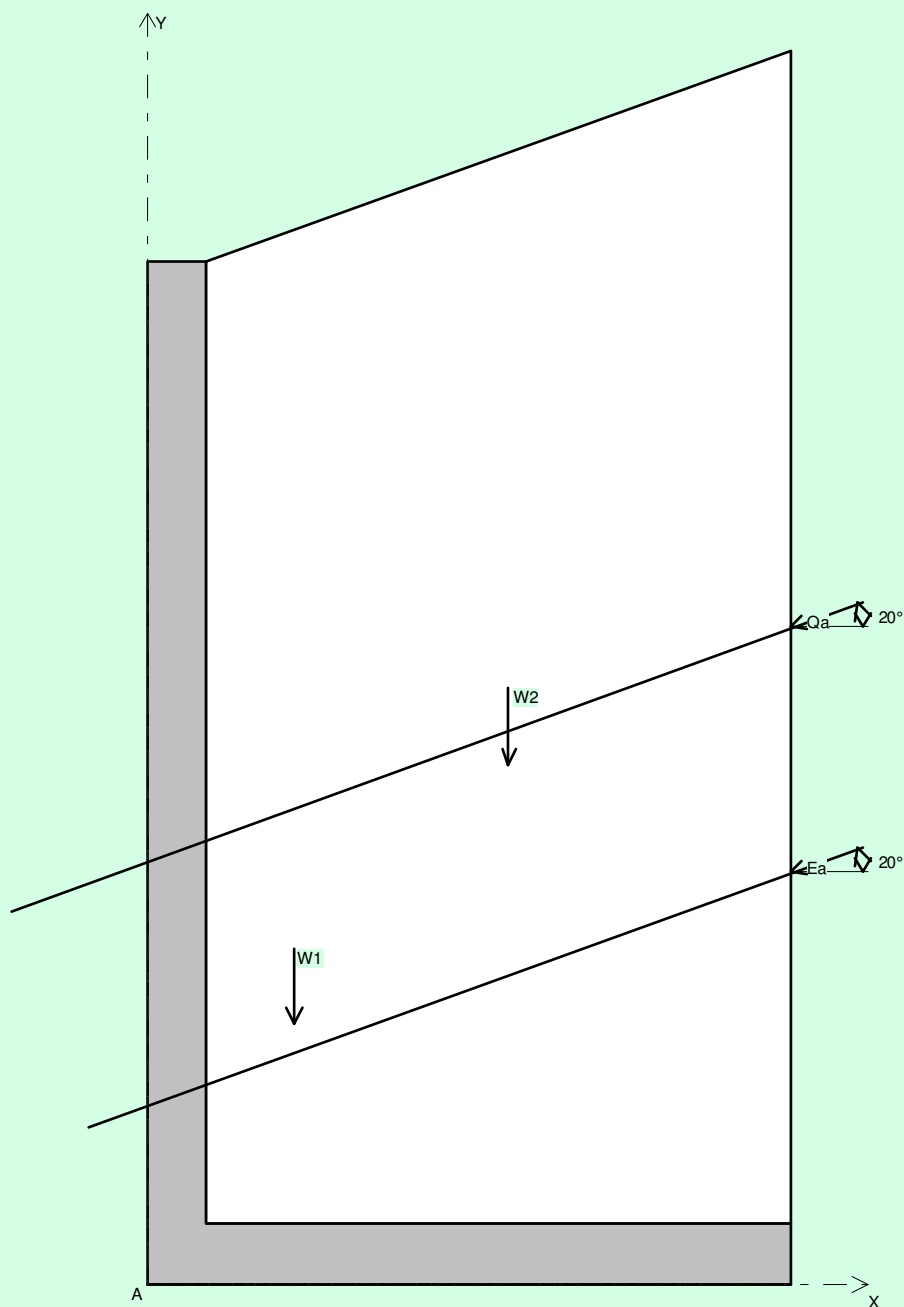


STATIČNA PRESOJA ZIDU PO EC7-PP2



PODATKI:

