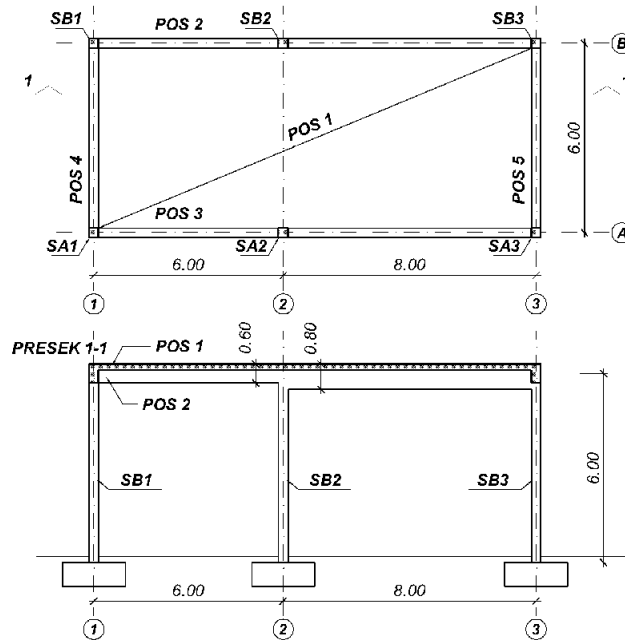


Pismeni ispit 07.06.2011.

1



Pismeni ispit 07.06.2011.

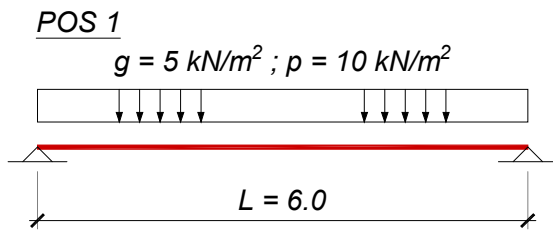
2

1. Konstrukcija prikazana na skici 1, pored sopstvene težine elemenata, opterećena je i povremenim opterećenjem, $p = 10.0 \text{ kN/m}^2$. Na **PODUŽNU** fasadu konstrukcije deluje i vetar, čije dejstvo se može predstaviti **UKUPNOM** horizontalnom silom od $W = \pm 80 \text{ kN}$. Ova sila deluje u nivou tavanice, koja se može smatrati krutom ravni. Usvojiti da uticaje usled dejstva vetra prihvataju samo ramovi u osama 1 i 3.

- 1.1 Dimenzionisati ploču **POS1** ($d_p = 20 \text{ cm}$) i za usvojenu armaturu odrediti ugibe u toku vremena. Skicirati u približnoj razmeri plan armature ploče (sa specifikacijom).
- 1.2 Izvršiti analizu opterećenja, sračunati statičke uticaje i dimenzionisati gredu **POS 2** ($b/d = 30/60 \text{ cm}$ između osa 1 i 2, odnosno $b/d = 30/80 \text{ cm}$ između osa 2 i 3). Skicirati u približnoj razmeri plan armature grede (sa specifikacijom).
- 1.3 Izvršiti analizu opterećenja, sračunati statičke uticaje i dimenzionisati ramove u osi 1 i osi 3 (POS4 i POS5, $b/d = 30/60 \text{ cm}$, stubovi $b/d = 30/30 \text{ cm}$). Ukoliko je potrebno, pri proračunu stubova uvesti u proračun izvijanje. Skicirati plan armature poprečnog rama u približnoj razmeri (podužni presek, karakteristični poprečni preseci).

Pismeni ispit 07.06.2011.

