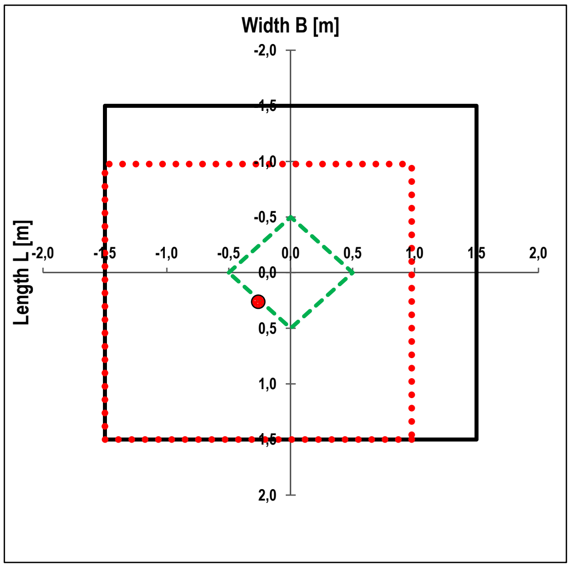
Ultimate bearing capacity calculation according to EC 7, Annex D - RECTANGULAR FOUNDATION

Project: Nosilnost temeljnih tal pod točkovnim temeljem

Conditions: ☑ Drained conditions ☐ Undrained conditions



Foundation dimensions:

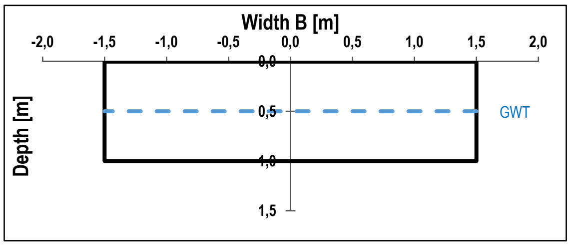
Foundation
Kern
Resulting vertical force
Effective foundation area

B =	3,00	m	...foundation width
L =	3,00	m	...foundation length
T =	1,00	m	...foundation thickness
z =	1,00	m	...depth of foundation below the surface
α =	0,00	°	...inclination of foundation base

Soil parameters:

γ =	20,00	kN/m^3	...unit weight of soil below foundation base
φ' =	30,00	°	...effective angle of internal friction of soil
c' =	0,00	kPa	...effective cohesion of soil

GWT present: ☐ No ☑ Yes



h_w =	0,50	m	...depth of water below the surface

Effective soil parameters and GWT conditions:

γ_{sat} =	20,00	kN/m^3	...saturated unit weight of soil
γ_w =	10,00	kN/m^3	...unit weight of water

$\gamma' = \gamma_{sat} - \gamma_w$ γ' = 10,00 kN/m^3 ...effective unit weight of soil below foundation base

GWT condtions:

$0 \leq h_w \leq z \rightarrow \quad \bar{\gamma} = \gamma'$ ...water table is located above foundation base

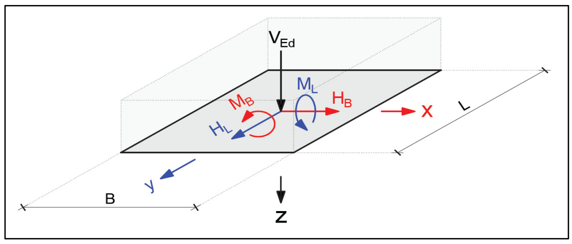
$z < h_w \leq z + B(L) \rightarrow \quad \bar{\gamma} = \gamma' + \dfrac{(h_w - z)}{B(L)}(\gamma - \gamma')$ ...water table is located below foundation base

$h_w > z + B(L) \rightarrow \quad \bar{\gamma} = \gamma$ ...water has no effect on bearing capacity

$\bar{\gamma}$ =	10,00	kN/m^3	...average effective unit weight of soil below foundation base
q' =	15,00	kPa	...effective compression at foundation level
F_U =	-45,00	kN	...uplift on the foundation use: ☐ No ☑ Yes

Design load on foundation base:

V_{Ed} =	1000,00	kN	...vertical force (compression is positive)
M_B =	250,00	kNm	...bending moment in B direction
M_L =	250,00	kNm	...bending moment in L direction
H_B =	50,00	kN	...horizontal force in B direction
H_L =	50,00	kN	...horizontal force in L direction



Eccentricities:

