

ПОТПОРНИ ЗИДОВИ

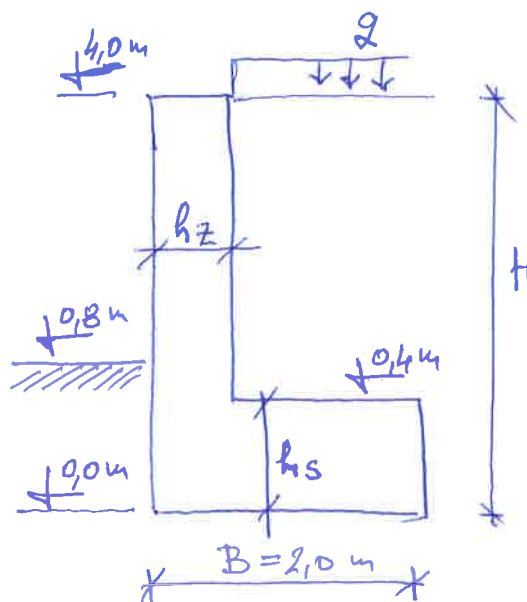
①

ПРИМЕР 1

1) КАРАКТЕРИСТИКЕ КОНСТРУКЦИЈЕ

$$H = 4,0 \text{ m} \quad B = 2,0 \text{ m}$$

$$h_z = 0,3 \text{ m} \quad h_s = 0,4 \text{ m}$$



2) ОПТЕРЕЖЕЊЕ

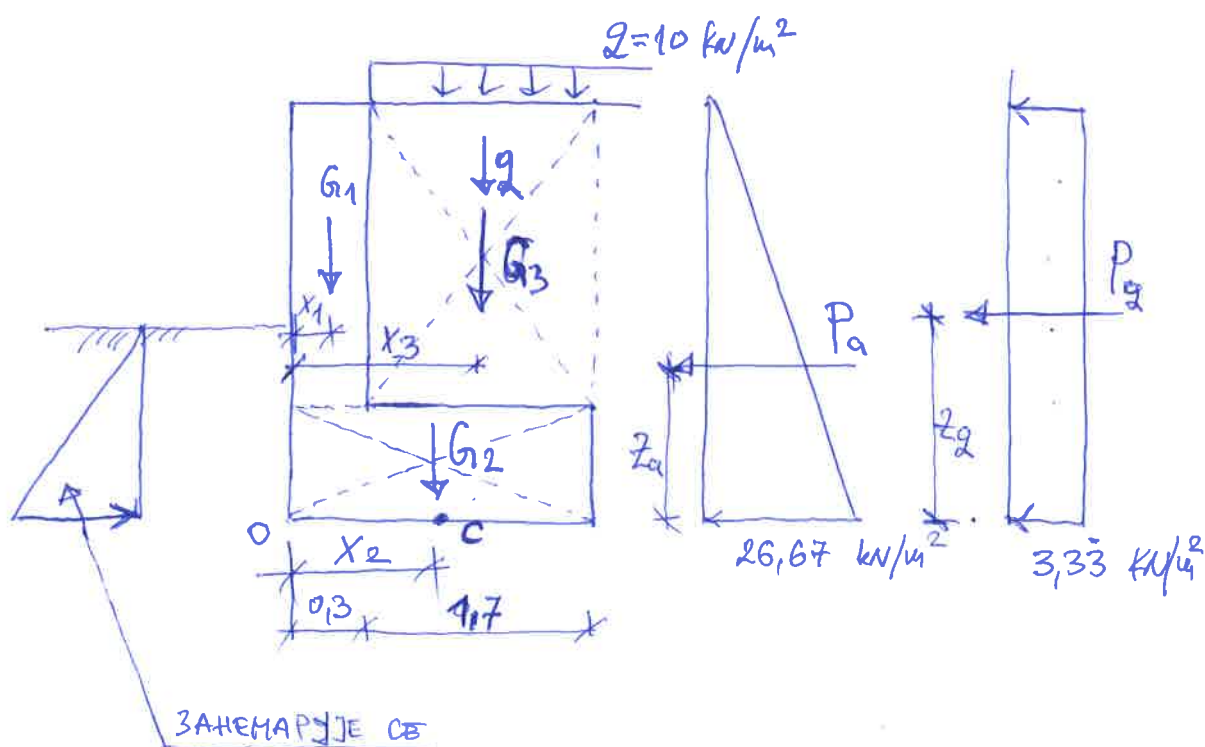
$$q = 10 \text{ kN/m}^2$$

$$k_a = \tan^2(45 - \gamma/2) = 0,33$$

КАРАКТЕРИСТИКЕ ТЛА

$$\gamma_t = 20 \text{ kN/m}^3 \quad \gamma = 30^\circ \quad C = 0 \text{ kN/m}^2$$

$$\sigma_{\text{доп}} = 200 \text{ kN/m}^2$$



①

2.1) ПОВОЉНИ УТИЦАЈИ

$$G_1 = 0,3 \cdot 3,6 \cdot 25 = 27,0 \text{ kN/m} \quad x_1 = 0,15 \text{ m}$$

$$G_2 = 0,4 \cdot 2,0 \cdot 25 = 20,0 \text{ kN/m} \quad x_2 = 1,0 \text{ m}$$

$$G_3 = 1,7 \cdot 3,6 \cdot 20 = 122,4 \text{ kN/m} \quad x_3 = 1,15 \text{ m}$$

$$g = 10 \cdot 1,7 = 17,0 \text{ kN/m} \quad x_g = 1,15 \text{ m}$$

2.2) НЕПОВОЉНИ УТИЦАЈИ

$$P_a = 0,33 \cdot 20 \cdot 4,0 \cdot 4,0 \cdot \frac{1}{2} = 53,33 \text{ kN/m} \quad z_a = \frac{4}{3} = 1,33 \text{ m}$$

