1
2
3
16
44
60
⑩15Ø10/12.5
⑩8Ø10/25
⑩20Ø10/15
⑩20Ø10/15
⑩8Ø10/25
⑩18Ø10/10
①4Ø20, ③1Ø20
⑪15Ø10/15
①4Ø20
⑪15Ø10/15
①4Ø20
②2Ø20
40
20
③1Ø20 L=450 (1)
450
85
②2Ø20 L=525 (2)
525
45
780
①4Ø20 L=825 (8)
780
①4Ø20 L=825 (8)
20
20
⑨2Ø12 L=680 (4)
680
680
⑨2Ø12 L=680 (4)
220
40
680
40
680
40
240
720
720
20
A
B
C
1-1
R=1:20
⑦2Ø20
16
60
44
⑩Ø10/25
⑨2Ø12
③1Ø20
①4Ø20
5
4x7.5
5
40
2-2
R=1:20
⑥2Ø25
⑤2Ø25
5.5
6
16
60
44
④4Ø25
⑨2Ø12
⑩Ø10/15
⑪Ø10/15
①4Ø20
5
7.5
7.5
5
40
3-3
R=1:20
⑦2Ø20
16
60
44
⑩Ø10/10
⑨2Ø12
②2Ø20
5.5
5.5
①4Ø20
5
7.5
7.5
5
40

Šipke - specifikacija

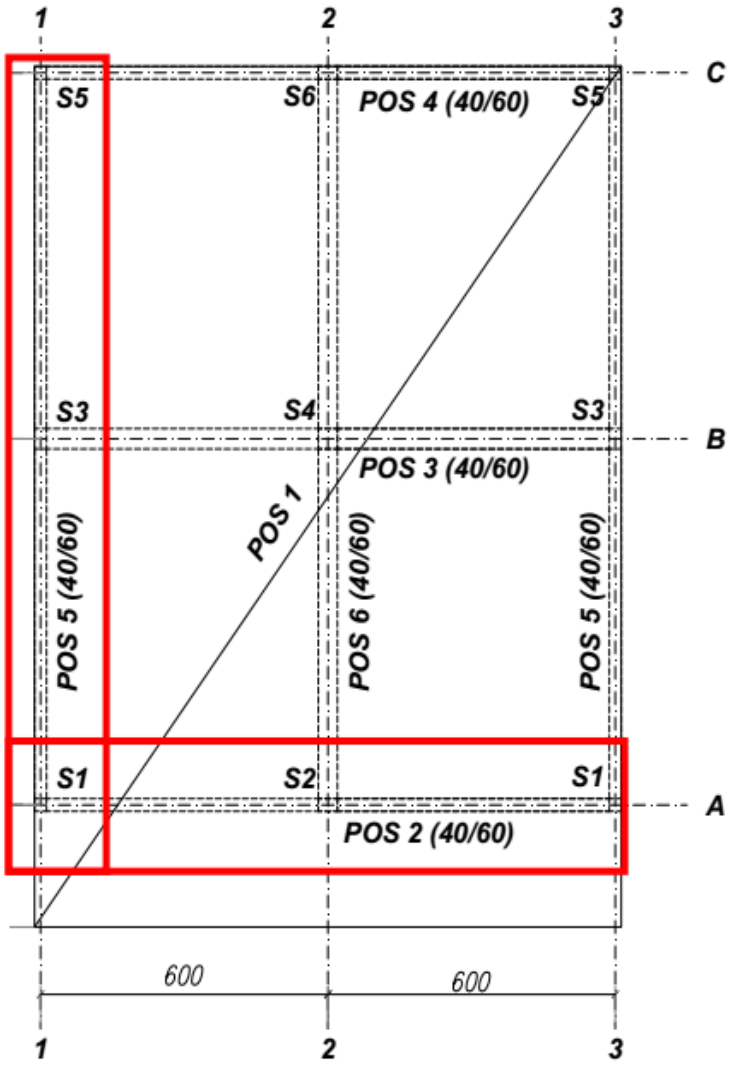
ozn.	oblik i mere [cm]	ozn.	Ø	lg [m]	n [kom]	lgn [m]
POS 6 (1 kom)						
1		B500B	20	8.25	8	66.00
2		B500B	20	5.25	2	10.50
3		B500B	20	4.50	1	4.50
4		B500B	25	5.20	4	20.80
5		B500B	25	6.00	2	12.00
6		B500B	25	8.00	2	16.00
7		B500B	20	4.65	2	9.30
8		B500B	20	6.40	2	12.80
9		B500B	12	6.80	4	27.20
10		B500B	10	1.88	89	167.32
11		B500B	10	1.58	30	47.40

Šipke - rekapitulacija

Ø [mm]	lgn [m]	Jedinična težina [kg/m']	Težina [kg]
B500B			
10	214.72	0.62	133.13
12	27.20	0.89	24.15
20	103.10	2.47	254.24
25	48.80	3.85	188.03
Ukupno			599.55

7. Analiza opterećenja stubova

7.1. Stub POS S1



Stalno opterećenje

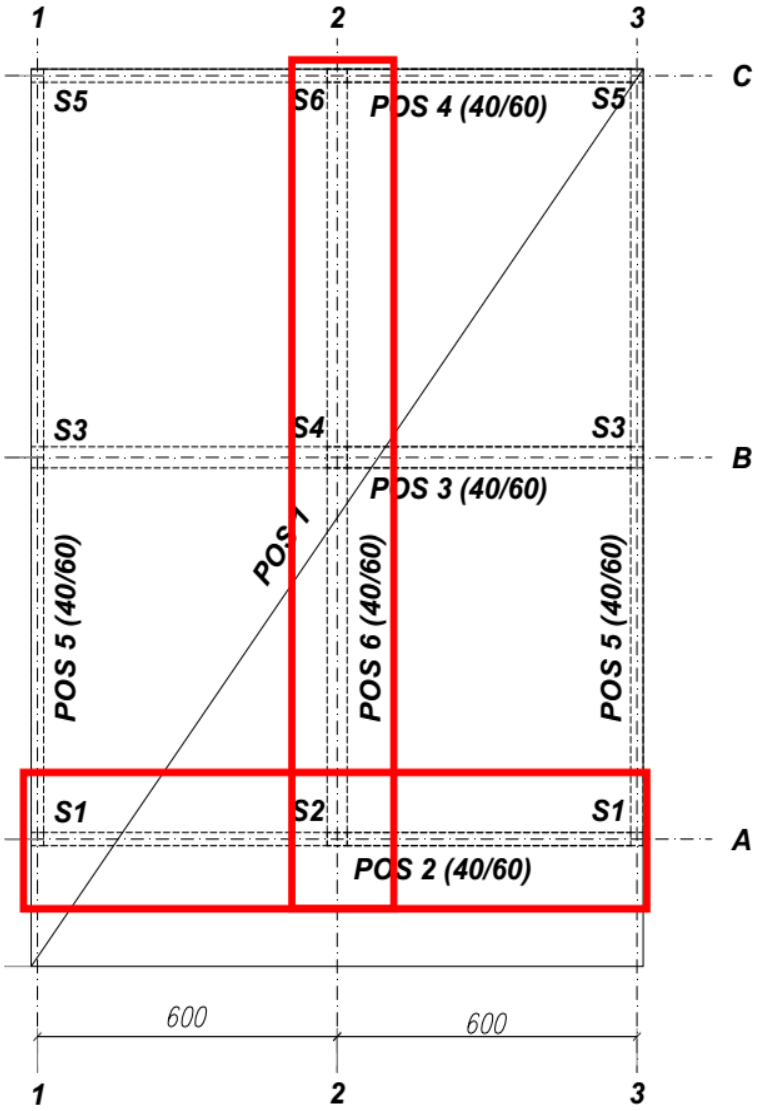
reakcija POS 2 $R_{g,2} = 69.7$ kN
reakcija POS 5 $R_{g,5} = 36.4$kN

Promenljivo opterećenje

reakcija POS 2 $R_{q,2} = 93.7$kN
reakcija POS 5 $R_{q,5} = 33.6$kN

$$\boldsymbol{R_{g,S1} = 106.1\text{kN}}$$
$$\boldsymbol{R_{q,S1} = 127.3\text{kN}}$$