$E_{ak} = 183.93 \text{ kN},$	$Q_{ak} = 33.85 \text{ kN}$
$g1 = 25 \text{ kN/m}^3$	$g2 = 20 \text{ kN/m}^3$
$\beta_{zaledja} = 20^\circ$	$\gamma_{tal} = 19 \text{ kN/m}^3$
$c_{k,t} = 0 \text{ kPa}$	$\varphi_{k,t} = 34^\circ$
Modul reakcije tal K	$= 30 \text{ MN/m}^3$
Kot trenja tal δ_d	$= 20^\circ$
Kot trenja zid/zaledje θ	$= 20^\circ$

Koeficienti varnosti:

$$\gamma_G = 1.35, \gamma_{Gi} = 1, \gamma_Q = 1.5, \gamma_\phi = 1, \text{GEO/STR}$$

$$\gamma_c = 1, \gamma_{R;v} = 1.4, \gamma_{R;h} = 1.1, \gamma_{R;e} = 1.4$$

$$\gamma_{G;dst} = 1.1, \gamma_{G;stb} = 0.9, \gamma_{Q;dst} = 1.5, \gamma_{Q;stb} = 0, \text{EQU}$$

TEŽE ZIDU:

$$W1 = 4.24 \cdot 25.00 = 106.00 \text{ kN/m'}$$

$$W2 = 27.14 \cdot 20.00 = 542.90 \text{ kN/m'}$$

$$W = 648.90 \text{ kN/m'}$$

ROČICE SIL:

$$x = x' \cdot \cos(\alpha) + y' \cdot \sin(\alpha) \quad y = -x' \cdot \sin(\alpha) + y' \cdot \cos(\alpha)$$

$$W1: \quad y = 2.22 \text{ m} \quad x = r1 = 0.97 \text{ m}$$

$$W2: \quad y = 3.94 \text{ m} \quad x = r2 = 2.39 \text{ m}$$

$$Ea: \quad y = 2.72 \text{ m} \quad x = 4.25 \text{ m}$$

$$re = (Ea \cdot \cos(20^\circ) \cdot y - Ea \cdot \sin(20^\circ) \cdot x) / Ea = 1.10 \text{ m}$$

$$Qa: \quad y = 4.34 \text{ m} \quad x = 4.25 \text{ m}$$

$$rq = (Qa \cdot \cos(20^\circ) \cdot y - Qa \cdot \sin(20^\circ) \cdot x) / Qa = 2.62 \text{ m}$$

1. MEJNO STANJE NOSILNOSTI (ULS)**1.1. VARNOST NA PREVRNITEV - EQU (glede na točko A)****- MOMENT ODPORA**

$$\begin{aligned} Mo_{EQU} &= \gamma_{G;stb} \cdot W1 \cdot r1 + \gamma_{G;stb} \cdot W2 \cdot r2 = \\ &= 0.9 \cdot 106 \cdot 0.97 + 0.9 \cdot 542.9 \cdot 2.39 = \mathbf{1259.88 \text{ kNm/m'}} \quad (1399.87 \text{ brez } \gamma) \end{aligned}$$

- MOMENT PREVRNITVE

$$Ma_{EQU} = \gamma_{G;dst} \cdot Ea \cdot re + \gamma_{Q;dst} \cdot Qa \cdot rq = 1.1 \cdot 183.93 \cdot 1.1 + 1.5 \cdot 33.85 \cdot 2.62 = \mathbf{355.59 \text{ kNm/m'}} \quad (291.01 \text{ brez } \gamma)$$

$$\text{Pogoj } E_d \leq R_d : \quad 355.59 < 1259.88 \quad \text{JE izpolnjen}$$

1.2. VARNOST NA ZDRS**- STRIŽNA SILA POD TEMELJEM**

$$\begin{aligned} H_d &= -\gamma_{Ginf} \cdot W \cdot \sin(0^\circ) + \gamma_G \cdot Ea \cdot \cos(0^\circ + 20^\circ) + \gamma_Q \cdot Qa \cdot \cos(0^\circ + 20^\circ) = \\ &= -1 \cdot 648.9 \cdot \sin(0^\circ) + 1.35 \cdot 183.93 \cdot \cos(20^\circ) + 1.5 \cdot 33.85 \cdot \cos(20^\circ) = \\ &= \mathbf{281.04 \text{ kN/m'}} \end{aligned}$$