$e_B = \dfrac{M_B}{V_{Ed}}$ e_B = -0,262 m ...eccentricity of axial force in B direction $\dfrac{e_B}{B} \leq \dfrac{1}{3}$ ✔

$e_L = \dfrac{M_L}{V_{Ed}}$ e_L = 0,262 m ...eccentricity of axial force in L direction $\dfrac{e_L}{L} \leq \dfrac{1}{3}$ ✔

$e_T = \sqrt{\left(\dfrac{e_B}{B}\right)^2 + \left(\dfrac{e_L}{L}\right)^2}$ e_T = 0,123 ...dimensionless total eccentricity $e_T \leq \dfrac{1}{3}$ ✔

Effective foundation dimensions:

$B' = B - 2 \cdot e_B$	B' =	2,476	m	...effective foundation width
$L' = L - 2 \cdot e_L$	L' =	2,476	m	...effective foundation length
$A' = B' \cdot L'$	A' =	6,133	m^2	...effective foundation area

DRAINED CONDITIONS:

Factors for the bearing resistance:

$N_q = e^{\pi \cdot \tan\varphi'} \cdot \tan^2\left(45 + \frac{\varphi'}{2}\right)$ N_q = 18,401 ...dimensionless factor for loading

$N_c = (N_q - 1) \cdot \cot\varphi'$ N_c = 30,140 ...dimensionless factor for cohesion

$N_\gamma = 2 \cdot (N_q - 1) \cdot \tan\varphi'$ N_γ = 20,093 ...dimensionless factor for soil density

Factors for the inclination of foundation base:

$b_c = b_q - \frac{1 - b_q}{N_c \cdot \tan\varphi'}$ b_c = 1,000 ...dimensionless factor for cohesion

$b_q = (1 - \alpha \cdot \tan\varphi')^2$ b_q = 1,000 ...dimensionless factor for loading

$b_\gamma = (1 - \alpha \cdot \tan\varphi')^2$ b_γ = 1,000 ...dimensionless factor for soil density

Factors for the shape of foundation:

$s_q = 1 + \left(\frac{B'}{L'}\right) \cdot \sin\varphi'$ s_q = 1,500 ...dimensionless factor for loading

$s_\gamma = 1 - 0.3 \cdot \frac{B'}{L'}$ s_γ = 0,700 ...dimensionless factor for soil density

$s_c = \frac{s_q \cdot N_q - 1}{N_q - 1}$ s_c = 1,529 ...dimensionless factor for cohesion

Factors for the inclination of the load, caused by a horizontal load H:

$H = \sqrt{(H_B{}^2 + H_L{}^2)}$ H = 70,711 kN ...total horizontal force

$i_c = i_q - \frac{1 - i_q}{N_c \cdot \tan\varphi'}$ i_c = 0,885 ...dimensionless factor for cohesion

$i_q = \left[1 - \frac{H}{V + A' \cdot c' \cdot \cot\varphi'}\right]^m$ i_q = 0,891 ...dimensionless factor for loading

$i_\gamma = \left[1 - \frac{H}{V + A' \cdot c' \cdot \cot\varphi'}\right]^{m+1}$ i_γ = 0,825 ...dimensionless factor for soil density

$m_B = \frac{2 + \frac{B'}{L'}}{1 + \frac{B'}{L'}}$ m_B = 1,500 ...exponent in forumlas for the inclination factor i

$m_L = \frac{2 + \frac{L'}{B'}}{1 + \frac{L'}{B'}}$ m_L = 1,500 ...exponent in forumlas for the inclination factor i

$m = m_L \cdot \cos^2\theta + m_B \cdot \sin^2\theta$ m = 1,500 ...exponent in forumlas for the inclination factor i

$\tan\theta = \frac{H_B}{H_L}$ θ = 45,000 ° ...inclination of horizontal force forming an angle with L' direction

Design vertical load and design vertical bearing resistance:

$V_d = \frac{V_{Ed}}{A'}$ V_{Ed}/A' = 155,72 kPa ...design vertical load of foundation base

$$\frac{R}{A'} = c' \cdot N_c \cdot b_c \cdot s_c \cdot i_c + q' \cdot N_q \cdot b_q \cdot s_q \cdot i_q + 0.5 \cdot \bar{\gamma} \cdot B' \cdot N_\gamma \cdot b_\gamma \cdot s_\gamma \cdot i_\gamma$$

R_d/A' = 366,14 kPa ...design vertical bearing resistance of foundation base

Bearing resistance utilization:

U = 42,53 % **BEARING RESISTANCE IS SUFFICIENT!**