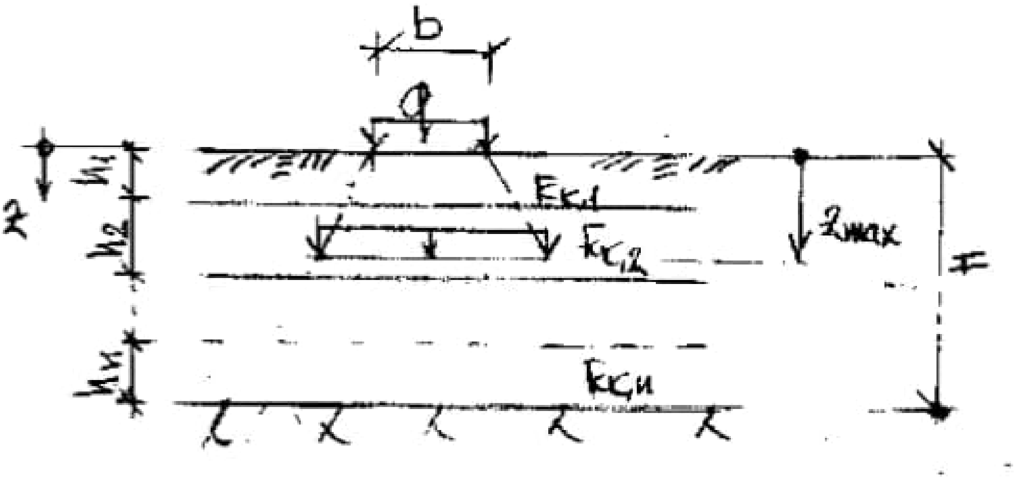
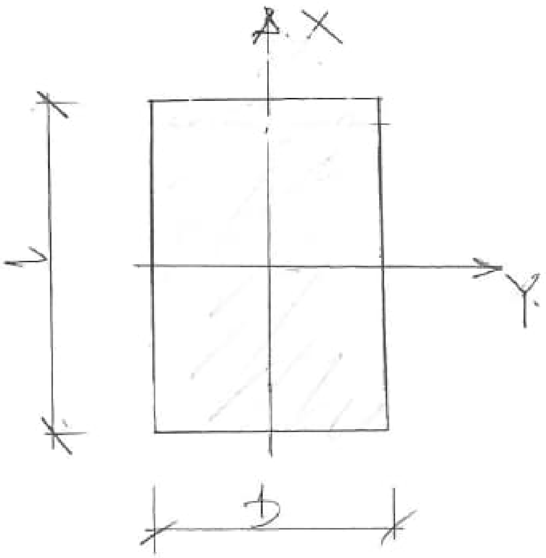
Object : Support 1

PRINCIPLE SKETCH

Geometry and foundation

The calculation of the equivalent stiffness in the foundation has been carried out according to TRVINFRA-00227, Appendix 4 (method 1). The equivalent E-modulus assumes a load spread of 2:1. The determination was made for a fictitious load corresponding to q (= 100 kPa).

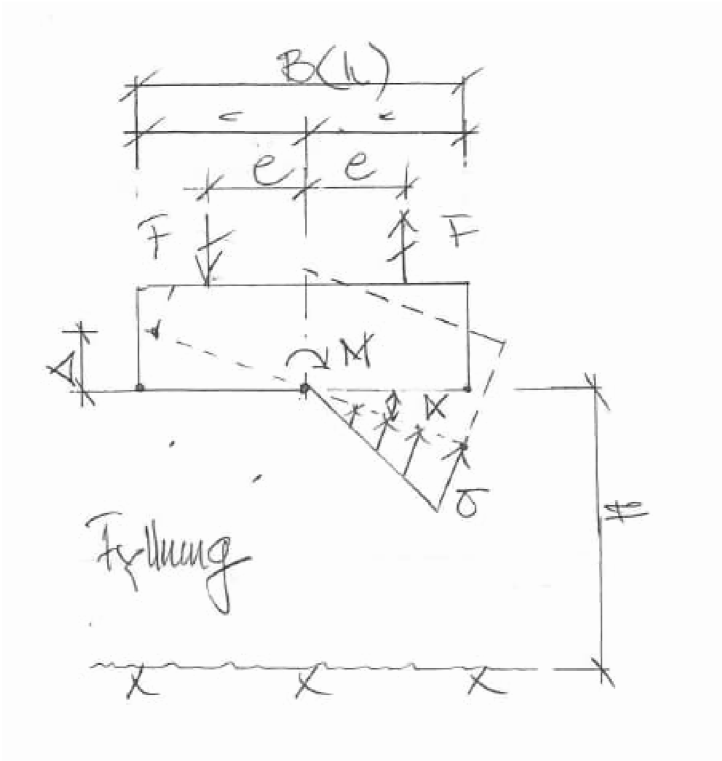




THEORY

When the distance to the rock is less than 2B, the formula below is applied, which also appears in BH page 594 (section 6.4:22 Calculation model).