3



$$R_g = \frac{5.0 \times 6.0}{2} = 15 \frac{\text{kN}}{\text{m}}$$

$$R_p = \frac{10.0 \times 6.0}{2} = 30 \frac{\text{kN}}{\text{m}}$$

Sopstvena težina POS 2:

- deo 1-2: $0.3 \times 0.6 \times 25 = 4.5 \text{ kN/m}$
- deo 2-3: $0.3 \times 0.8 \times 25 = 6.0 \text{ kN/m}$

Ukupno stalno opterećenje POS 2:

$$g_1 = 4.5 + 15.0 = 19.5 \text{ kN/m} \quad (\text{deo 1-2})$$

$$g_2 = 6.0 + 15.0 = 21.0 \text{ kN/m} \quad (\text{deo 2-3})$$

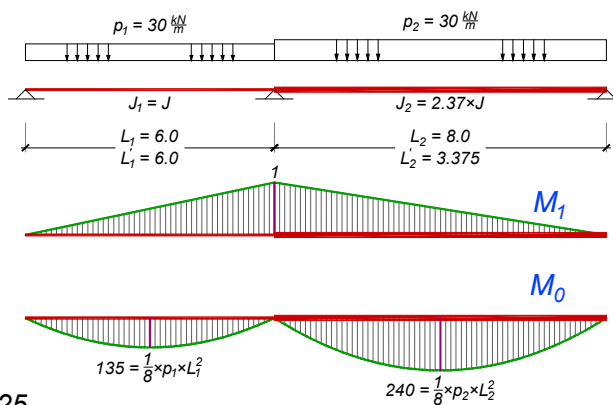
Povremeno opterećenje POS 2:

$$p_1 = p_2 = 30 \text{ kN/m}$$

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4

$$L'_2 = \frac{J_1}{J_2} \times L_2 = \frac{8.0}{2.37} = 3.375 \text{ m}$$



$$EJ\delta_{11} = \frac{6}{3} \times 1^2 + \frac{3.375}{3} \times 1^2 = 3.125$$

$$-EJ\delta_{10} = \frac{6.0}{3} \times 1.0 \times 135 + \frac{3.375}{3} \times 1.0 \times 240 = 270 + 270 = 540$$

$$X_{1,p} = M_p^{osl} = \frac{-EJ\delta_{10}}{EJ\delta_{11}} = \frac{270}{3.125} + \frac{270}{3.125} = 86.4 + 86.4 = 172.8 \text{ kNm}$$

$$X_{1,g} = M_g^{osl} = \frac{19.5}{30} \times 86.4 + \frac{21}{30} \times 86.4 = 116.64 \text{ kNm}$$

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5

$$A_g = \frac{19.5 \times 6.0}{2} - \frac{116.64}{6.0} = 39.1 \text{ kN}$$

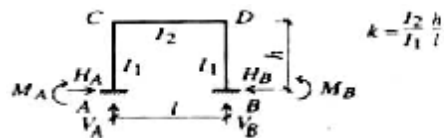
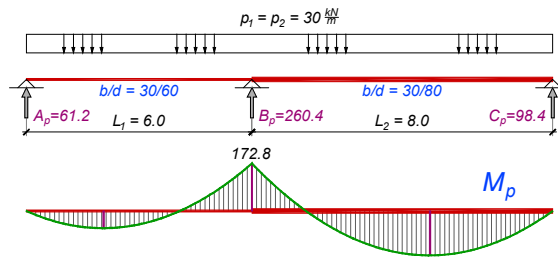
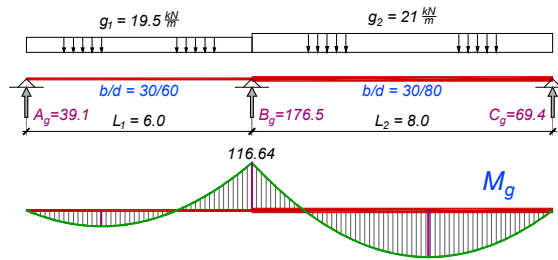
$$C_g = \frac{21 \times 8.0}{2} - \frac{116.64}{8.0} = 69.4 \text{ kN}$$