7.2. Stub POS S2



Stalno opterećenje

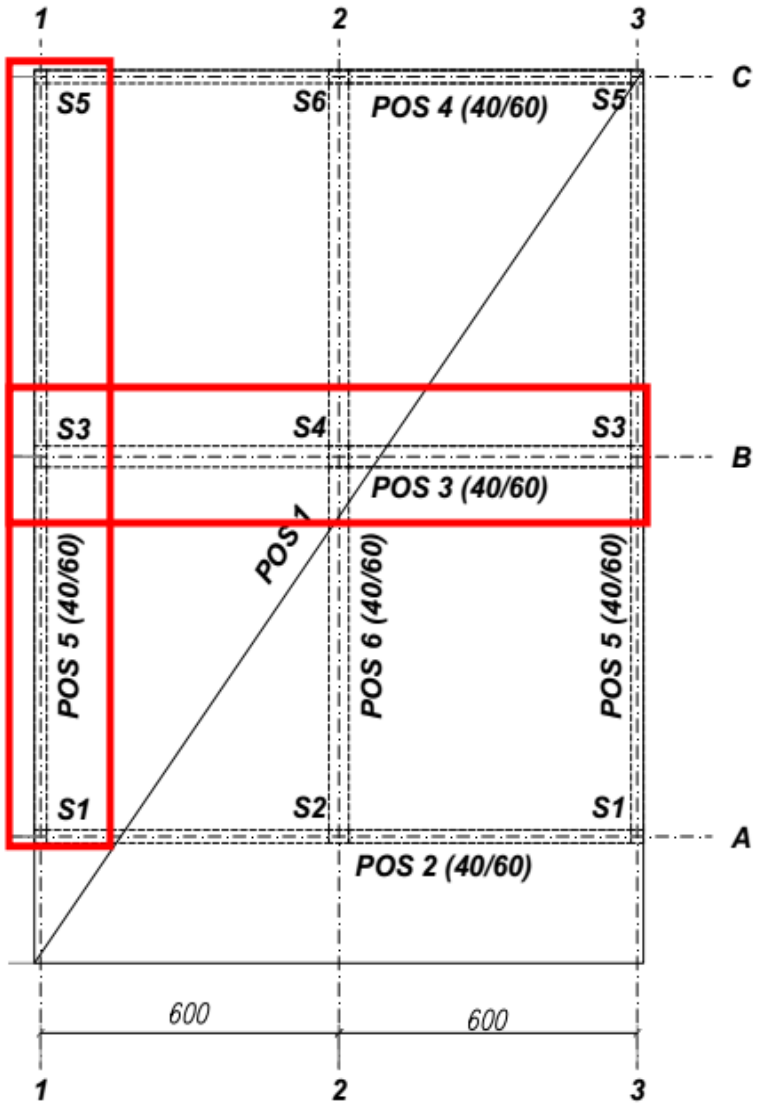
reakcija POS 2 $R_{g,2} = 232.4\text{kN}$
reakcija POS 6 $R_{g,6} = 73.5\text{kN}$

Promenljivo opterećenje

reakcija POS 2 $R_{q,2} = 312.2\text{kN}$
reakcija POS 6 $R_{q,6} = 95.5\text{kN}$

$$\boldsymbol{R_{g,S2} = 305.9\text{kN}}$$
$$\boldsymbol{R_{q,S2} = 407.7\text{kN}}$$

7.3. Stub POS S3



Stalno opterećenje

reakcija POS 3 $R_{g,3} = 62.3\text{kN}$

reakcija POS 5 $R_{g,5} = 124.7\text{kN}$

Promenljivo opterećenje

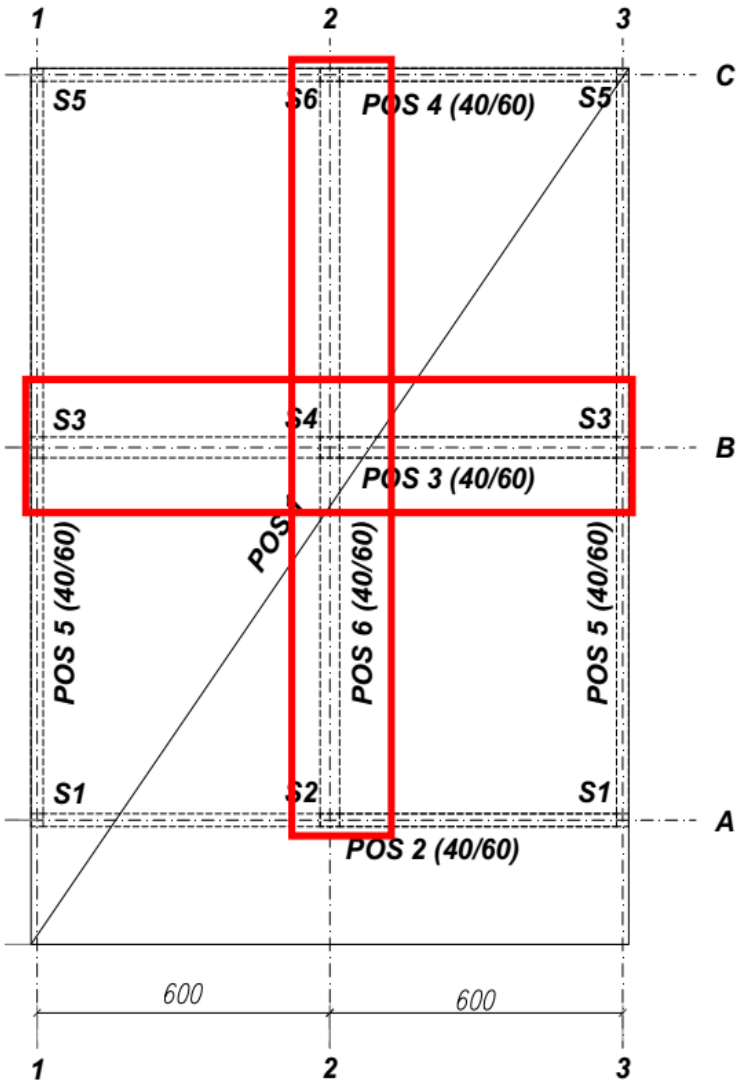
reakcija POS 3 $R_{q,3} = 81.3\text{kN}$

reakcija POS 5 $R_{q,5} = 117.7\text{kN}$

$$\boldsymbol{R_{g,S3} = 187.0\text{kN}}$$

$$\boldsymbol{R_{q,S3} = 199.0\text{kN}}$$

7.4. Stub POS S4



Stalno opterećenje

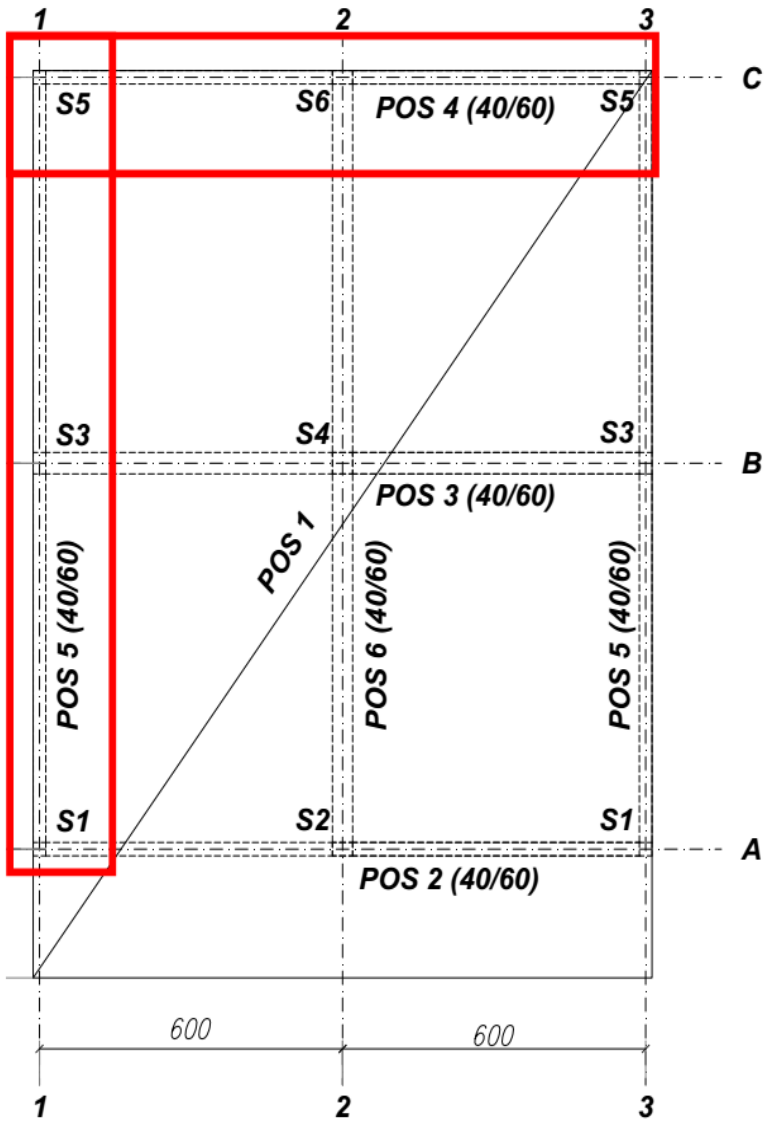
reakcija POS 3 $R_{g,3} = 207.6\text{kN}$
reakcija POS 6 $R_{g,6} = 258.5\text{kN}$