- STRIŽNA ODPORNOST POD TEMELJEM

$$\begin{aligned} V_d &= \gamma_{Ginf} \cdot W \cdot \cos(0^\circ) + \gamma_G \cdot Ea \cdot \sin(0^\circ + 20^\circ) + \gamma_Q \cdot Qa \cdot \sin(0^\circ + 20^\circ) = \\ &= 1 \cdot 648.9 \cdot \cos(0^\circ) + 1.35 \cdot 183.93 \cdot \sin(20^\circ) + 1.5 \cdot 33.85 \cdot \sin(20^\circ) = \\ &= \mathbf{751.19 \text{ kN/m'}} \end{aligned}$$

$$R_d = V_d \cdot \tan \delta_d / \gamma_{R;h} = 751.19 \cdot \tan(20^\circ) / 1.1 = \mathbf{248.56 \text{ kN/m'}}$$

$$\text{Pogoj } H_d \leq R_d : \quad 281.04 > 248.56 \quad \text{NI izpolnjen}$$

1.3. KONTROLA NOSILNOSTI TAL

$c = 0 \text{ kPa}$, $\varphi = 34^\circ$, $g_z = 19 \text{ kN/m}^3$, $D = 0.75 \text{ m}$, $\alpha = 0^\circ$, L_{temelja} nedefinirana

$$R_d = B_{ef} \cdot (c \cdot N_c \cdot b_c \cdot s_c \cdot i_c + D \cdot g_z \cdot N_q \cdot b_q \cdot s_q \cdot i_q + 0.5 \cdot g_z \cdot B_{ef} \cdot N_\gamma \cdot b_\gamma \cdot s_\gamma \cdot i_\gamma) / \gamma_{R,v}$$

Nosilnost tal:	$N_q = e^{\pi \tan \varphi} \cdot \tan^2(45 + \varphi/2)$	$N_c = (N_q - 1) \cdot \cot \varphi$	$N_\gamma = 2(N_q - 1) \cdot \tan \varphi$
Oblika temelja:	$s_q = 1$	$s_c = 1$	$s_\gamma = 1$
Nagib temeljne ploskve:	$b_q = (1 - \alpha \cdot \tan \varphi)^2$	$b_c = b_q - (1 - b_q) / N_c \cdot \tan \varphi$	$b_\gamma = b_q$
Nagib zaradi H:	$i_q = (1 - H / (V + A' \cdot c \cdot \cot \varphi))^m$ $m = (2 + B_{ef}/L) / (1 + B_{ef}/L)$	$i_c = i_q - (1 - i_q) / (N_q - 1)$ $A' = B_{ef} \cdot L$	$i_\gamma = (1 - H / (V + A' \cdot c \cdot \cot \varphi))^{(m+1)}$

- MOMENT na točko A

$$M_{a_d} = \gamma_G \cdot E_a \cdot r_e + \gamma_Q \cdot Q_a \cdot r_q = 1.35 \cdot 183.93 \cdot 1.1 + 1.5 \cdot 33.85 \cdot 2.62 = 406.17 \text{ kNm/m'}$$

- HORIZONTALNA SILA

$$\begin{aligned} H_d &= \gamma_G \cdot E_a \cdot \cos(20^\circ) + \gamma_Q \cdot Q_a \cdot \cos(20^\circ) = \\ &= 1.35 \cdot 183.93 \cdot \cos(20^\circ) + 1.5 \cdot 33.85 \cdot \cos(20^\circ) = \\ &= 281.04 \text{ kN/m'} \end{aligned}$$

- UGODNO DELOVANJE

- VERTIKALNA SILA

$$\begin{aligned} V_d &= \gamma_{Ginf} \cdot W + \gamma_G \cdot E_a \cdot \sin(20^\circ) + \gamma_Q \cdot Q_a \cdot \sin(20^\circ) = \\ &= 1 \cdot 648.9 + 1.35 \cdot 183.93 \cdot \sin(20^\circ) + 1.5 \cdot 33.85 \cdot \sin(20^\circ) = \\ &= 751.19 \text{ kN/m'} \end{aligned}$$

