

Project – Part 3 – 30.10.2025 (due on 19.12.2025)

Evaluation and design of a geotechnical project using finite element method

Problem statement

As a geotechnical engineer, you are tasked with conducting a detailed assessment of the soil conditions for an upcoming geotechnical project. The assessment includes a series of triaxial tests that were done on samples taken from soil cores extracted on site. You will analyse the results provided by the lab and determine the key soil parameters necessary for the design process. The data and parameters you establish at this phase will be critical for the geotechnical design in subsequent phases of the project. In this phase, you will determine the soil parameters of the Modified Cam-Clay constitutive model.

3. Modified Cam-Clay parameters determination

Using the experimental results from the previous phase determine the parameters for the Modified Cam-Clay (MCC) models:

1. Determine the values q and p' at the critical state and plot the Critical State Line (CSL) in the ($q - p'$) plane, and calculate the parameter M .
2. Identify the specific volume at the end of the isotropic compression stage (v_0) and calculate the specific volume at the critical state (v_{cs}) for all three tests. Using these values, plot the NCL and CSL in the $v - \ln(p')$ plane as well as the stress path followed during each test.
3. Calculate the parameters λ , N and Γ from the NCL and CSL in the $v - \ln(p')$ plane.
4. Using the unloading-reloading cycle performed in the third test, with $p'_0 = 400 \text{ kPa}$, determine the elastic parameter κ by plotting the results of this test in the suitable plane.
5. In the plane $q-p'$, plot the Modified Cam-Clay yield surface for 1) the initial yield surface at the end of the isotropic compression stage and 2) the final yield surface and the end of the shearing stage. In the same plane, plot the stress path followed during the shearing stage.
6. Another series of laboratory tests is to be carried on the same soil in undrained CTC conditions. Can we predict the soil behaviour using the same critical state parameters determined from the drained tests?