

Exercise 8 – 16/12/2024

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 (σ_1 and σ_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]	σ_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

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.