Promenljivo opterećenje

reakcija POS 3 $R_{q,3} = 271.0\text{kN}$
reakcija POS 6 $R_{q,6} = 340.7\text{kN}$

$$\boldsymbol{R_{g,S4} = 478.6\text{kN}}$$
$$\boldsymbol{R_{q,S4} = 599.2\text{kN}}$$

7.5. Stub POS S5



Stalno opterećenje

reakcija POS 4 $R_{g,4} = 32.0\text{kN}$

reakcija POS 5 $R_{g,5} = 38.4\text{kN}$

Promenljivo opterećenje

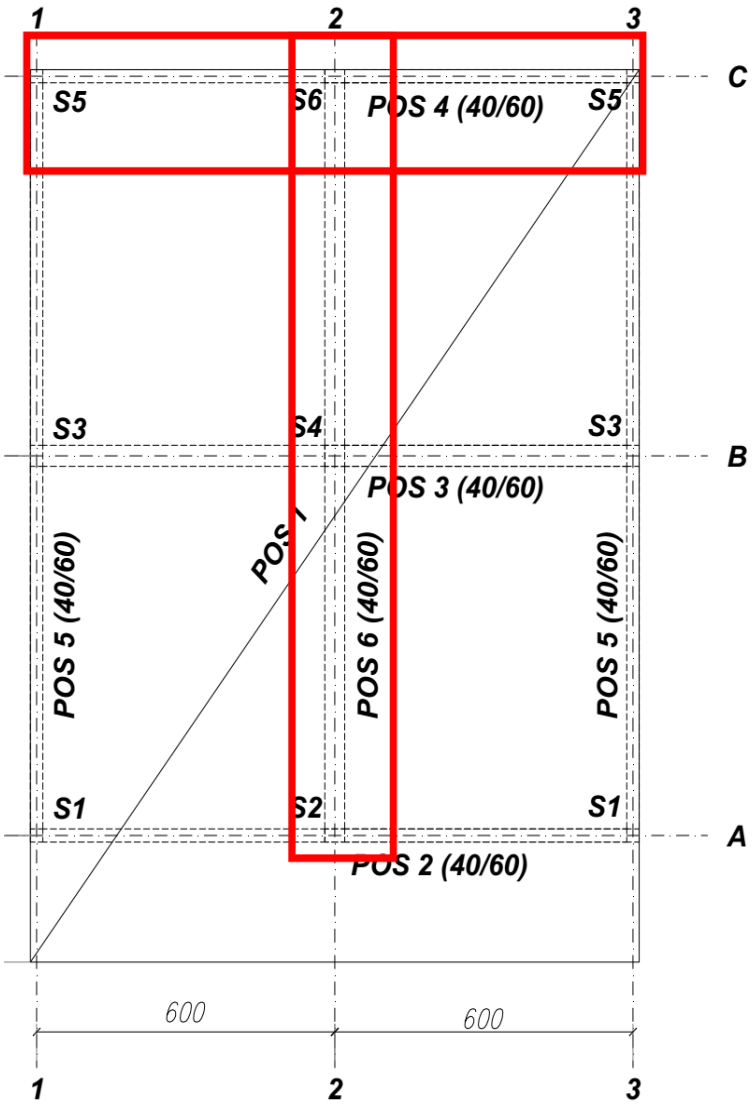
reakcija POS 4 $R_{q,4} = 30.1\ \text{kN}$