$$P_g = 0,33 \cdot 10 \cdot 4,0 = 13,33 \text{ kN/m} \quad z_g = 2,0 \text{ m}$$

3) КОНТРОЛ НАПОНА У ТЛУ (У ОДНОСУ НА „C“)

$$\sigma_{1,2} = \frac{N}{A} \pm \frac{M}{W}$$

$$N = \sum_{i=1}^3 G_i + g = 27,0 + 20,0 + 122,4 + 17,0 = 186,4 \text{ kN/m}$$

$$\begin{aligned} M_c &= P_a \cdot z_a + P_g \cdot z_g + G_1 (B/2 - x_1) + G_3 (B/2 - x_3) + g \cdot (B/2 - x_g) \\ &= 53,33 \cdot 1,33 + 13,33 \cdot 2,0 + 27 \left(\frac{2}{2} - 0,15 \right) + 122,4 \left(\frac{2}{2} - 1,15 \right) + 17 \left(\frac{2}{2} - 1,15 \right) \\ &= 99,63 \text{ kN/m} \end{aligned}$$

$$A = B \cdot L = 2,0 \cdot 1,0 = 2,0 \text{ m}^2/\text{m}$$

$$W = \frac{LB^2}{6} = \frac{1,0 \cdot 2,0^2}{6} = 0,66 \text{ m}^3/\text{m}$$

$$\sigma_{1,2} = \frac{186,4}{2,0} \pm \frac{99,63}{0,66} \Rightarrow \begin{aligned} \sigma_1 &= 241,9 \text{ kN/m}^2 \\ \sigma_2 &= -55,5 \text{ kN/m}^2 \quad (*) \end{aligned}$$

(*) НАПОН σ_2 ЈЕ НАПОН ЗАТЕЗАЊА, ПА ЈЕ ПОТРЕБНО КОРИГОВАТИ НАПОНИЕ.

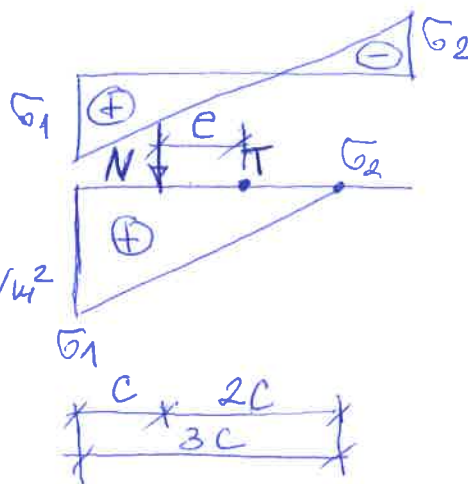
$$e = \frac{M}{N} = \frac{99,63}{186,4} = 0,534 \text{ m}$$

$$c = \frac{b}{2} - e = \frac{2,0}{2} - 0,534 = 0,465 \text{ m}$$

$$\sigma_1 = \frac{2N}{3c} = \frac{2 \cdot 186,4}{3 \cdot 0,465} = 267,24 \text{ kN/m}^2$$