When distance to rock is greater than 2B use TRVINFRA-00227, Appendix 5.



$$\Delta = \alpha \cdot \frac{B}{2} ; \qquad \varepsilon = \frac{\Delta}{H} = \frac{\alpha \cdot \frac{B}{2}}{H}$$

$$\sigma = \varepsilon \cdot E'_k = \frac{E'_k \cdot \alpha \cdot B}{2 \cdot H}$$

$$F = \sigma \cdot \frac{B}{2} \cdot \frac{1}{2} \cdot L = \frac{E'_k \cdot \alpha \cdot B}{2 \cdot H} \cdot \frac{B \cdot L}{4} = \frac{E'_k \cdot \alpha \cdot B^2 \cdot L}{8 \cdot H}$$

$$M = F \cdot 2e \quad ; \qquad e = \frac{B}{3} ;$$

$$M = F \cdot \frac{2 \cdot B}{3} = \alpha \cdot \frac{L \cdot B^3 \cdot E'_k}{12 \cdot H}$$

$$\Rightarrow \frac{\alpha}{M} = \frac{12 \cdot H}{L \cdot B^3 \cdot E'_k}$$

INPUT

Geometry

Bottom slab : $b := 4.0\ m$ $l := 9.0 \cdot m$

Soil material

Number of layers (min. 2 layers): $n := 2$

Layer	E_k	h
1	50	3,00
2	50	3,00
-	MPa	m

CALCULATIONS

Total layer thickness

$$H := \sum_{i=1}^{n} h_i \qquad H = 6\ m$$

Total settlement thickness

$$z_{max} := min(2 \cdot b, H) \qquad z_{max} = 6\ m$$

Levels for each layer

$$z_s := \left\| \begin{array}{l} z_1 \leftarrow 1 \cdot mm \\ \text{for } i \in 1..n \\ \quad \left\| \begin{array}{l} z_{2 \cdot i} \leftarrow z_{2 \cdot i - 1} + h_i - 1 \cdot mm \\ z_{2 \cdot i + 1} \leftarrow z_{2 \cdot i} + 1 \cdot mm \end{array} \right. \end{array} \right.$$

$$z_s = [0\ \ 3\ \ 3.001\ \ 6\ \ 6.001]\ m$$

Function - settlement modulus

$$E_{sk} := \left\| \begin{array}{l} E_1 \leftarrow E_{k_1} \\ \text{for } i \in 1..n-1 \\ \quad \left\| \begin{array}{l} E_{2 \cdot i} \leftarrow E_{k_i} \\ E_{2 \cdot i + 1} \leftarrow E_{k_{i+1}} \end{array} \right. \\ E_{2 \cdot n} \leftarrow E_{k_n} \\ E_{2 \cdot n + 1} \leftarrow 1000 \cdot MPa \end{array} \right.$$

$$E_{sk} = [50\ \ 50\ \ 50\ \ 50\ \ 1000]\ MPa$$

$$E_{kar}(z) := \text{linterp}(z_s, E_{sk}, z)$$

Stress according to method 2:1

$q := 100 \cdot kPa$

$$\Delta\sigma_v(z) := q \cdot \frac{b \cdot l}{(b+z) \cdot (l+z)}$$

Characteristic settlement

$$s_k := \int_{0 \cdot m}^{H} \frac{\Delta\sigma_v(z)}{E_{kar}(z)} \, dz \qquad s_k = 5.8 \ mm$$

Equivalent settlement modulus

$$E'_k := \frac{\int_{0 \cdot m}^{z_{max}} \Delta\sigma_v(z) \, dz}{s_k} \qquad E'_k = 50 \ MPa$$

Function - stiffness when H < 2B
(See derivation section THEORY)

$$k_{\theta k}(B, L) := \frac{L \cdot B^3 \cdot E'_k}{12 \cdot H}$$

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RESULTS

Results when H < 2B

Rotation about bottom slab short direction (x-x direction):

$$k_{\theta k}(b, l) = 400000 \frac{kNm}{rad}$$

$$C_{\phi.1} := \frac{1}{k_{\theta k}(b, l)} \qquad 10^9 \cdot C_{\phi.1} = 2500 \frac{rad}{kNm}$$

Rotation about bottom slab long direction (y-y direction):

$$k_{\theta k}(l, b) = 2025000 \frac{kNm}{rad}$$

$$C_{\eta.1} := \frac{1}{k_{\theta k}(l, b)} \qquad 10^9 \cdot C_{\eta.1} = 494 \frac{rad}{kNm}$$

Results when H > 2B

Rotation about bottom slab short direction (x-x direction):

$$K_{\phi} := E'_k \cdot \frac{b^2 \cdot l}{5} = 1440000 \frac{kNm}{rad}$$

$$C_{\phi.2} := \frac{1}{K_{\phi}} \qquad 10^6 \cdot C_{\phi.2} = 0.694 \frac{rad}{kNm}$$

Rotation about bottom slab long direction (y-y direction):

$$K_{\eta} := E'_k \cdot \frac{l^2 \cdot b}{5} = 3240000 \frac{kNm}{rad}$$

$$C_{\eta.2} := \frac{1}{K_{\eta}} \qquad 10^6 \cdot C_{\eta.2} = 0.309 \frac{rad}{kNm}$$