reakcija POS 5 $R_{q,5} = 37.1\text{kN}$

$$\boldsymbol{R_{g,S5} = 70.4\text{kN}}$$

$$\boldsymbol{R_{q,S5} = 75.5\text{kN}}$$

7.6. Stub POS S6



Stalno opterećenje

reakcija POS 4 $R_{g,4} = 105.3\text{kN}$

reakcija POS 6 $R_{g,6} = 81.6\text{kN}$

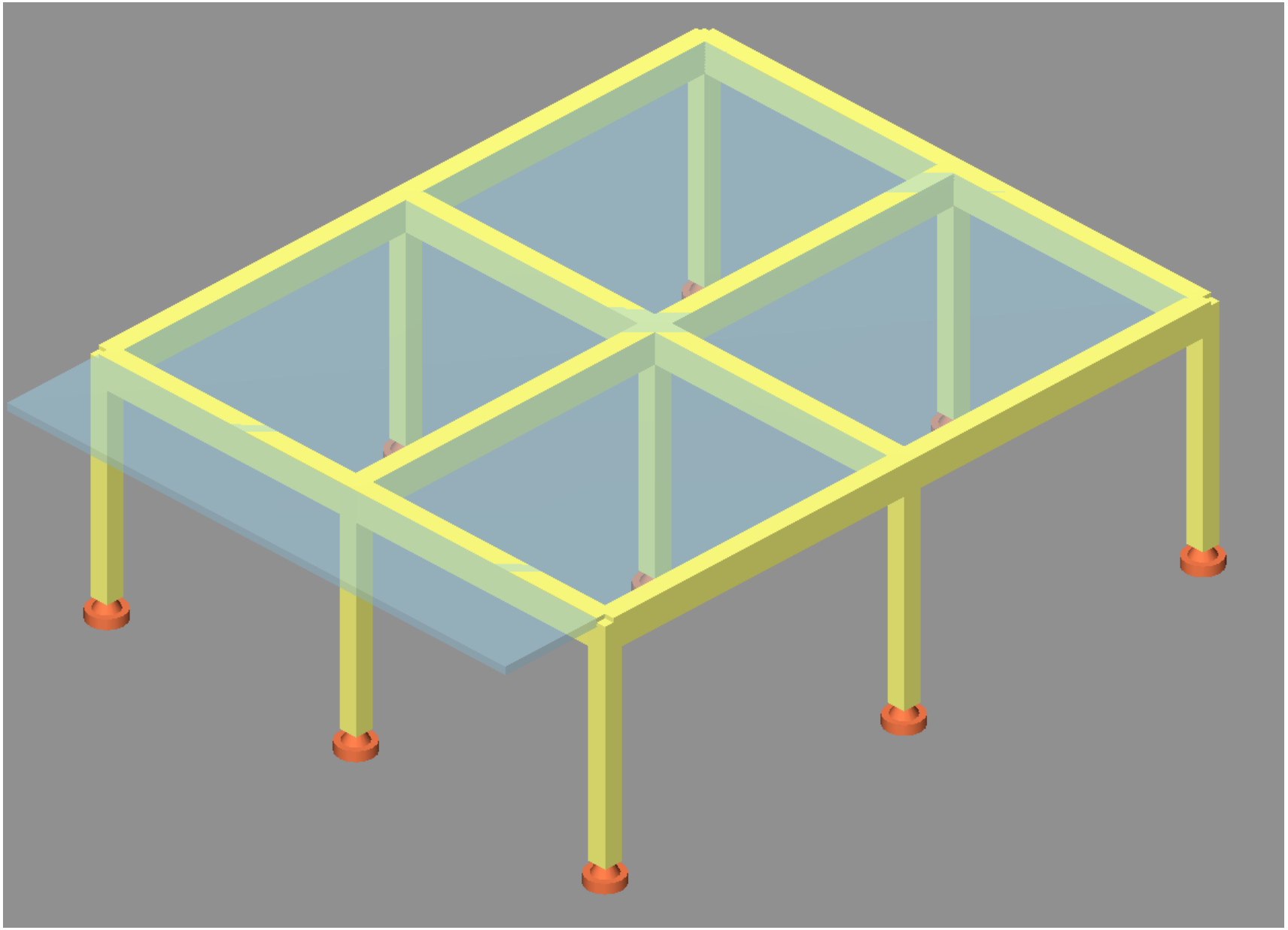
Promenljivo opterećenje

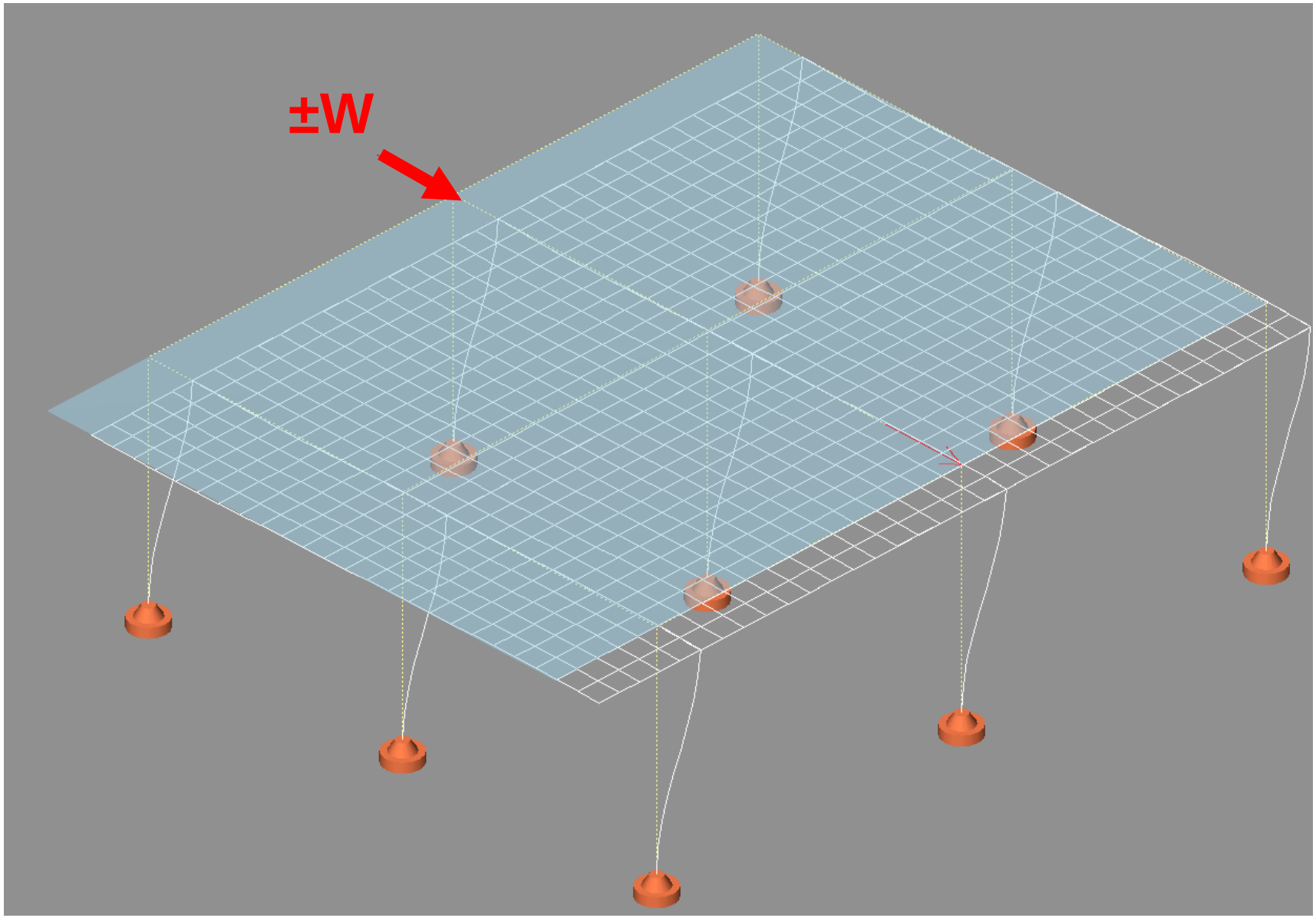
reakcija POS 4 $R_{q,4} = 100.4\text{kN}$

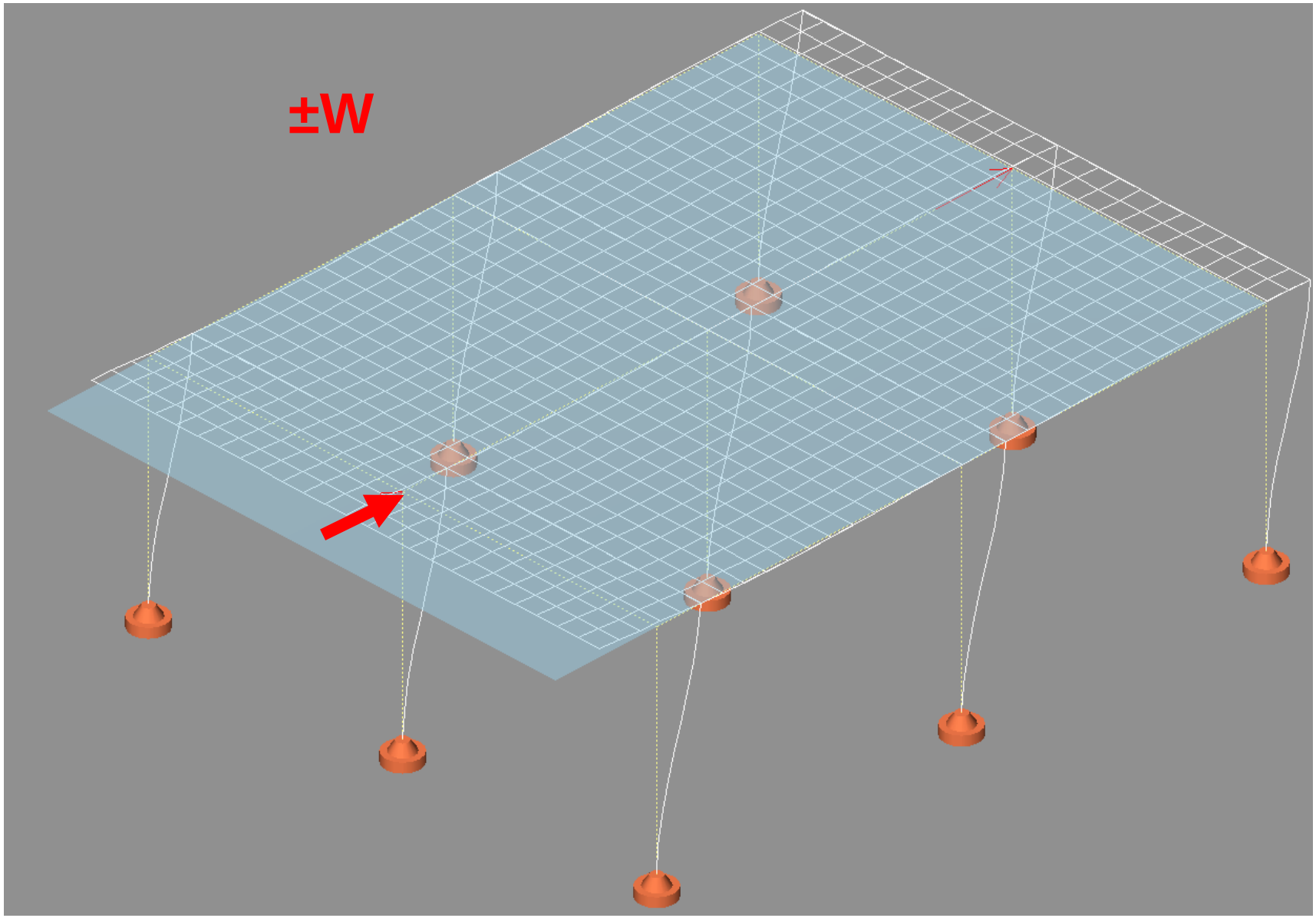
reakcija POS 6 $R_{q,6} = 109.0\text{kN}$

