

Exercise 8 – 11.12.2025

## Lateral earth pressure under different hydraulic conditions

### Problem statement

A 3-m-high retaining wall is going to be embedded 3 m in a silty soil that extends to considerable depth. To evaluate the horizontal stresses acting on the retaining wall, please answer the following questions.

### Question 1 – Hydraulic and mechanical characterization

Provide the hydraulic and mechanical characterization of the soil in saturated and unsaturated conditions by answering the following questions.

- a) The soil has the following properties: dry unit weight  $\gamma_d = 16.70 \text{ kN/m}^3$ , saturated water content  $w_{\text{sat}} = 0.257$ . Calculate the saturated unit weight of the soil.
- b) Triaxial tests were conducted and experimental results are available for RTC (Reduced Triaxial Compression) tests. The principal stresses ( $\sigma_1$  and  $\sigma_3$ ) at failure are reported in the following table. Determine the parameters for the Mohr-Coulomb (M-C) failure criterion.

Sample	$\sigma_3 = \sigma_2$ [kPa]	$\sigma_1$ [kPa]
1	1	20
2	5	30
3	7	40

- c) Use the Gardner's model to plot the permeability vs. matric suction relationship within the range of matric suction  $\leq 10^3 \text{ kPa}$ . The following parameters can be assumed:  $k_s = 1 \cdot 10^{-6} \text{ m/s}$  and  $\alpha = 0.0226 \text{ kPa}^{-1}$ .
- d) Use the Van Genuchten's model to plot the Soil Water Retention Curve (SWRC) within the range of matric suction  $\leq 10^3 \text{ kPa}$ . The following parameters can be assumed:  $\alpha = 0.0226 \text{ kPa}^{-1}$ ,  $n = 6.34$ ,  $m = 0.13$ .
- e) Based on your answers above, estimate the permeability of the soil when degree of saturation is 50 % and 90 %. Comment on the influence of the degree of saturation on the permeability.

## Question 2 – Lateral earth pressure

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Draw the matric suction and lateral earth pressure profiles at an active state for the following conditions. Plot the results for depth up to 3 m.

- a) Retained soil is dry (GWT well below the base of the wall)
- b) Retained soil is fully saturated with GWT at the top of the wall
- c) Retained soil is partially saturated due to capillary rise. In particular, the GWT is at the base of the wall). Consider the following scenarios:
  - hydrostatic distribution of the matric suction ( $p_a - p_w$ )
  - distribution of the matric suction with infiltration rate  $q = -1/10 k_s$ ,  $q = -1/5 k_s$ ,  $q = -1/2 k_s$ , and  $q = -k_s$  being  $k_s$  the saturated hydraulic conductivity

Comment on the evolution of the resultant horizontal force acting on the retaining wall when an initially dry retained soil becomes fully saturated (e. g. condition a to b). Also discuss what events/conditions can induce such a change on a site.