$$B_g = 19.5 \times 6.0 + 21 \times 8.0 - (39.1 + 69.4) = 176.5 \text{ kN}$$

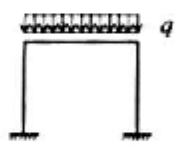
$$A_p = \frac{30 \times 6.0}{2} - \frac{172.8}{6.0} = 61.2 \text{ kN}$$

$$C_p = \frac{30 \times 8.0}{2} - \frac{172.8}{8.0} = 98.4 \text{ kN}$$

$$B_p = 30 \times (6.0 + 8.0) - (61.2 + 98.4) = 260.4 \text{ kN}$$



6

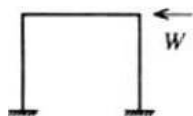


$$H = H_A = H_B = \frac{ql^2}{4h(k+2)}$$

$$V_A = V_B = \frac{ql}{2}$$

$$M_A = M_B = \frac{ql^2}{12(k+2)} = H \frac{h}{3}$$

$$M_C = M_D = \frac{ql^2}{6(k+2)} = -2H \frac{h}{3}$$



$$H_A = -H_B = \frac{W}{2}$$

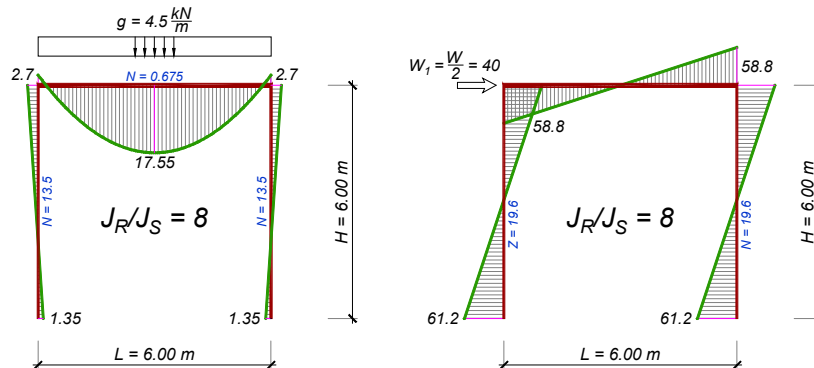
$$V_A = -V_B = \frac{3Whk}{l(6k+1)}$$

$$M_A = -M_B = \frac{Wh}{2} \frac{3k+1}{6k+1}$$

$$M_C = -M_D = \frac{Wh}{2} \frac{3k}{6k+1}$$

Grede POS 4, POS 5: $b/d = 30/60$ cm, stubovi $b/d = 30/30$ cm

7



Za ovakav odnos krutosti grede i stubova, opravdano je za vertikalno opterećenje smatrati da su stubovi tačkasti oslonci za grede, a za horizontalno opterećenje da su stubovi obostrano uklješteni:

$$M_g \approx \frac{g \times L^2}{8} = \frac{4.5 \times 6.0^2}{8} = 20.25 \text{ kNm} ; M_w \approx \pm \frac{W_1 \times H}{2} = \pm \frac{40 \times 6.0}{2} = \pm 60 \text{ kNm}$$

$$N_g = \frac{g \times L}{2} = \frac{4.5 \times 6.0}{2} = 13.5 \text{ kN} ; N_w \approx \pm \frac{M_1 + M_2}{L} = \pm \frac{60 + 60}{6.0} = \pm 20 \text{ kN}$$

Dimenzionisanje stubova

8

stubovi u osama A i C:

$$M = M_w = \pm 60 \text{ kNm}$$

minimalna sila u stubovima (osa A):

$$G = A_g^{POS 2} + G^{POS 4} = 39.1 + 13.5 = 52.6 \text{ kN}$$

$$P_{min} = Z_w = -20 \text{ kN}$$

$$e_1 = \frac{M_u}{N_u} = \frac{1.8 \times 60}{1.0 \times 52.6 + 1.8 \times (-20)} = \frac{108}{16.6} = 6.5 \text{ m} \Rightarrow \frac{e_1}{d} = \frac{650}{30} > 3.5$$