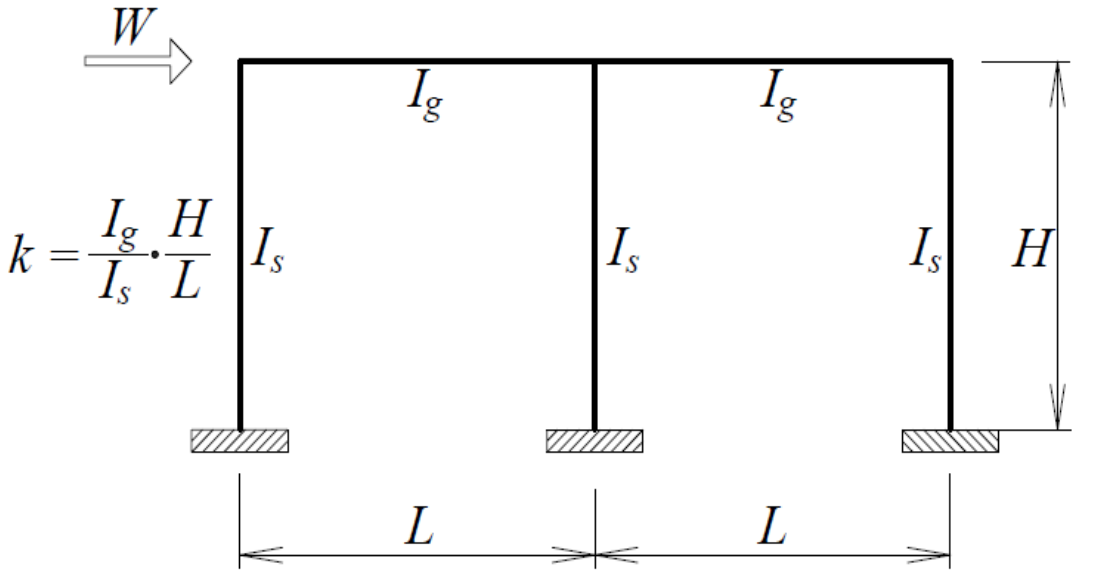
$$\boldsymbol{R_{g,S6} = 186.9\text{kN}}$$