$$\sigma_2 = 0 \text{ kN/m}^2$$

$$\sigma_1 > \sigma_{\text{dop}} = 200 \text{ kN/m}^2$$



⊗ ПРОШИРЕЊЕ ТЕМЕЉНЕ СЛОЈИЦЕ ЗА B_1 $q = 10 \text{ kN/m}^2$

$$B_1 = 0,4 \text{ m}$$

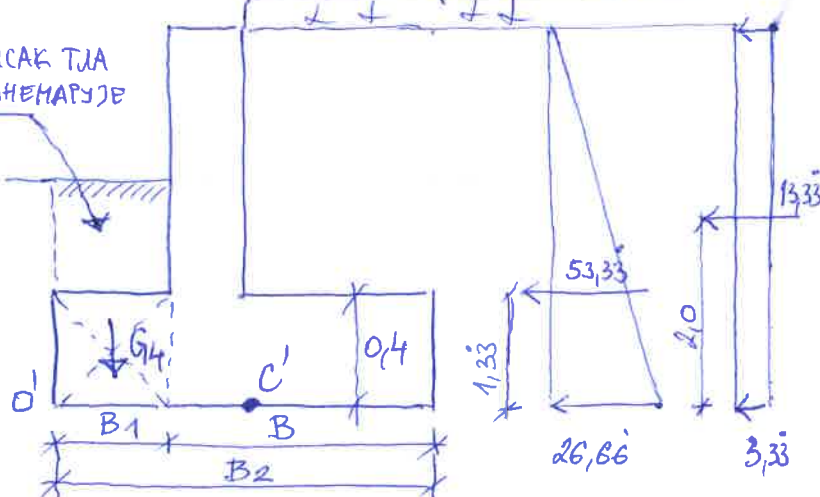
$$B_2 = 2,0 + 0,4 = 2,4 \text{ m}$$

$$G_4 = 0,4 \cdot 0,4 \cdot 25 = 4,0 \text{ kN/m}$$

$$A = 2,4 \cdot 1,0 = 2,4 \text{ m}^2/\text{m}$$

$$W = \frac{1,0 \cdot 2,4^2}{6} = 0,96 \frac{\text{m}^3}{\text{m}}$$

ПРИБРАЊА ТЈА
СЕ ЗАПЕЧАЉУЈЕ

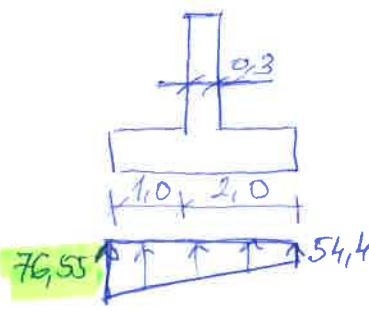
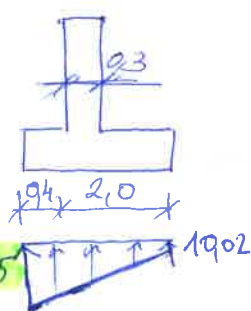
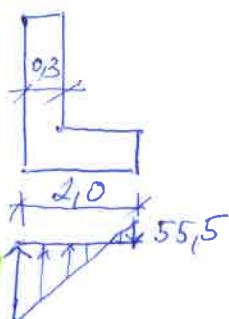


$$N = \sum_{i=1}^4 G_i + q = 27,0 + 20,0 + 12,4 + 4,0 + 17,0 = 190,4 \text{ kN/m}^2$$

$$\begin{aligned} M_{C'} &= P_a \cdot z_a + P_g \cdot z_g + G_1 \cdot \left(\frac{B_2}{2} - B_1 - x_1 \right) + G_3 \cdot \left(\frac{B_2}{2} - B_1 - x_3 \right) + q \cdot \left(\frac{B_2}{2} - B_1 - x_q \right) \\ &= 53,33 \cdot 1,33 + 13,33 \cdot 2,0 + 27 \cdot \left(\frac{2,4}{2} - 0,4 - 0,15 \right) + 12,4 \cdot \left(\frac{2,4}{2} - 0,4 - 1,15 \right) + 17 \cdot \left(\frac{2,4}{2} - 0,4 - 1,15 \right) \\ &= 66,54 \text{ kN/m} \end{aligned}$$

$$\sigma_{1,2} = \frac{190,4}{2,4} \pm \frac{66,54}{0,96} \Rightarrow \begin{aligned} \sigma_1 &= 148,65 \text{ kN/m}^2 < \sigma_{\text{dop}} = 200 \text{ kN/m}^2 \\ \sigma_2 &= 10,02 \text{ kN/m}^2 \end{aligned}$$

⊗ СТА ТЈА НА ПОСТА У ТЕМЕЉНОЈ СЛОЈИЦИ У ФУНКЦИЈИ ШИРИНЕ



③

4) КОНТРОЛ НА СигурНОСТИ НА КИЗАНЕ

$$\sum N = \sum_{i=1}^4 G_i + q = 190,4 \text{ kN/m}$$

$$\sum H = P_a + P_g = 53,33 + 13,33 = 66,66 \text{ kN/m}$$

$$F_{sk} = \frac{\sum N \cdot \tan \varphi}{\sum H} = \frac{190,4 \cdot \tan 30^\circ}{66,66} = 1,649 > 1,5$$

5) КОНТРОЛ НА СигурНОСТИ НА ПРЕДУПАТЪЕ (УДАКОУ НА О')

$$\begin{aligned} M_v &= G_1(B_1+x_1) + G_2(B_1+x_2) + G_3(B_1+x_3) + q(B_1+x_4) + G_4 \cdot \frac{B_1}{2} \\ &= 27(9,4+9,15) + 20(9,4+1,0) + 122,4(9,4+1,15) + 17(9,4+1,15) + 40 \cdot \frac{9,4}{2} \\ &= 259,72 \text{ kNm/m} \end{aligned}$$

$$M_p = P_a \cdot z_a + P_g \cdot z_g = 53,33 \cdot 1,33 + 13,33 \cdot 2,0 = 97,78 \text{ kNm/m}$$

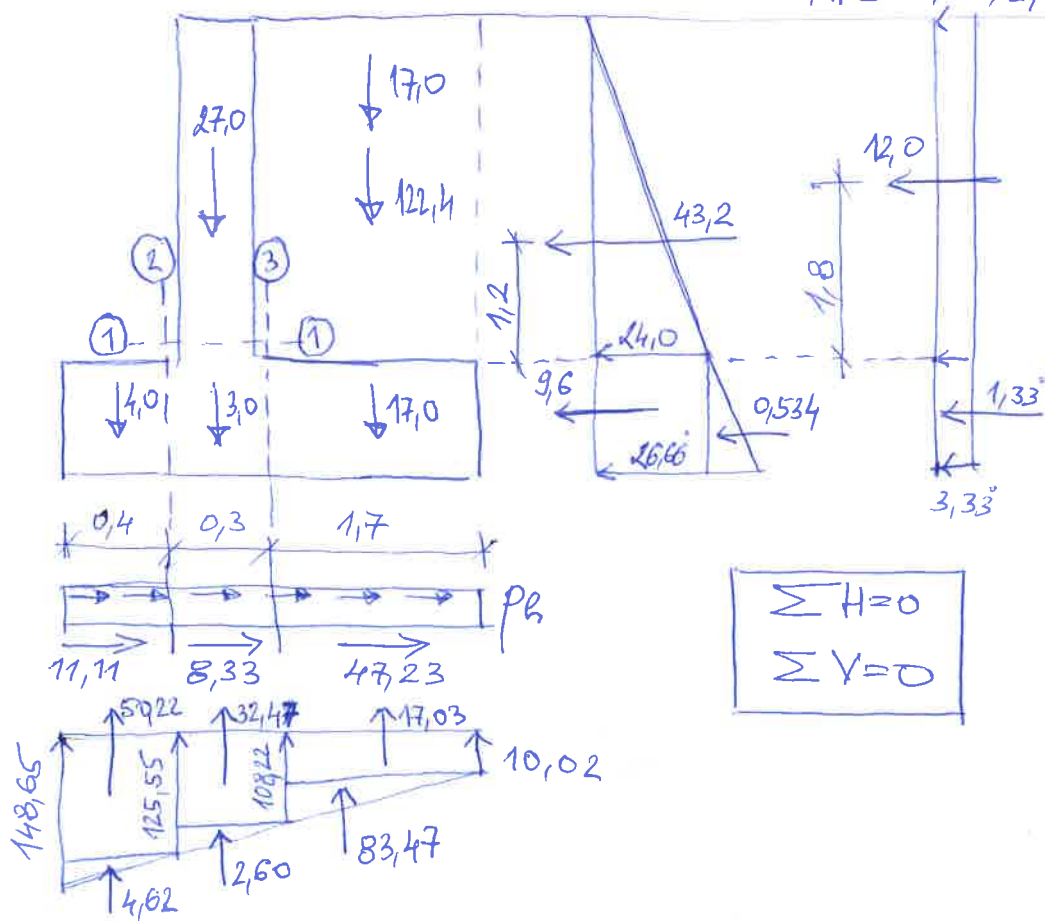
$$F_{sp} = \frac{M_v}{M_p} = \frac{259,72}{97,78} = 2,656 > 1,5$$