maksimalna sila u stubovima (osa C):

$$G = C_g^{POS 2} + G^{POS 4} = 69.4 + 13.5 = 82.9 \text{ kN}$$

$$P_{max} = C_p^{POS 2} + N_w = 98.4 + 20 = 118.4 \text{ kN}$$

$$e_1 = \frac{M_u}{N_u} = \frac{1.8 \times 60}{1.6 \times 82.9 + 1.8 \times 118.4} = \frac{108}{345.8} = 0.312 \text{ m} \Rightarrow \frac{e_1}{d} = \frac{31.2}{30} < 3.5$$

stubovi u osi B:

$$M = 0$$

$$G = B_g^{POS 2} = 176.5 \text{ kN}$$

$$P_{max} = B_p^{POS 2} = 260.4 \text{ kN}$$

Pismeni ispit 07.06.2011. – zadatak 2

9

2. Konstrukcija prikazana na skici 2, pored sopstvene težine elemenata, opterećena je i povremenim opterećenjem, $p = 5.0 \text{ kN/m}^2$. Usvajajući da seizmička sila iznosi 10% mase, $S = 0.1(G+P)$, potrebno je:

- 2.1 Dimenzionisati stubove POS St, tako da pomeranje vrha konstrukcije bude u dopuštenim granicama
- 2.2 Izvršiti kontrolu probijanja stuba kroz ploču POS PI (dpl = 20 cm) i po potrebi izvršiti osiguranje.

$$g = 0.20 \times 25 = 5.0 \text{ kN/m}^2 \quad ; \quad p = 5.0 \text{ kN/m}^2$$

$$G = P = 5.0 \times 6.0 \times 6.0 = 180 \text{ kN}$$

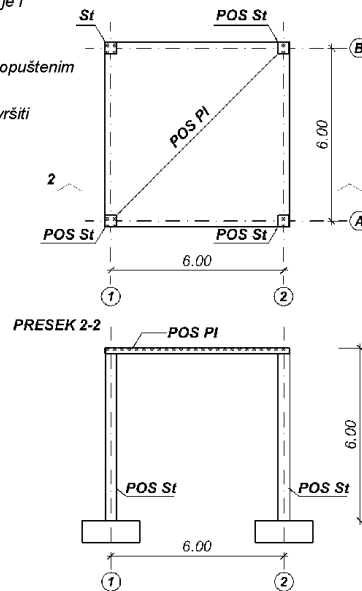
$$S = 0.1 \times (G+P) = 0.1 \times (180+180) = 36.0 \text{ kN}$$

sila koja deluje na jedan stub:

$$S_1 = 36.0/4 = 9.0 \text{ kN}$$

$$M_{s1} = S_1 \times H = 9.0 \times 6.0 = 54.0 \text{ kNm}$$

$$M_u = 1.3 \times M_{s1} = 1.3 \times 54.0 = 70.2 \text{ kNm}$$



“beskonačno” kruta ploča ($A \rightarrow \infty, J \rightarrow 0$)

10

$$k = \frac{J_R}{J_S} \times \frac{H}{L} = 0 \Rightarrow M_c = 0$$

pomeranje vrha stuba usled sile S_1 :

$$dx = \frac{S_1 \times H^3}{3 \times E_b \times J_S} \leq dx_{dop.} = \frac{H}{600}$$

$$J_S \geq \frac{S_1 \times H^3}{3 \times E_b \times dx_{dop.}}$$

$$J_S \geq \frac{9.0 \times 6.0^3}{3 \times 3.15 \times 10^7 \times \frac{6.0}{600}} = 0.00205 \text{ m}^4$$

$$J_S = \frac{a^4}{12} = 0.00205 \text{ m}^4 \Rightarrow a = \sqrt[4]{12 \times 0.00205} = 0.396 \text{ m}$$

usvojeni stubovi $b/d = 40/40 \text{ cm}$