- MOMENT NA TEŽIŠČE TEMELJNE PLOSKVE

$$\begin{aligned} M_d &= M_{a_d} + V_d \cdot 4.25/2 - M_o \cdot \gamma_{Ginf} = \\ &= 406.17 + 751.19 \cdot 2.13 - 1399.87 \cdot 1 = \\ &= 602.58 \text{ kNm/m'} \end{aligned}$$

- Ekscentričnost: $e = M_d / V_d = 602.58 / 751.19 = 0.8 \text{ m}$

- Efektivna širina temelja: $B_{ef} = B - 2e = 4.25 - 2 \cdot 0.8 = 2.65 \text{ m}$

$$N_q = 29.44, N_c = 42.16, N_\gamma = 38.37$$

$$b_q = 1, b_c = 1, b_\gamma = b_q$$

$$i_q = 1, i_c = 1, i_\gamma = 1, m = 2$$

$$R_d = 2.65 \cdot 1383.8 / 1.4 = 2615.06 \text{ kN}$$

Pogoj $V_d \leq R_d$: $751.19 < 2615.06$ JE izpolnjen

- NEUGODNO DELOVANJE

- VERTIKALNA SILA

$$\begin{aligned} V_d &= \gamma_G \cdot W + \gamma_G \cdot E_a \cdot \sin(20^\circ) + \gamma_Q \cdot Q_a \cdot \sin(20^\circ) = \\ &= 1.35 \cdot 648.9 + 1.35 \cdot 183.93 \cdot \sin(20^\circ) + 1.5 \cdot 33.85 \cdot \sin(20^\circ) = \\ &= 978.31 \text{ kN/m'} \end{aligned}$$

- MOMENT NA TEŽIŠČE TEMELJNE PLOSKVE

$$\begin{aligned} M_d &= M_{a_d} + V_d \cdot 4.25/2 - M_o \cdot \gamma_G = \\ &= 406.17 + 978.31 \cdot 2.13 - 1399.87 \cdot 1.35 = \\ &= 595.24 \text{ kNm/m'} \end{aligned}$$

- Ekscentričnost: $e = M_d/V_d = 595.24/978.31 = 0.61 \text{ m}$
- Efektivna širina temelja: $B_{ef} = B - 2e = 4.25 - 2 \cdot 0.61 = 3.03 \text{ m}$

$$N_q = 29.44, N_c = 42.16, N_\gamma = 38.37$$

$$b_q = 1, b_c = 1, b_\gamma = b_q$$

$$i_q = 1, i_c = 1, i_\gamma = 1, m = 2$$

$$R_d = 3.03 \cdot 1525.01 / 1.4 = 3303.96 \text{ kN}$$

$$\text{Pogoj } V_d \leq R_d : 978.31 < 3303.96 \quad \text{JE izpolnjen}$$

1.4 DIMENZIONIRANJE ARMATURE EC2

- PODATKI

$$\text{beton C25/30} \Rightarrow f_{cd} = 16.67 \text{ MPa}, \alpha = 1, \gamma_c = 1.5$$

$$\text{armatura S400} \Rightarrow f_{sd} = 347.83 \text{ MPa}, \gamma_s = 1.15$$

$$\text{prerez pravokoten: } 40 \times 100 \text{ cm, } D = 5 \text{ cm}$$

- MOMENT V T1: $x = 0.2 \text{ m}, y = 0.4 \text{ m}$

$$E_a = 183.93 \text{ kN}, x = 4.25 \text{ m}, y = 2.72 \text{ m}, 20^\circ$$

$$Q_a = 33.85 \text{ kN}, x = 4.25 \text{ m}, y = 4.34 \text{ m}, 20^\circ$$

$$\begin{aligned} M_{d,1-1} &= \gamma_g \cdot (E_a \cdot \cos(20^\circ) \cdot (2.72 - 0.4) - E_a \cdot \sin(20^\circ) \cdot (4.25 - 0.2)) + \\ &+ \gamma_q \cdot (Q_a \cdot \cos(20^\circ) \cdot (4.34 - 0.4) - Q_a \cdot \sin(20^\circ) \cdot (4.25 - 0.2)) = \\ &= 1.35 \cdot (172.84 \cdot 2.32 - 62.91 \cdot 4.05) + \\ &+ 1.5 \cdot (31.81 \cdot 3.94 - 11.58 \cdot 4.05) = \\ &= 314.89 \text{ kNm/m'} \end{aligned}$$