6) ДИМЕНЗИОНИРАНЕ НА КАРАКТЕРИСТИЧНИК НА ПРЕСЕКА

- СКА ТРЕТЪ НА ТЕМЕЛНОУ СПОЛНИЦА

$$P_R = \sum H = 66,66 \text{ kN/m}$$

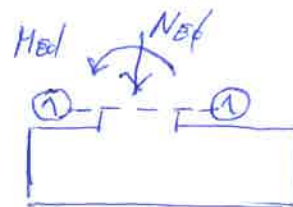
$$P_R = 66,66 / 2,4 = 27,77 \text{ kN/m}^2$$



ПРЕСЕК 1-1 / (B500B)

$$M_{ed} = 1,35 \cdot 43,2 \cdot 1,2 + 1,5 \cdot 12,0 \cdot 1,8 = 102,38 \text{ кНм/м}$$

$$N_{ed} = 1,0 \cdot 27,0 = 27,0 \text{ кН/м}$$



$$d_1 = 5 \text{ см} \Rightarrow d = h_z - d_1 = 30 - 5 = 25 \text{ см}$$

$$M_{ed,s} = 102,38 + 27,0 \left(\frac{0,3}{2} - 0,05 \right) = 105,08 \text{ кНм/м}$$

$$A_{s,1} = \frac{105,08 \cdot 100}{0,9 \cdot 25 \cdot 43,5} - \frac{27,0}{43,5} = 10,74 - 0,62 = 10,12 \frac{\text{см}^2}{\text{м}}$$

ПРЕСЕК 2-2 /

$$P_{SR} \approx 1,4$$

$$d = 40 - 5 = 35 \text{ см}$$

— ЭКСПЛУАТАЦИОНН УТИЦАЈИ :

$$M = 10,04 + 1,23 - 0,8 - 2,22 = 8,22 \frac{\text{кНм}}{\text{м}}$$

$$N = 11,1 \text{ кН/м}$$

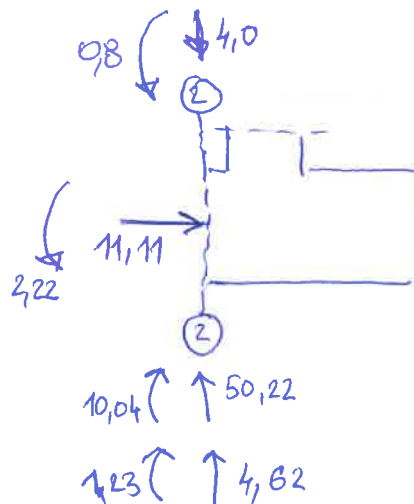
— ГРАНИЧНИ УТИЦАЈИ :

$$M_{ed} = 1,4 \cdot 8,22 = 11,51 \text{ кНм/м}$$

$$N_{ed} = 1,0 \cdot 11,1 = 11,1 \text{ кН/м}$$

$$M_{ed,s} = 11,51 + 11,1 \cdot \left(\frac{0,4}{2} - 0,05 \right) = 13,18 \frac{\text{кНм}}{\text{м}}$$

$$A_{s,2} = \frac{13,18 \cdot 100}{0,9 \cdot 35 \cdot 43,5} - \frac{11,1}{43,5} = 0,71 \frac{\text{см}^2}{\text{м}}$$