$$\boldsymbol{R_{q,S6} = 209.4\text{kN}}$$

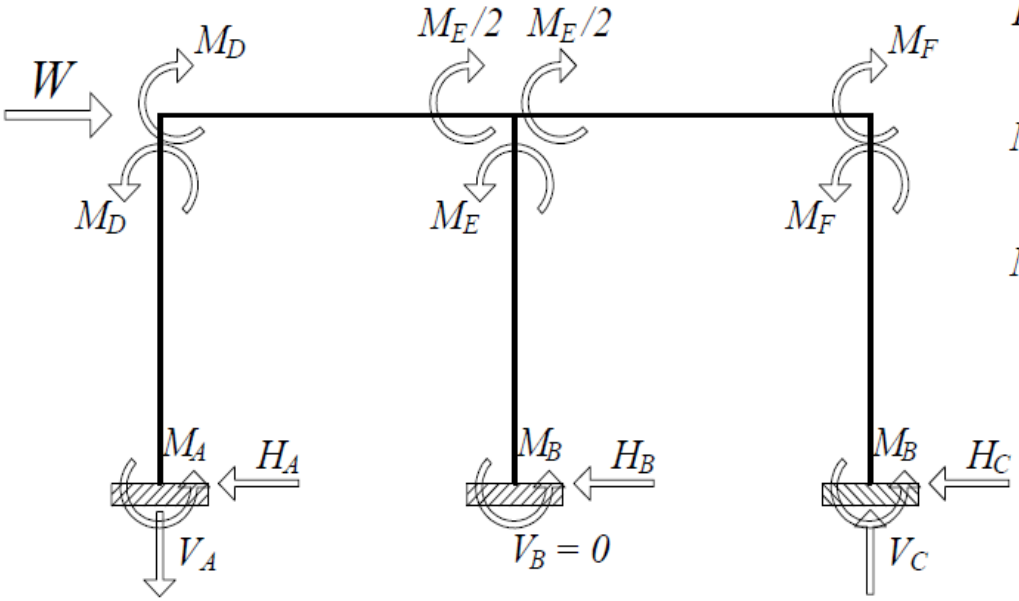



±W


±W



$$k = \frac{I_g}{I_s} \cdot \frac{H}{L}$$

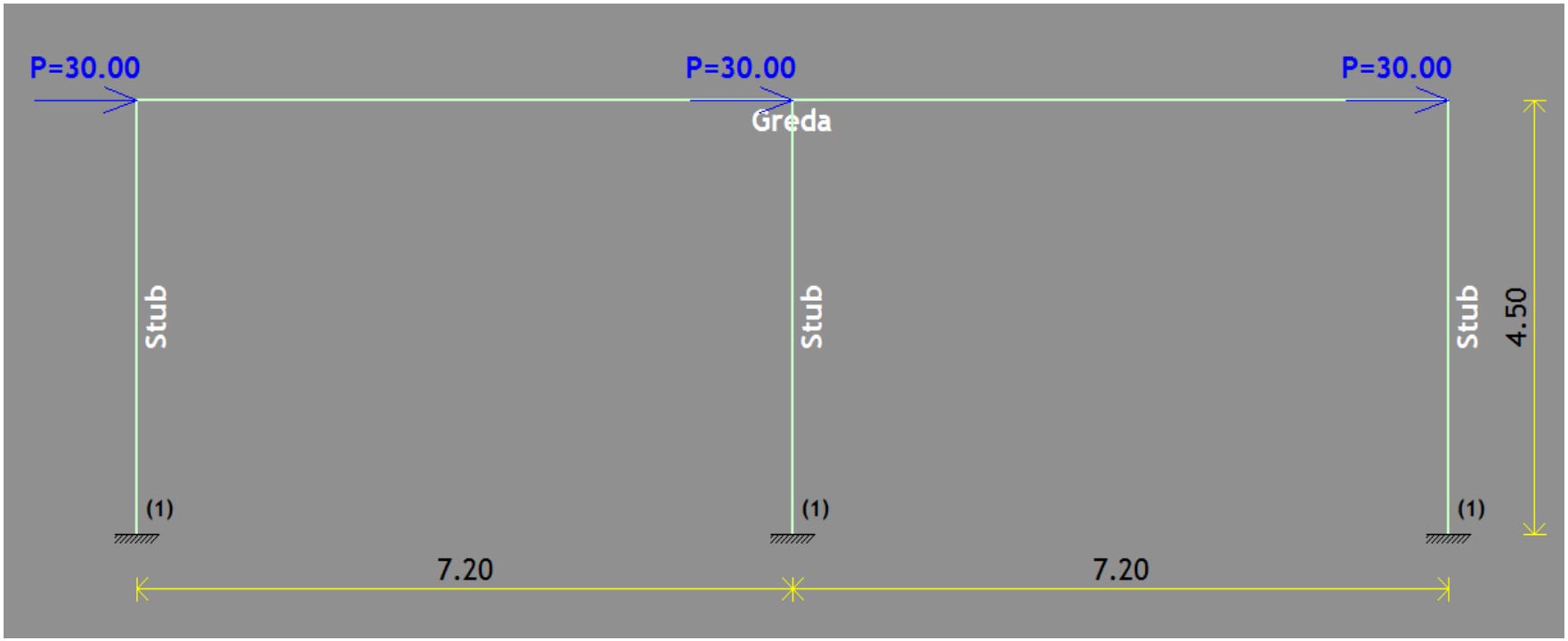


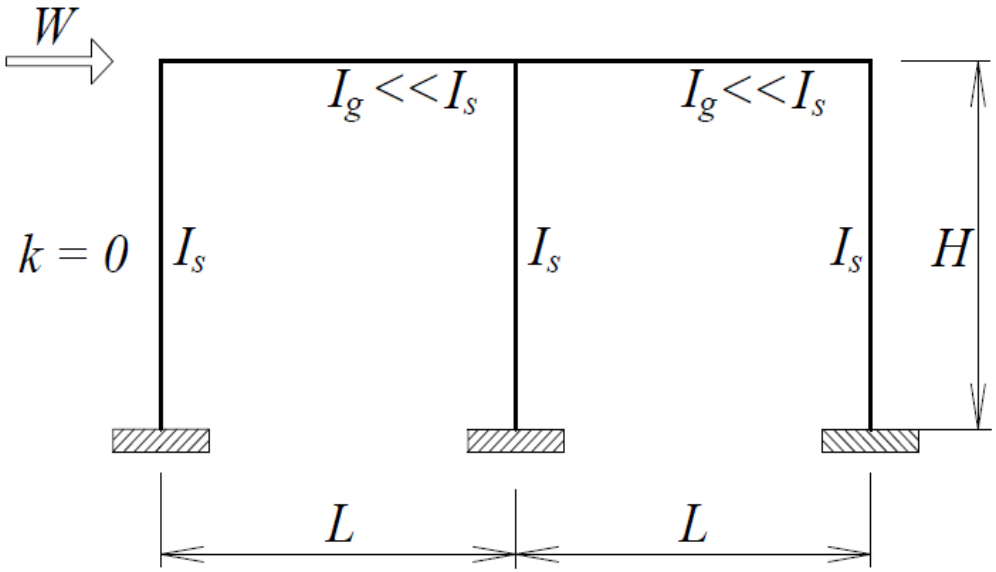
$$H_A = H_B = H_C = \frac{W}{3}$$

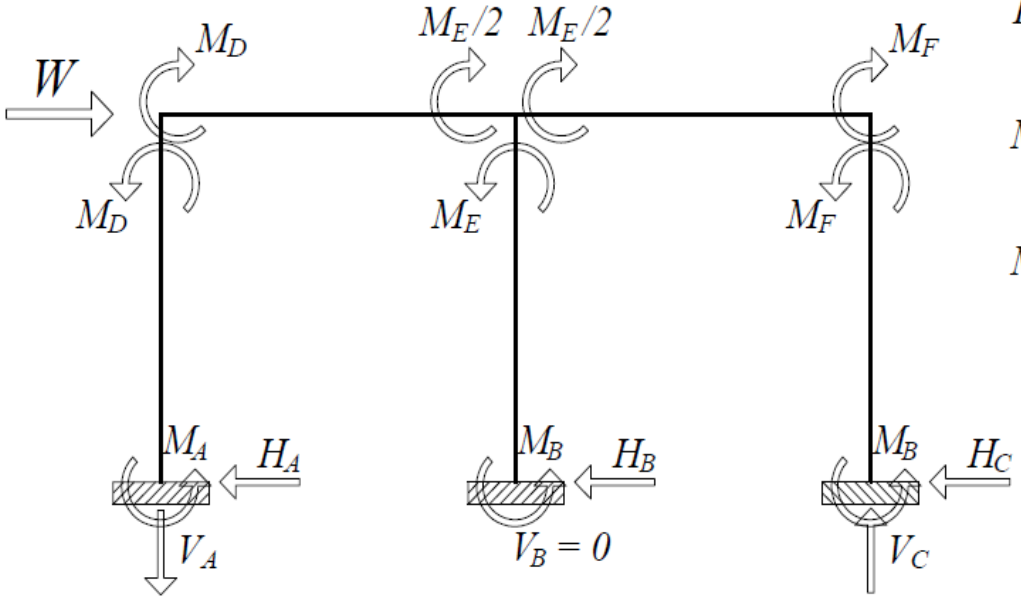
$$M_A = M_B = M_C = \frac{WH}{3} \cdot \frac{3k+1}{6k+1}$$