- NORMALNA SILA

$$\begin{aligned} N_{d,1-1} &= \gamma_g \cdot E_a \cdot \sin(20^\circ) + \gamma_q \cdot Q_a \cdot \sin(20^\circ) + \gamma_{gl} \cdot W_1 = \\ &= 1.35 \cdot 62.91 + 1.5 \cdot 11.58 + 1 \cdot 63.4 = \\ &= 165.69 \text{ kN/m'} \end{aligned}$$

- Izračun potrebne upogibne armature

$$\epsilon_b = 3.07\text{‰}, \epsilon_a = 10\text{‰}, \sigma_b = 16.67 \text{ MPa}, \sigma_a = 347.83 \text{ MPa}, Z = 31.66 \text{ cm}, X_{os} = 8.22 \text{ cm}$$

$$A_a = 26.09 \text{ cm}^2/\text{m'} \quad (\mu = 0.65\%)$$

- Kontrola strižne armature

$$\tau_{cd} = 0.299 \text{ MPa}, f_{sd} = 347.83 \text{ MPa}, \text{strižnost} = 2$$

$$\text{Strižna odpornost betona } V_{rd1} = 217.73 \text{ kN/m'}$$

$$k = 1.6 - 0.4 - 0.05 \quad (>=1) = 1.25$$

$$\text{Strižna odpornost armature } V_{wd} = 334.57 \text{ kN/m'}$$

$$6\phi 18/\text{m'}$$

- STRIŽNA SILA

$$\begin{aligned} V_{d,1-1} &= \gamma_g \cdot E_a \cdot \cos(20^\circ) + \gamma_q \cdot Q_a \cdot \cos(20^\circ) = \\ &= 1.35 \cdot 172.84 + 1.5 \cdot 31.81 = \\ &= 281.04 \text{ kN/m'} \end{aligned}$$

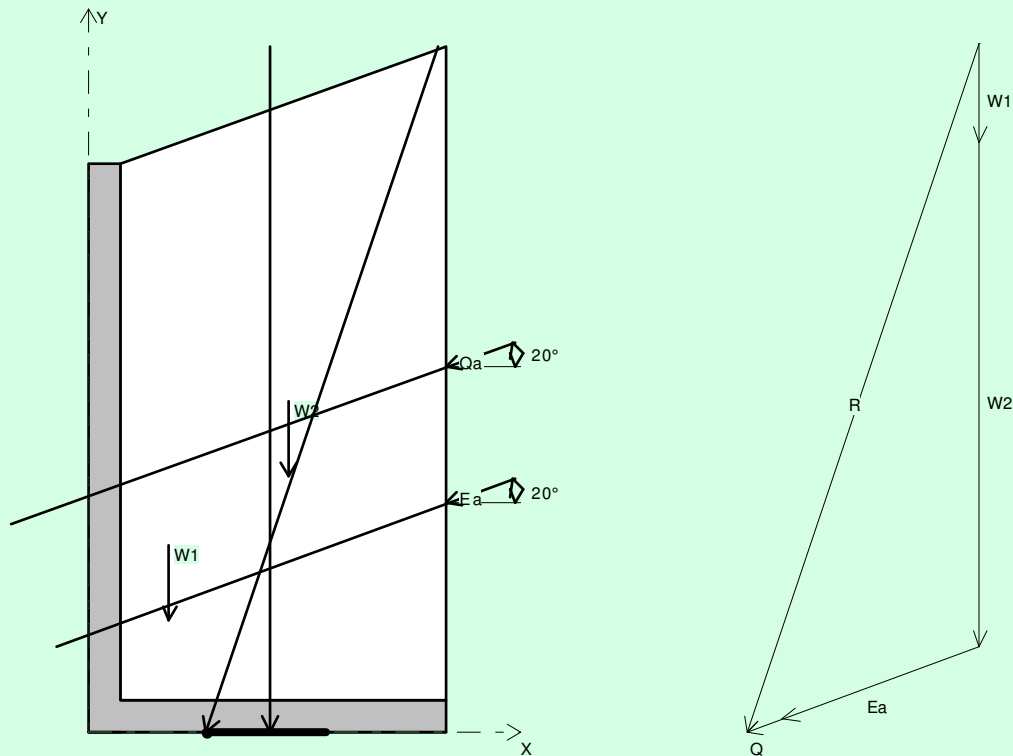
- pogoj $R_d \geq E_d : 334.57 > 281.04 \text{ JE izpolnjen}$