ПРЕСЕК 3-3 /

— ЭКСПЛУАТАЦИОНН УТИЦАЈИ :

$$M = 132,94 - 9,45 + 0,036 - 14,48 - 47,3 = 61,67 \frac{\text{кНм}}{\text{м}}$$

$$N = 47,23 - 9,6 - 0,534 - 1,33 = 35,76 \text{ кН/м}$$

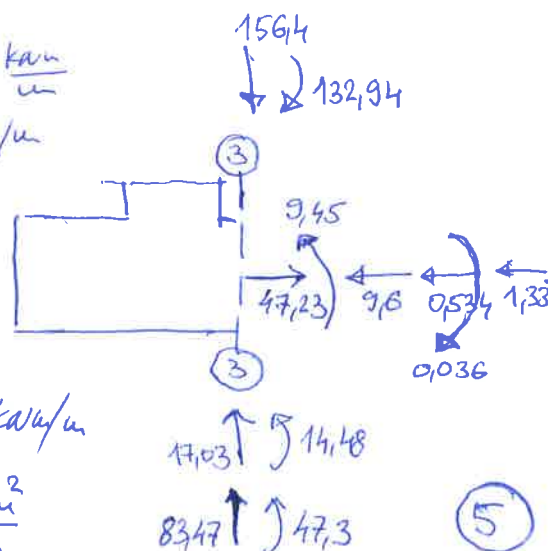
— ГРАНИЧНИ УТИЦАЈИ :

$$M_{ed} = 1,4 \cdot 61,67 = 86,34 \text{ кНм/м}$$

$$N_{ed} = 1,4 \cdot 35,76 = 50,06 \text{ кН/м}$$

$$M_{ed,s} = 86,34 - 50,06 \left(\frac{0,4}{2} - 0,05 \right) = 78,83 \text{ кНм/м}$$

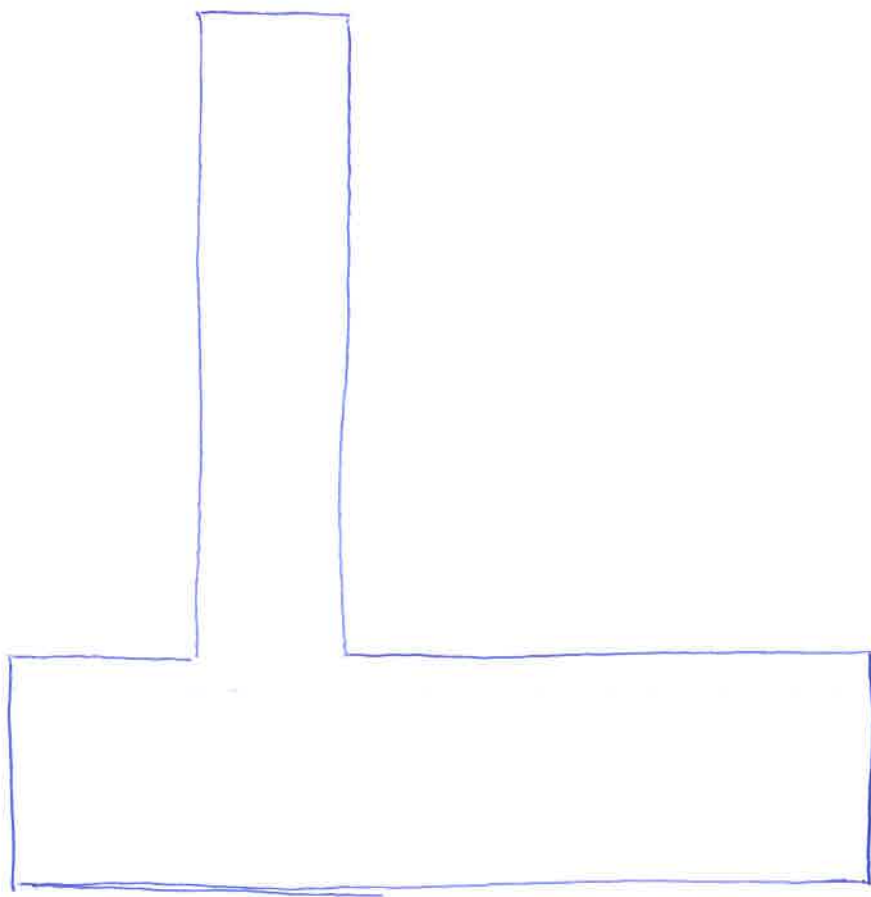
$$A_{s,3} = \frac{78,83 \cdot 100}{0,9 \cdot 35 \cdot 43,5} + \frac{50,06}{43,5} = 6,9 \frac{\text{см}^2}{\text{м}}$$



ШЕМА АРМИРАЊА

30

[a]



40

40 200 240

ПРИМЕР 2

* ДИСПОЗИЦИЈА ЈЕ ИСТА КАО У ПРИМЕРУ 1, ПРИ ЧЕМУ ЈЕ КОРИСНО ОПТЕРЕЋЕЊЕ $q = 30 \text{ kN/m}^2$

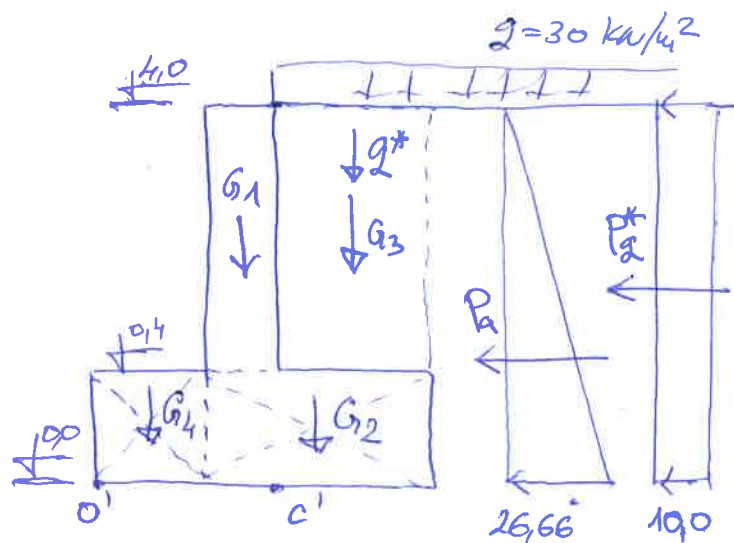
1) ОПТЕРЕЋЕЊЕ

$$q^* = 30 \cdot 1,7 = 51,0 \text{ kN/m}^2$$

$$x_g = 1,15 \text{ m}$$

$$p_g^* = k_a \cdot 30 \cdot 4,0 = 40 \text{ kN/m}^2$$

$$z_g = 2,0 \text{ m}$$



2) КОНТРОЛ НАПОНА У ТЛУ (У ОДНОСУ НА C')