$$M_D = M_E = M_F = \frac{WH}{3} \cdot \frac{3k}{6k+1}$$

$$-V_A = V_C = \frac{3WHk}{L(12k+1)}$$


P=30.00
P=30.00
P=30.00
Greda
Stub
Stub
Stub
4.50
(1)
(1)
(1)
7.20
7.20



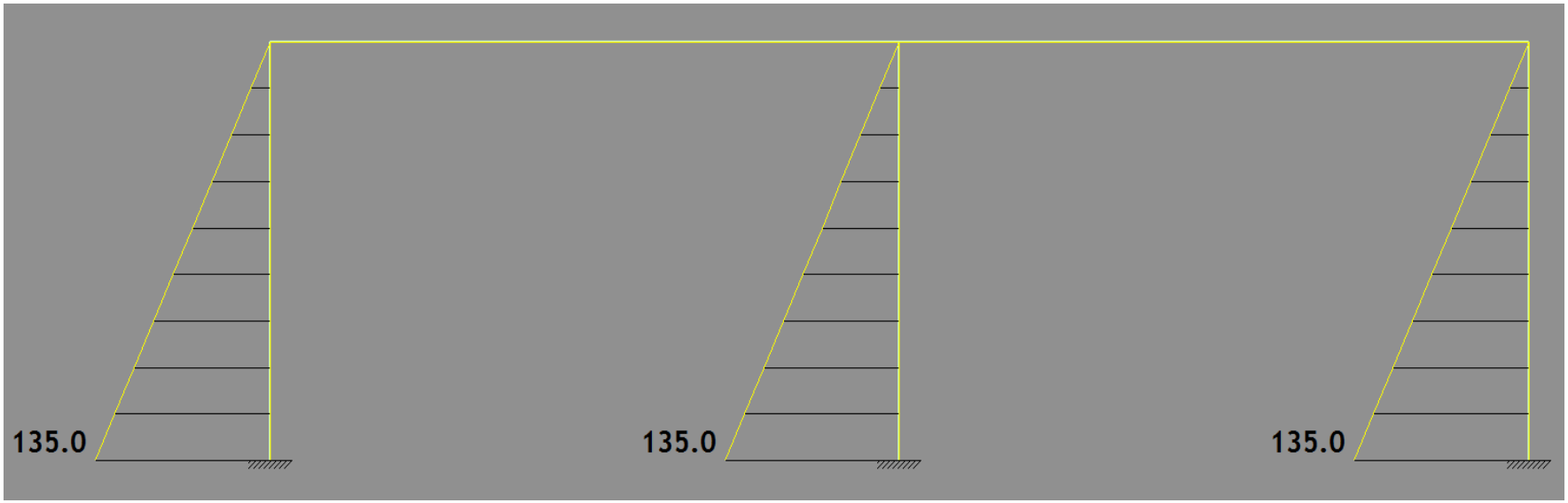


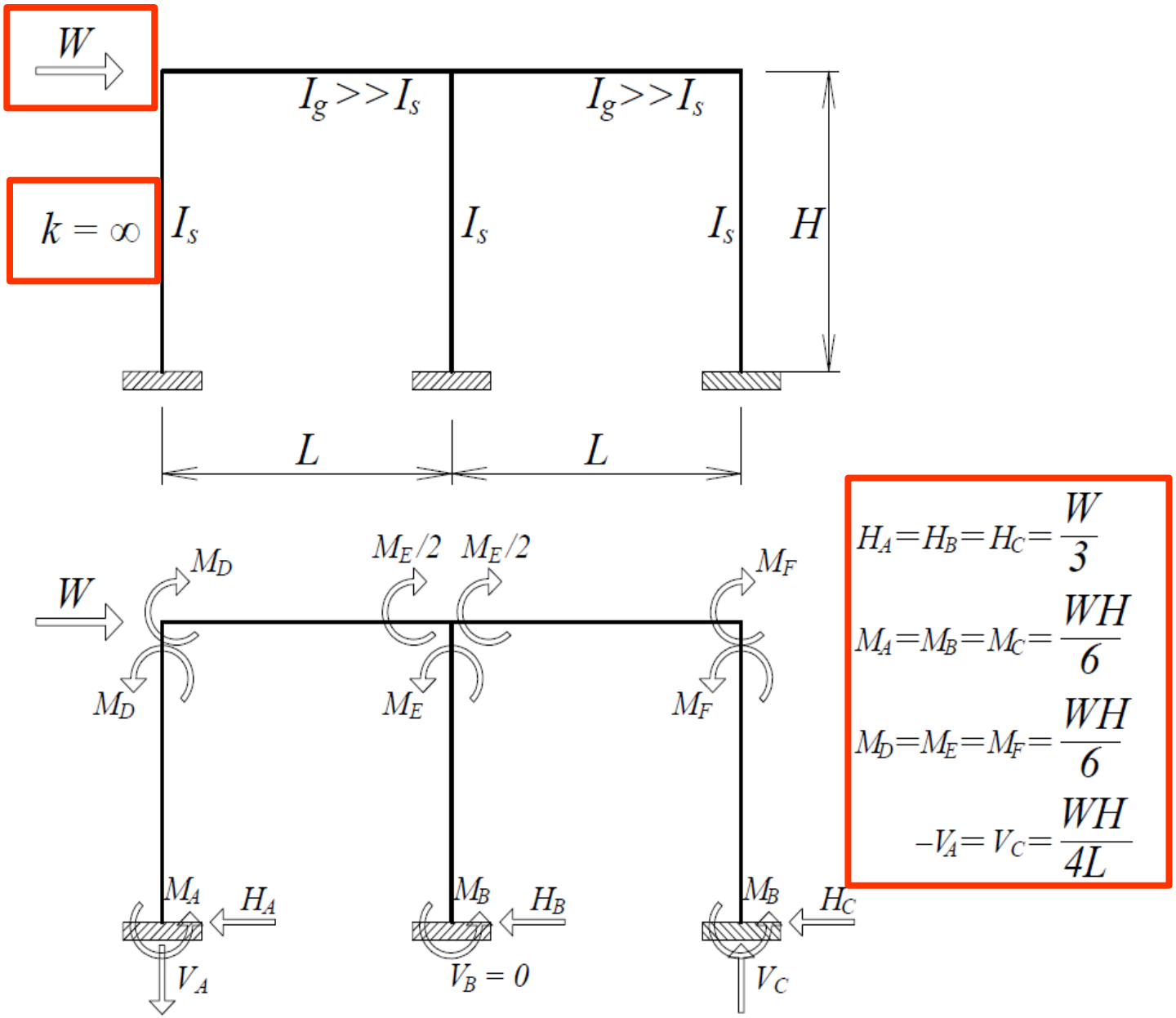
$$H_A = H_B = H_C = \frac{W}{3}$$

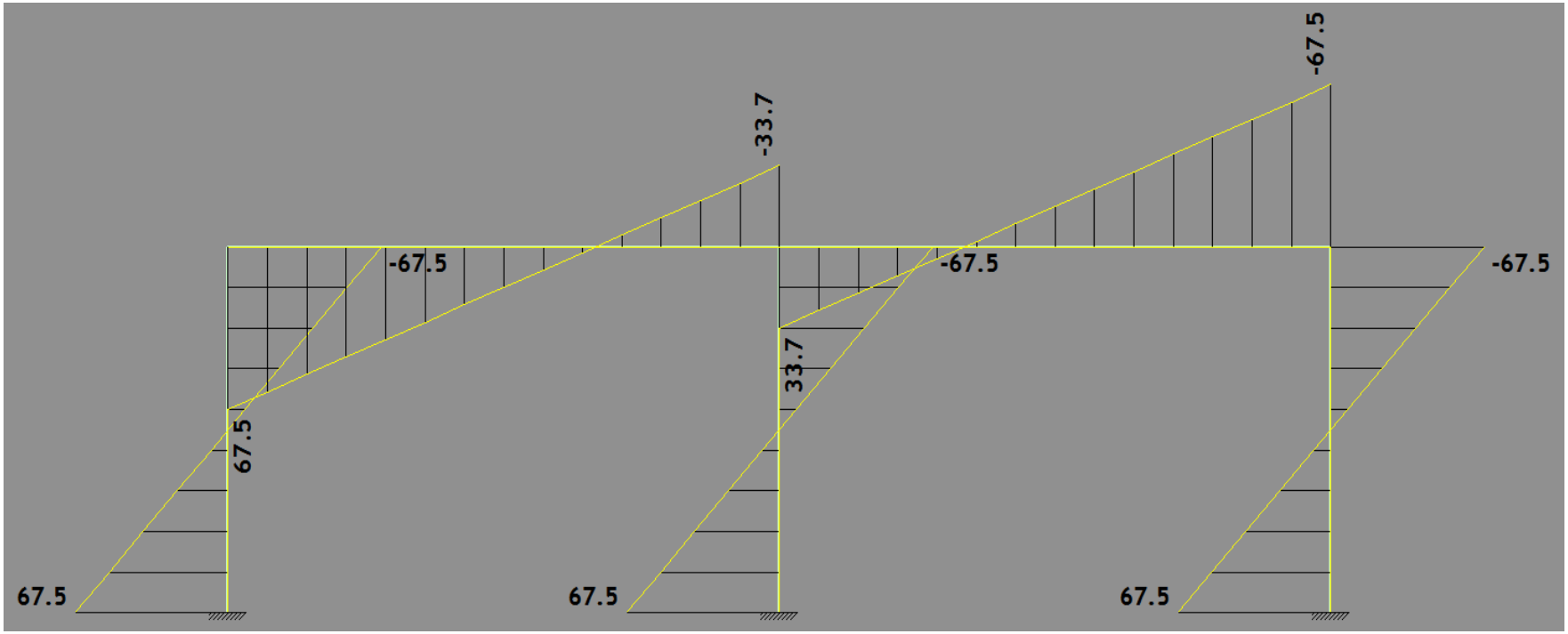
$$M_A = M_B = M_C = \frac{WH}{3}$$

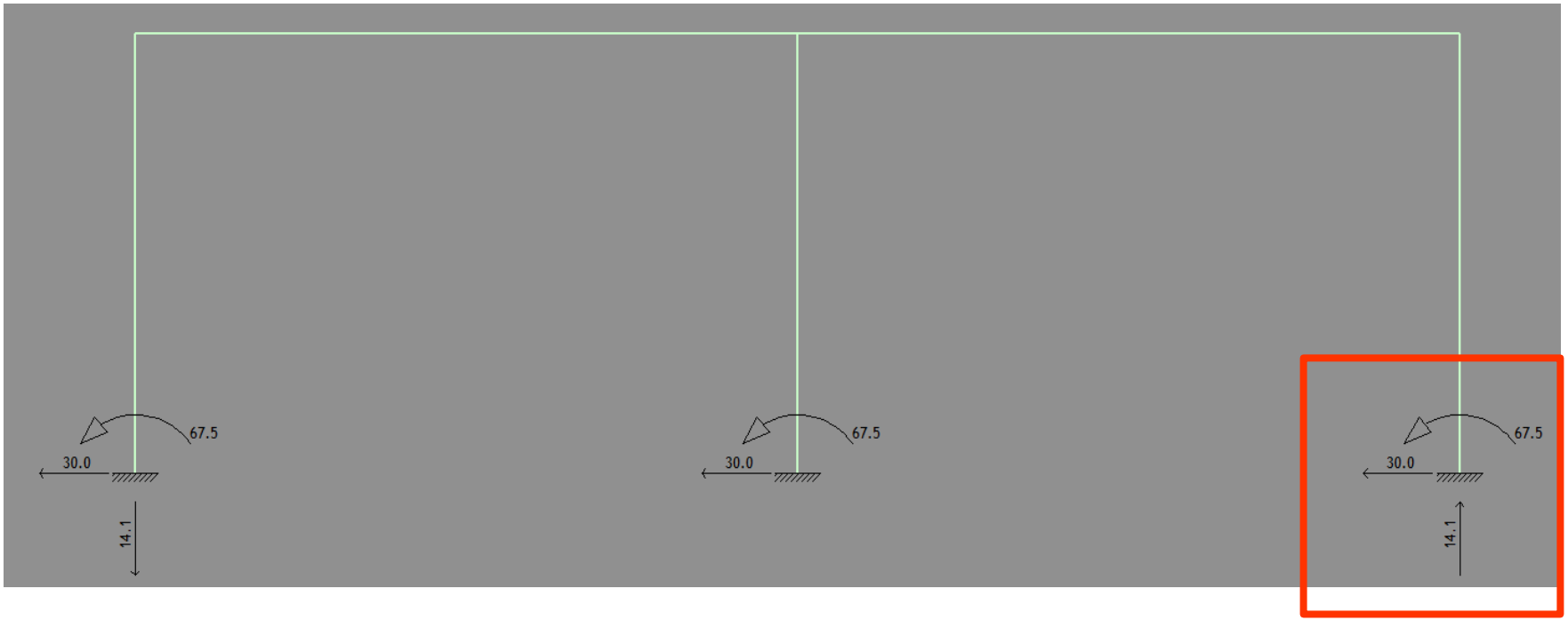
$$M_D = M_E = M_F = 0$$

$$-V_A = V_C = 0$$


135.0
135.0
135.0


W
$k = \infty$
$I_g >> I_s$
$I_g >> I_s$
I_s
I_s
I_s
H
L
L
W
M_D
M_D
$M_E/2$
$M_E/2$
M_E
M_F
M_F
M_A
H_A
V_A
M_B
H_B
$V_B = 0$
M_B
H_C
V_C
$H_A = H_B = H_C = \frac{W}{3}$
$M_A = M_B = M_C = \frac{WH}{6}$
$M_D = M_E = M_F = \frac{WH}{6}$
$-V_A = V_C = \frac{WH}{4L}$


-67.5
-33.7
-67.5
-67.5
-67.5
67.5
33.7
67.5
67.5
67.5


67.5
30.0
14.1
67.5
30.0
67.5
30.0
14.1

Analiza opterećenja – stub POS S6

Stalno opterećenje:

$N_G = 186.9$ kN

Povremeno opterećenje:

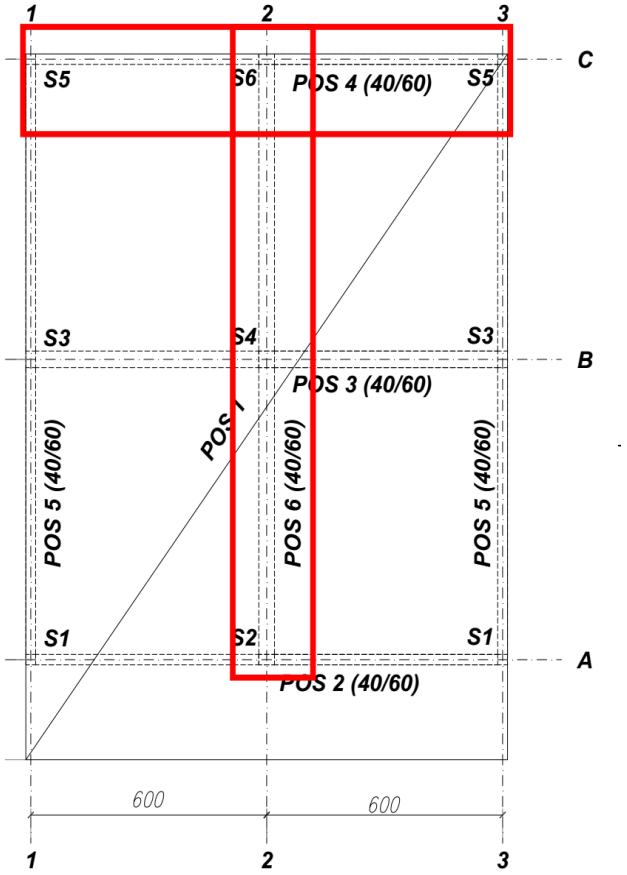
$N_Q = 209.4$ kN

Opterećenje vetrom:

$N_w = \pm 14.1$ kN $M_w = \pm 67.5$ kNm

$\Rightarrow$ Simetrično armiranje (u oba pravca!)

