

Exercise 1 – 18.09.2025

## Processing triaxial tests

You are requested to analyze the results of a drained and an undrained triaxial compression tests. The word *drained* is used to describe the condition in which the pore water is allowed to flow freely into or out of the soil sample, and thus dissipate any excess pore pressure. In drained test, a *backpressure* is applied throughout the test in order to ensure sample saturation: the pore water pressure is kept constant and equal to a static value  $p_w$ . The word *undrained* indicates that pore water is not allowed to move into or out of the specimen, thus the pore water pressure is not constant.

### 1. Test conditions

Both samples are prepared in triaxial cells at following dimensions: diameter 38 mm, height 76 mm.

Conditions for tests:

a) drained triaxial test

- Initial isotropic compression up to a cell pressure  $\sigma_c = 250$  kPa.
- Initial pore water pressure  $p_w = 50$  kPa.

The sample undergoes a conventional drained triaxial compression test with cell pressure  $\sigma_c$  and pore water pressure  $p_w$  held constant.

b) undrained triaxial test

- Initial isotropic compression up to a cell pressure  $\sigma_c = 500$  kPa.
- Initial pore water pressure  $p_w = 80$  kPa.

An undrained conventional triaxial compression test is carried out at a constant cell pressure  $\sigma_c$  on the sample.

### 2. Experimental data

a) Drained triaxial test

After the isotropic compression, the shearing phase is performed. During the shearing phase, the following results are obtained, where  $F$  is the applied force,  $\delta$  is the axial displacement (negative means that the sample height is reducing),  $\Delta V_w$  is the pore water volume variation (*note*: positive  $\Delta V_w$  implies that water flows out of the sample).

| F<br>(N) | $\delta$<br>(mm) | $\Delta V_w$<br>(mm <sup>3</sup> · 10 <sup>3</sup> ) |
|----------|------------------|--|
| 0        | 0                | 0  |
| 108      | -0.85            | 1.2  |
| 240      | -4.31            | 4.9  |
| 305      | -8.72            | 7.1  |
| 360      | -16.52           | 8.0  |
| 412      | -24.02           | 8.2  |
| 443      | -27.3            | 8.2  |

b) Undrained triaxial test

After the isotropic compression, the shearing phase is performed. The following results are obtained during the shearing phase, where  $F$  is the applied force,  $\delta$  is the axial displacement (negative means that the sample height is reducing) and  $p_w$  is the pore water pressure.

| <b>F<br/>(N)</b> | <b><math>\delta</math><br/>(mm)</b> | <b><math>p_w</math><br/>(kPa)</b> |
|------------------|-------------------------------------|-----------------------------------|
| 0                | 0                                   | 80                                |
| 46               | -1.30                               | 112                               |
| 85               | -3.58                               | 150                               |
| 120              | -8.39                               | 198                               |
| 135              | -12.98                              | 206                               |
| 152              | -18.50                              | 211                               |
| 156              | -20.50                              | 211                               |

### 3. Instructions

Calculate deviatoric stress  $q$ , mean effective  $p'$  and mean total stress  $p$ , axial strain  $\epsilon_a$ , and volumetric strain  $\epsilon_v$  for each step of the test. Give the resulting values in a table. Then, plot the experimental results in the following planes (y axis - x axis):

1.  $q - \epsilon_a$
2.  $q - p (p')$
3.  $\epsilon_v - \epsilon_a$
4.  $\epsilon_v - p'$
5.  $p_w - \epsilon_a$

Represent both the total and effective stress paths in the plane  $q - p (p')$ , highlighting the difference between the two.

Comment on the difference between the total stress paths and the effective stress path. How is it different from the drained case?