$$N = \sum_{i=1}^4 G_i + q^* = 27 + 20 + 122,4 + 4,0 + 51 = 224,4 \text{ kN/m}$$

$$M_{C'} = 53,33 \cdot 1,33 + 40 \cdot 2,0 + 27 \left(\frac{2,4}{2} - 0,4 - 0,15 \right) + 122,4 \left(\frac{2,4}{2} - 0,4 - 1,15 \right) + 51 \left(\frac{2,4}{2} - 0,4 - 1,15 \right)$$

$$M_{C'} = 107,97 \text{ kNm/m}$$

$$\sigma_{1,2} = \frac{224,4}{2,4} \pm \frac{107,97}{0,96} \Rightarrow \sigma_1 = 205,97 \frac{\text{kN}}{\text{m}^2} \quad \sigma_2 = -18,97 \frac{\text{kN}}{\text{m}^2}$$

$$e = \frac{107,97}{224,4} = 0,481 \text{ m}$$

$$C = \frac{2,4}{2} - 0,481 = 0,719 \text{ m} \Rightarrow \sigma_1 = 208,1 \frac{\text{kN}}{\text{m}^2} \quad \sigma_2 = 0 \text{ kN/m}^2$$

$$\sigma_1 = 208,1 > \sigma_{\text{доп}} = 200 \frac{\text{kN}}{\text{m}^2} \quad !$$

3) КОНТРОЛ СИГУРНОСТИ НА КЛИЗАЊЕ

$$\sum N = \sum_{i=1}^4 G_i + q^* = 224,4 \text{ kN/m}$$

$$\sum H = P_a + P_g^* = 53,33 + 40 = 93,33 \frac{\text{kN}}{\text{m}}$$

$$F_{sk} = \frac{\sum N \cdot \tan \varphi}{\sum H} = \frac{224,4 \cdot \tan 30^\circ}{93,33} = 1,388 < 1,5 \quad !$$

4) КОНТРОЛЬ СИГУРНОСТ НА ПРЕДУПАВЕ (У ОДНОСУ НА O')

$$M_V = 27(0,4+0,15) + 20(0,4+1,0) + 122,4(0,4+1,15) + 51(0,4+1,15) + 4,0 \cdot \frac{0,4}{2}$$

$$M_V = 312,42 \text{ kNm/m}$$

$$M_P = 53,33 \cdot 1,33 + 40 \cdot 2,0 = 151,11 \text{ kNm/m}$$

$$F_{SP} = \frac{M_V}{M_P} = \frac{312,42}{151,11} = \underline{\underline{2,067 > 1,5}}$$

РЕШЕНИЕ I

— ПРОУЧЕНИЕ ТЕПЕЛНЕ СТОРЕ ЗА B_3

$$\frac{F_{SK, POT}}{F_{SK}} = \frac{1,5}{1,388} = 1,08$$

УСВОЈЕНО;

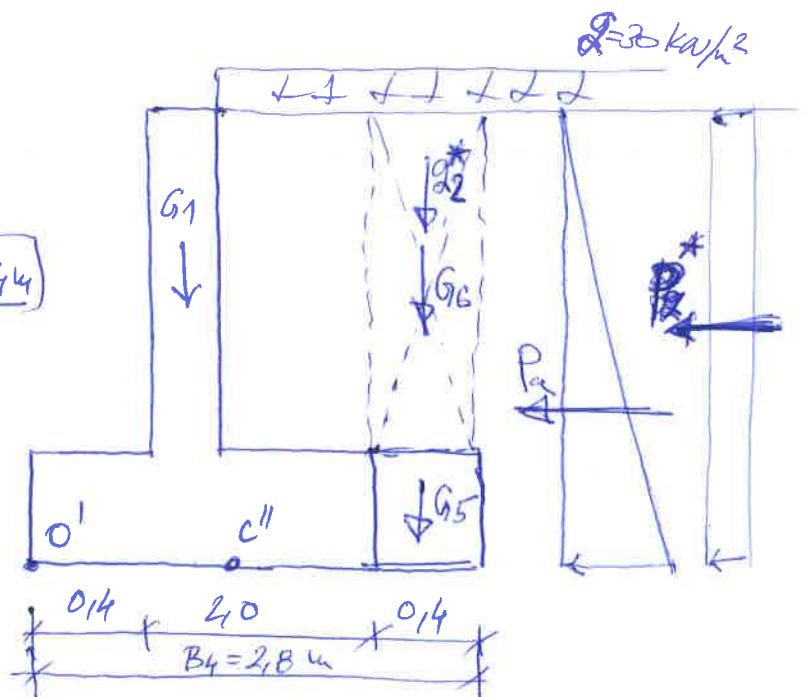
$$\frac{B_3}{B_2} \approx 0,15 \rightarrow B_3 = 0,36 \text{ m} \Rightarrow \boxed{B_3 = 0,44}$$

$$G_5 = 0,4 \cdot 0,4 \cdot 25 = 4,0 \text{ kN/m}$$

$$G_6 = 0,4 \cdot 3,6 \cdot 20 = 28,8 \text{ kN/m}$$

$$q_2^* = 0,4 \cdot 30 = 12,0 \text{ kN/m}$$

$$B_4 = 0,4 + 2,0 + 0,4 = 2,8 \text{ m}$$



Ia) КОНТРОЛЬ НАПОНА У ТЛУ (У ОДНОСУ НА C'')

$$N = \sum_{i=1}^6 G_i + q_2^* + q_2^* = 27 + 20 + 122,4 + 4,0 + 4,0 + 28,8 + 51,0 + 12 = 269,2 \text{ kN/m}$$

$$M_{C''} = 53,33 \cdot 1,33 + 40 \cdot 2,0 + 27\left(\frac{2,8}{2} - 0,4 - 0,15\right) + 122,4\left(\frac{2,8}{2} - 0,4 - 1,15\right) + 51\left(\frac{2,8}{2} - 0,4 - 1,15\right) + (28,8 + 12)\left(\frac{2,8}{2} - 0,4 - 0,2\right) = 99,09 \text{ kNm/m}$$

$$\sigma_{1,2} = \frac{269,2}{2,8} \pm \frac{99,09}{2,8^2/6} \Rightarrow \sigma_1 = 171,98 \frac{\text{kN}}{\text{m}^2} \quad \sigma_2 = 20,31 \frac{\text{kN}}{\text{m}^2}$$

$$\underline{\underline{\sigma_1 = 171,98 < \sigma_{\text{dop}} = 200 \frac{\text{kN}}{\text{m}^2} \quad \text{OK}}} \quad (8)$$

I 8) КОНТРОЛ НА СЪУПЛОТНОСТ НА КИЧЗАТЪ

$$\sum N = \sum_{i=1}^6 G_i + q^* + q_2^* = 269,2 \text{ kN/m}$$

$$\sum H = P_a + P_q^* = 93,33 \text{ kN/m}$$

$$F_{sk} = \frac{269,2 \cdot \tan 30^\circ}{93,33} = 1,665 > 1,5 \quad \checkmark$$

I 6) КОНТРОЛ НА СЪУПЛОТНОСТ НА ПРЕТУПАТЪ (У ОАНОСУ НА О')

$$M_V = [G_1(B_1+x_1) + G_2(B_1+x_2) + G_3(B_1+x_3) + q^*(B_1+x_2) + G_4 \frac{B_1}{2}] + (G_5 + G_6 + q_2^*)(B_1 - \frac{B_3}{2})$$

$$= [312,42] + (4,0 + 298 + 12,0) \cdot (28 - \frac{0,4}{2}) = 428,9 \text{ kNm/m}$$

$$M_F = 151,11 \text{ kNm/m}$$

$$F_{sp} = \frac{428,9}{151,11} = 2,838 > 1,5 \quad \checkmark$$

РЕШЕНИЕ II

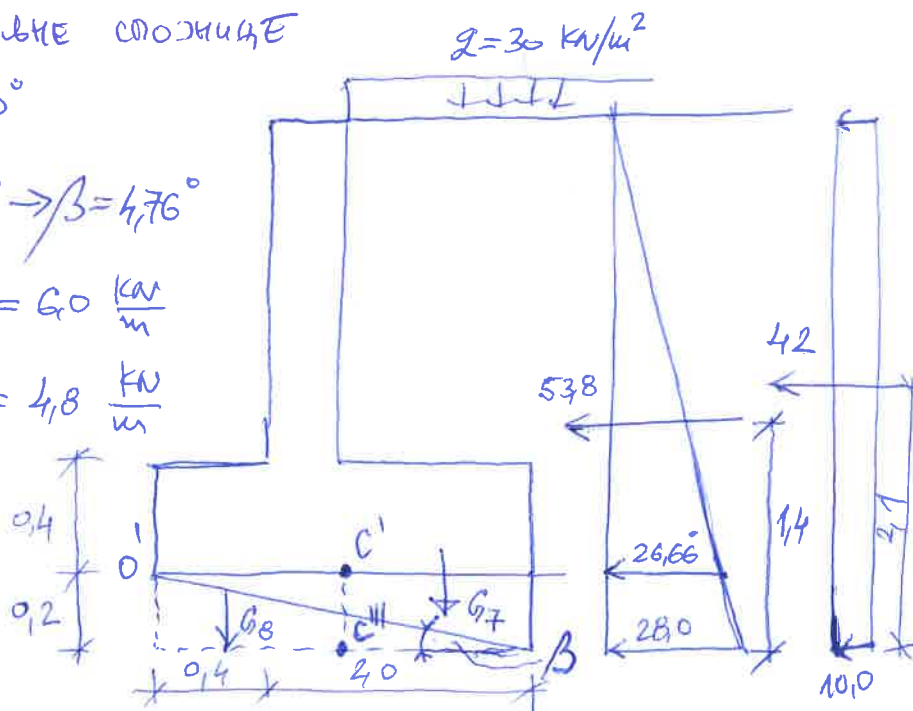
- ЗАКОШЕЪЕ ТЕЧЕЛЪНЕ СЛОЖИЦЪ

ПРЕПОСУКА : $\beta \leq 10^\circ$

$$\tan \beta = \frac{0,2}{2,4} = 0,0833 \rightarrow \beta = 4,76^\circ$$

$$G_7 = \frac{1}{2} \cdot 2,4 \cdot 0,2 \cdot 25 = 6,0 \text{ kN/m}$$

$$G_8 = \frac{1}{2} \cdot 2,4 \cdot 0,2 \cdot 20 = 4,8 \text{ kN/m}$$



II 9) КОНТРОЛ НА ПОСЛА (У ОАНОСУ НА С''')

$$N = [\sum_{i=1}^4 G_i + q^*] + G_7 + G_8 = 224,4 + 6,0 + 4,8 = 235,2 \text{ kN/m}$$

$$M = 58,8 \cdot 1,4 + 42 \cdot 2,1 + 27 \left(\frac{2,4}{2} - 0,4 - 0,15 \right) + 122,4 \left(\frac{2,4}{2} - 0,4 - 1,15 \right) + 51 \cdot \left(\frac{2,4}{2} - 0,4 - 1,15 \right) + G_7 \left(\frac{2,4}{3} - \frac{2,4}{2} \right) + G_8 \left(\frac{2,4}{2} - \frac{2,4}{3} \right) = 126,9 \text{ kNm/m}$$

$$\sigma_{1,2} = \frac{235,2}{2,4} \pm \frac{126,9}{0,96} \Rightarrow \sigma_1 = 230,19 \frac{\text{kN}}{\text{m}^2} \quad \sigma_2 = -34,19 \frac{\text{kN}}{\text{m}^2}$$

$$e = \frac{126,9}{235,2} = 0,54 \text{ m} \quad \left. \begin{array}{l} \\ C = \frac{2,4}{2} - 0,54 = 0,66 \end{array} \right\} \Rightarrow \sigma_1 = \frac{2 \cdot 235,2}{3 \cdot 0,66} = 237,58 \frac{\text{kN}}{\text{m}^2}$$

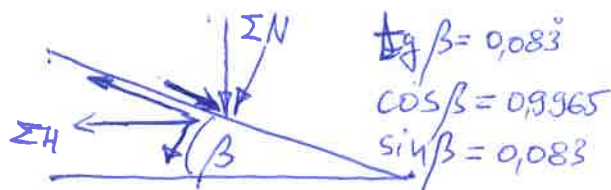
$$\sigma_2 = 0 \frac{\text{kN}}{\text{m}^2}$$

$$\sigma_1 = 237,58 > \sigma_{\text{доп}} = 200 \frac{\text{kN}}{\text{m}^2} \quad \text{!}$$

II д) КОНТРОЛЬ НАГРУЖЕННОСТИ НА КЛИЗЖЕНИЕ

$$\Sigma N = \left[\sum_{i=1}^4 G_i + q^* \right] + G_7 = 224,4 + 6,0 = 230,4 \frac{\text{kN}}{\text{m}}$$

$$\Sigma H = 58,8 + 42,0 = 100,8 \frac{\text{kN}}{\text{m}}$$



$$\Sigma N' = \Sigma N \cdot \cos \beta + \Sigma H \sin \beta$$

$$= 230,4 \cdot 0,9965 + 100,8 \cdot 0,083 = 229,59 + 8,37 = 237,96 \text{ kN/m}$$

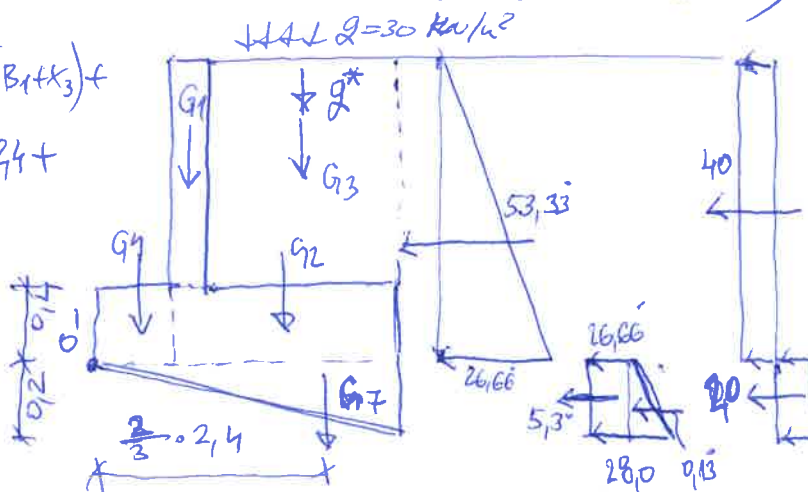
$$\Sigma H' = \Sigma H \cdot \cos \beta - \Sigma N \sin \beta = 100,8 \cdot 0,9965 - 230,4 \cdot 0,083 = 81,33 \frac{\text{kN}}{\text{m}}$$

$$F_{sk} = \frac{\Sigma N' \cdot \mu}{\Sigma H'} = \frac{237,96 \cdot \mu}{81,33} = 1,689 > 1,5 \quad \text{OK}$$

II б) КОНТРОЛЬ НАГРУЖЕННОСТИ НА ПРЕСЛАЖЕНИЕ (с откосом 1:0')

$$M_V = [G_1(B_1 + x_1) + G_2(B_1 + x_2) + G_3(B_1 + x_3) + G_4 \cdot \frac{B_1}{2} + q^*(B_1 + x_4)] + G_7 \cdot \frac{2}{3} \cdot 2,4 + 5,3 \cdot 0,1 + 0,13 \cdot \frac{2}{3} \cdot 0,2 + 2,0 \cdot 0,1$$

$$M_V = [312,42] + 12,15 = 324,57 \frac{\text{kNm}}{\text{m}}$$



$$M_P = 53,33 \cdot 1,33 + 4,0 \cdot 2,0 = 151,11 \text{ kNm/m}$$

$$F_{sp} = \frac{324,57}{151,11} = 2,148 > 1,5 \quad \text{OK}$$