$\Rightarrow$ Primena dijagrama interakcije



Analiza opterećenja – stub POS S6

Kombinacija 1 – Maksimalni moment i minimalna normalna sila:

$N_{Ed} = N_G – 1.5*N_w = 165.75$ kN

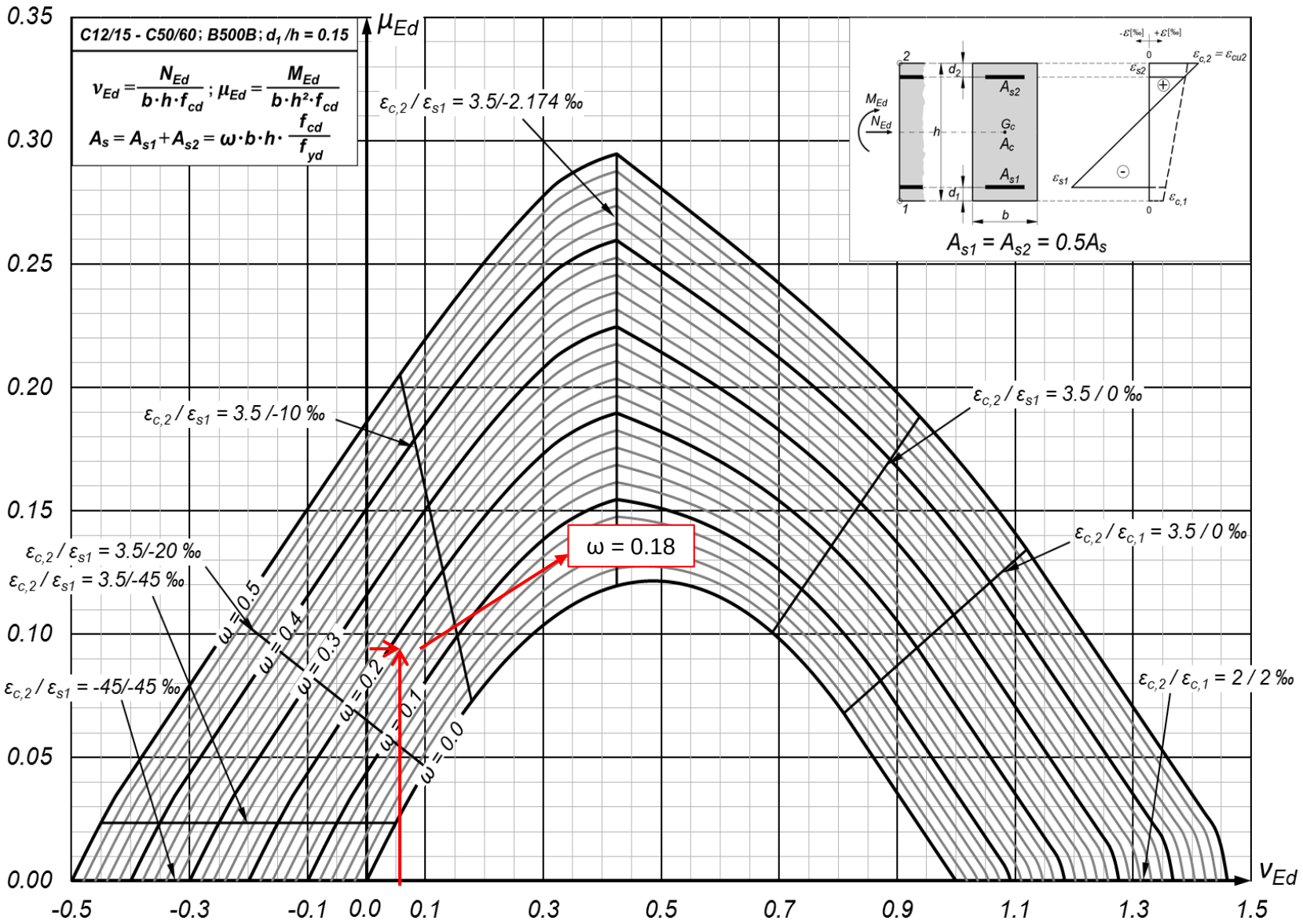
$M_{Ed} = 1.5*M_w = 101.25$ kNm

Proračunske bezdimenzionalne vrednosti uticaja:

$$v_{Ed} = \frac{N_{Ed}}{b \cdot h \cdot f_{cd}} = \frac{165.75}{40 \cdot 40 \cdot 1.7} = 0.06$$

$$\mu_{Rd} = \frac{M_{Rd}}{b \cdot h^2 \cdot f_{cd}} = \frac{10125}{40 \cdot 40^2 \cdot 1.7} = 0.093$$

Položaj težišta armature: $d_1/h = d_2/h = 6/40 = 0.15$


C12/15 - C50/60; B500B; $d_1/h = 0.15$
$\nu_{Ed} = \frac{N_{Ed}}{b \cdot h \cdot f_{cd}}$; $\mu_{Ed} = \frac{M_{Ed}}{b \cdot h^2 \cdot f_{cd}}$
$A_s = A_{s1} + A_{s2} = \omega \cdot b \cdot h \cdot \frac{f_{cd}}{f_{yd}}$
μ_{Ed}
ν_{Ed}
$\varepsilon_{c,2} / \varepsilon_{s1} = 3.5/-2.174$ ‰
$\varepsilon_{c,2} / \varepsilon_{s1} = 3.5 /-10$ ‰
$\varepsilon_{c,2} / \varepsilon_{s1} = 3.5 / 0$ ‰
$\varepsilon_{c,2} / \varepsilon_{c,1} = 3.5 / 0$ ‰
$\varepsilon_{c,2} / \varepsilon_{s1} = 3.5/-20$ ‰
$\varepsilon_{c,2} / \varepsilon_{s1} = 3.5/-45$ ‰
$\varepsilon_{c,2} / \varepsilon_{s1} = -45/-45$ ‰
$\varepsilon_{c,2} / \varepsilon_{c,1} = 2 / 2$ ‰
ω = 0.18
ω = 0.5
ω = 0.4
ω = 0.3
ω = 0.2
ω = 0.1
ω = 0.0
$A_{s1} = A_{s2} = 0.5A_s$
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.5
-0.3
-0.1
0.0
0.1
0.3
0.5
0.7
0.9
1.1
1.3
1.5

Analiza opterećenja – stub POS S6

Kombinacija 2 – N_{max} – dominantno dejstvo vetra :

$N_{Ed} = 1.35*N_G + 1.5*N_w + 1.5*0.7*N_Q = 493.34$ kN

$M_{Ed} = 1.5*M_w = 101.25$ kNm

Proračunske bezdimenzionalne vrednosti uticaja:

$$v_{Ed} = \frac{N_{Ed}}{b \cdot h \cdot f_{cd}} = \frac{493.34}{40 \cdot 40 \cdot 1.7} = 0.18 < v_{bal} \approx 0.4$$

Kombinacija nije merodavna

Kombinacija 2 – N_{max} – dominantno dejstvo povremenog opterećenja:

$N_{Ed} = 1.35*N_G + 1.5*N_Q + 1.5*0.6*N_w = 579.1$ kN

$M_{Ed} = 1.5*0.6*M_w = 101.25$ kNm

Proračunske bezdimenzionalne vrednosti uticaja:

$$v_{Ed} = \frac{N_{Ed}}{b \cdot h \cdot f_{cd}} = \frac{579.1}{40 \cdot 40 \cdot 1.7} = 0.21 < v_{bal} \approx 0.4$$

Kombinacija nije merodavna

Analiza opterećenja – stub POS S6

Usvajanje armature:

$$A_s = \omega b h \frac{f_{cd}}{f_{yd}} = 0.18 \cdot 40 \cdot 40 \frac{1.7}{43.48} = 11.26\ cm^2$$

$$A_{s1} = A_{s2} = A_s/2 = 5.63\ cm^2$$

Usvojeno ±3Ø16 (12.06 cm²)