2. MEJNO STANJE UPORABNOSTI (SLS)

$$\text{Faktor za } E_a \text{ in } Q_a: K_{ah,k(SLS)} / K_{ah,k(ULS)} = 1.2276$$

$$Ea_k = 1.2276 \cdot 183.93 = 225.79 \text{ kN}, \quad Qa_k = 1.2276 \cdot 33.85 = 41.55 \text{ kN}$$

GRAFIČNA REŠITEV



- MOMENT ODPORA

$$\begin{aligned} Mo_k &= W1 \cdot r1 + W2 \cdot r2 = \\ &= 106 \cdot 0.97 + 542.9 \cdot 2.39 = 1399.87 \text{ kNm/m'} \end{aligned}$$

- MOMENT PREVRNITVE

$$Ma_k = Ea_k \cdot re + Qa_k \cdot rq = 225.79 \cdot 1.1 + 41.55 \cdot 2.62 = 357.23 \text{ kNm/m'}$$

- VERTIKALNA SILA

$$\begin{aligned} V_k &= W + Ea_k \cdot \sin(20^\circ) + Qa_k \cdot \sin(20^\circ) = \\ &= 648.9 + 225.79 \cdot \sin(20^\circ) + 41.55 \cdot \sin(20^\circ) = \\ &= 740.34 \text{ kN/m'} \end{aligned}$$

- MOMENT NA TEŽIŠČE TEMELJNE PLOSKVE

$$\begin{aligned} M_k &= Ma_k + V_k \cdot 4.25/2 - Mo_k = \\ &= 357.23 + 740.34 \cdot 2.13 - 1399.87 = \\ &= 530.57 \text{ kNm/m'} \end{aligned}$$

2.1 NAPETOSTI POD TEMELJEM (tlak + nateg -)

$$\sigma_{1,2} = N/At \pm Mt/Wt$$

- Odpornostni moment in površina temeljne ploskve

$$W_t = (1 \cdot 4.25^2)/6 = 3.01 \text{ m}^3$$

$$A_t = 1 \cdot 4.25 = 4.25 \text{ m}^2$$

- Ekscentričnost: $e = M_k/V_k = 530.57/740.34 = 0.72 \text{ m} > j = 0.71 \text{ m}$

REZULTANTA PADE IZVEN JEDRA PREREZA TEMELJNE PLOSKVE!

$$c = (a/2 - e) \geq a/5$$

$$c = (4.25/2 - 0.72) = 1.41 \text{ m} > 0.85 \text{ m}$$

- NAPETOST:

$$\sigma_1 = N \cdot 2/3/c = 740.34 \cdot 2/3/1.41 =$$

$$\sigma_1 = 350.45 \text{ kN/m}^2 \quad \sigma_2 = 0 \text{ kN/m}^2, B_{\text{tlač}} = 4.225 \text{ m}$$

2.2 PREMIK in ZASUK (ocena)

- Račun z modulom reakcije tal

$$w = \sigma / K = 350.45 / 30000 = 0.0117 \text{ m} = 1.17 \text{ cm}$$

$$\text{zasuk} = 0.0117 / 4.225 = 0.28 \% \text{ (rahla tla } 0.4\text{-}0.5\%, \text{ gosta tla } 0.1\text{-}0.2\%)$$

Računal: