Assignment 12 — Darina Ponomarenko

$R_d = 400\ kPa$

1. Design of the footing width

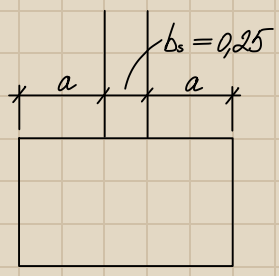
We use the condition: $G \leq R_d$

$$\frac{N_{Ed} + G_{0,d}}{A_{eff}} \leq R_d \Rightarrow A_{eff,rqd} = \frac{N_{Ed} + G_{0,d}}{R_d}$$

$N_{Ed} = 1683,2\ kN$ (from hw 2)

$G_{0,d} \approx 0,1 N_{Ed} = 168,3\ kN$

$$\Rightarrow A_{eff,rqd} = \frac{1683,2 + 168,3}{400} = 4,63\ m^2$$



$b^2 \geq 1,25 A_{eff,rqd} = 5,79\ m^2$

Design $b = 2,5\ m \Rightarrow A = 6,25\ m$

2. Design of the footing height

$$h \geq a \cdot tg\alpha = \frac{b - b_s}{2} \cdot tg\,60° = \frac{2,5 - 0,25}{2} \cdot tg\,60° = 1,95\ m$$

Design $h = 2\ m$

3. Eccentricity

Self-weight of the footing:

$G_{0,d} = 1,35 \cdot 25 \cdot b^2 \cdot h = 421,9\ kN$

$$e = \frac{M_{Ed} + H_{Ed} \cdot h}{N_{Ed} + G_{0,d}}$$

$M_{Ed} = 8,9\ kNm$

$H_{Ed} = 0$? (we didn't include V in the column in SCIA in hw 2)

I will take $H_{Ed} = 10\ kN$ for extra safety

$$\Rightarrow e = \frac{8,9 + 10 \cdot 2}{1683,2 + 421,9} = 0,014 \text{ m}$$

$$A_{eff} = b(b - 2e) = 2,5(2,5 - 2 \cdot 0,014) = 6,18 \text{ m}^2$$

4. Verification

$$\sigma = \frac{1683,2 + 421,9}{6,18} = 340,6 \text{ kPa}$$

$340,6 \text{ kPa} < 400 \text{ kPa}$ ✓

I. Plain concrete footing

5. Height of the footing – recalculation

$$\sigma_{ct} = \frac{M_c}{W} = \frac{0,5 f_d \cdot a^2}{\frac{bh^2}{6}} \leq f_{ctd} = \frac{\alpha_{ct} \cdot f_{ctk,0,05}}{\gamma_c}$$

$$f_d = b\sigma_d = b \cdot \frac{N_{Ed}}{A_{eff}} = \frac{2,5 \cdot 1683,2}{6,18} = 680,9 \text{ kN/m}$$

$$a = 0,5(b - b_s) = 0,5(2,5 - 0,25) = 1,125 \text{ m}$$

$\alpha_{ct} = 0,8$

$\gamma_c = 1,5$

$f_{ctk,0,05} = 1,8 \text{ MPa}$

$$\Rightarrow f_{ctd} = \frac{0,8 \cdot 1,8}{1,5} = 0,96 \text{ MPa}$$

$$\frac{0,5 f_d \cdot a^2}{\frac{bh^2}{6}} \leq f_{ctd} \Rightarrow h \geq a\sqrt{\frac{3 f_d}{b \cdot f_{ctd}}}$$

$$h \geq 1,125\sqrt{\frac{3 \cdot 680,9}{2,5 \cdot 960}} = 1,035 \text{ m}$$

Design $h = 1,05 \text{ m}$

6. Effective loading area

$G_{0,d} = 1,35 \cdot 25 \cdot 2,5^2 \cdot 1,05 = 221,5\ kN$

$M_{Ed} = 8,9\ kNm$

$H_{Ed} = 10\ kN$

$$e = \frac{M_{Ed} + H_{Ed} \cdot h}{N_{Ed} + G_{0,d}} = \frac{8,9 + 10 \cdot 1,05}{1683,2 + 221,5} = 0,010\ m$$

$$\Rightarrow A_{eff} = 2,5(2,5 - 2 \cdot 0,01) = 6,2\ m^2$$

7. Assessment

1) $$\sigma_{ct} = \frac{M_c}{W} = \frac{0,5 f_d \cdot a^2}{\frac{b h^2}{6}} \leq f_{ctd}$$

$$f_d = b \sigma_d = b \cdot \frac{N_{Ed}}{A_{eff}} = \frac{2,5 \cdot 1683,2}{6,2} = 678,7\ kN/m$$

$$\frac{0,5 \cdot 678,7 \cdot 1,125^2}{\frac{2,5 \cdot 1,05^2}{6}} = 934,9\ kPa < 960\ kPa \checkmark$$

2) $$\sigma = \frac{N_{Ed} + G_{0,d}}{A_{eff}} \leq R_d$$

$$\frac{1683,2 + 221,5}{6,2} = 307,2\ kPa < 400\ kPa \checkmark$$

II. Reinforced concrete footing

8. Height of the footing - recalculation

$$l_k = a + 0,15 b_s = 1,125 + 0,15 \cdot 0,25 = 1,163\ m$$

$h_{RC} \geq 0,2\ m$

$h_{RC} \approx 0,5 h_{RC}$

Design $h = 0,6\ m$

9. Effective loading area

$G_{0,d} = 1,35 \cdot 25 \cdot 2,5^2 \cdot 0,6 = 126,6 \text{ kN}$

$M_{Ed} = 8,9 \text{ kNm}$

$H_{Ed} = 10 \text{ kN}$

$$e = \frac{M_{Ed} + H_{Ed} \cdot h}{N_{Ed} + G_{0,d}} = \frac{8,9 + 10 \cdot 0,6}{1683,2 + 126,6} = 0,008 \text{ m}$$

$$\Rightarrow A_{eff} = 2,5(2,5 - 2 \cdot 0,008) = 6,21 \text{ m}^2$$

10. Reinforcement

$$A_{s,req} = \frac{M_{Ed}}{f_{yd} \cdot 0,9d}$$

$$M_{Ed} = 0,5 f_d \cdot l_k^2$$

$$f_d = b q_d = b \cdot \frac{N_{Ed}}{A_{eff}} = \frac{2,5 \cdot 1683,2}{6,21} = 677,6 \text{ kN/m}$$

$c = 50 \text{ mm}$

$\Rightarrow M_{Ed} = 0,5 \, 677,6 \cdot 1,163^2 = 458,3 \text{ kNm}$

$\phi = 16 \text{ mm}$

$d = 600 - 50 - 8 = 542 \text{ mm}$

$$\Rightarrow A_{s,req} = \frac{458,3 \cdot 10^3 \cdot 10^6}{434,78 \cdot 10^6 \cdot 0,9 \cdot 542} = 2161 \text{ mm}^2$$

Design $12 \phi 16$ mm ($A_{s,prov} = 2413 \text{ mm}^2$)

11. Assessment

1) $$x = \frac{A_{s,prov} \cdot f_{yd}}{0,8 b \cdot f_{cd}} = \frac{2413 \cdot 10^{-6} \cdot 434,78}{0,8 \cdot 2,5 \cdot 16,67} = 0,031 \text{ m}$$

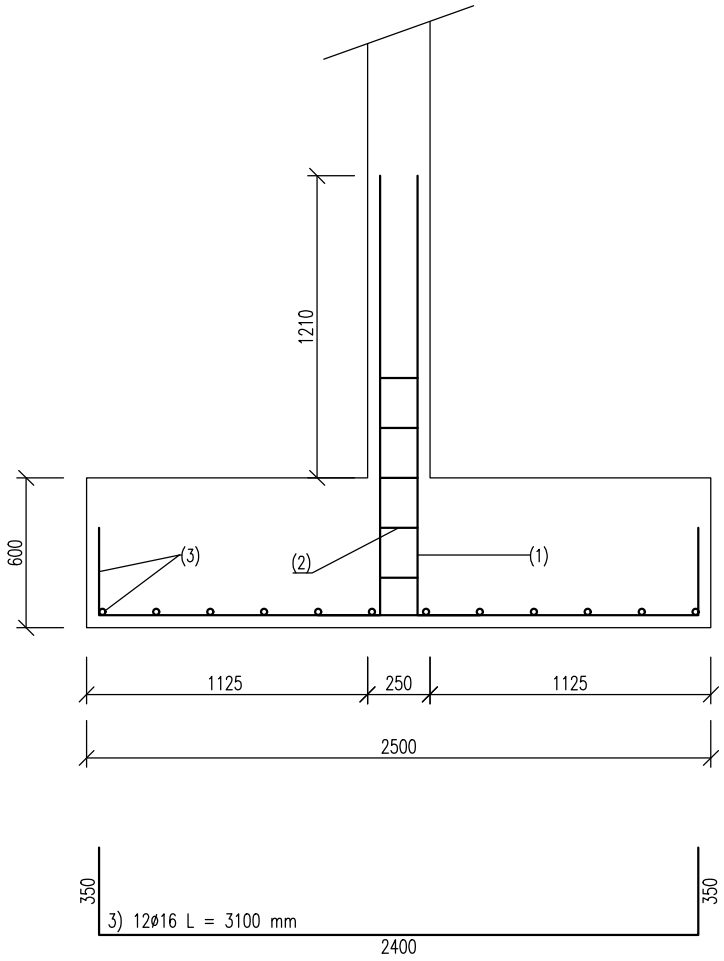
$z = d - 0,4x = 542 - 0,4 \cdot 31 = 529,6 \text{ mm}$

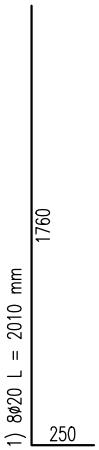
$M_{Rd} = A_{s,prov} \cdot f_{yd} \cdot z = 2413 \cdot 10^{-6} \cdot 434,78 \cdot 10^3 \cdot 0,5296 = 555,6 \text{ kNm}$

$458,3 \text{ kNm} < 555,6 \text{ kNm}$ ✓

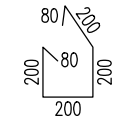
2) $$\sigma = \frac{N_{Ed} + G_{0,d}}{A_{eff}} \leq R_d$$

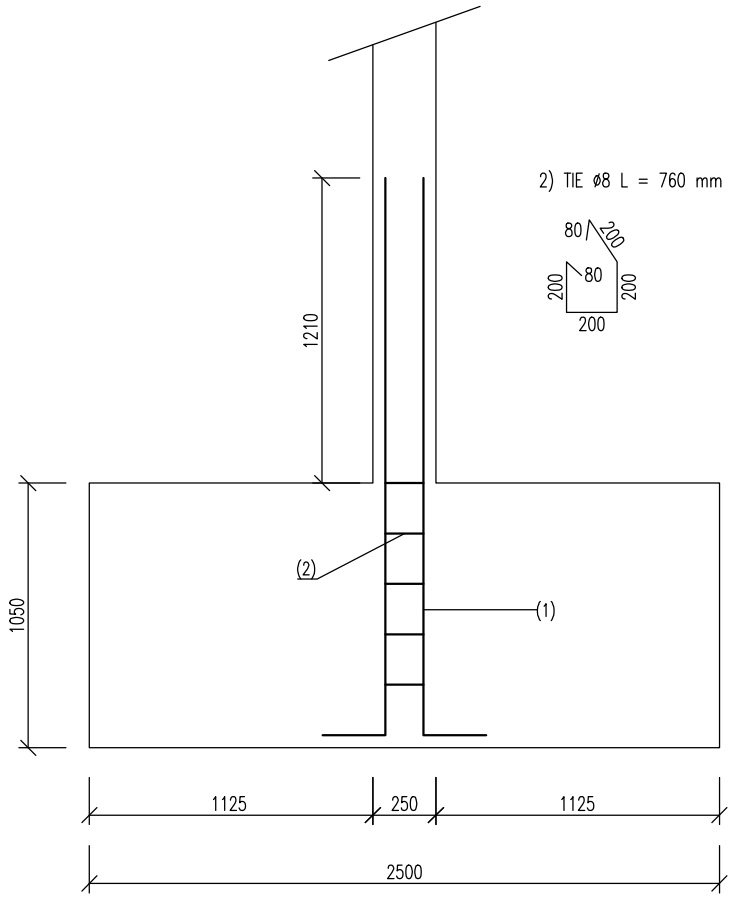
$$\frac{1683,2 + 126,6}{6,21} = 291,4 \text{ kPa} < 400 \text{ kPa}$$ ✓





2) TIE ø8 L = 760 mm





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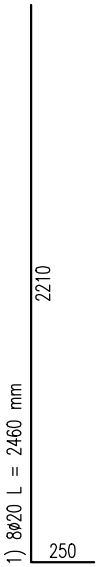
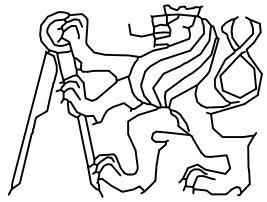


STUDENT: DARINA PONOMARENKO		
TEACHER: ING. JAKUB HOLAN		
COURSE: 133CM01	FORMAT:	A4
	SCALE:	1:30
CONTENT: PAD FOOTING DESIGN	DATE:	12/2024
	ASSIGNMENT:	4