
Master thesis/Semester project
Spring Semester 2024

Boreholes for geo-energy applications: a numerical study

EPFL Supervisors: Prof. Lyesse Laloui and Dr. Angelica Tuttolomondo

Motivation of the project

Deep boreholes are constructed for various purposes within geo-energy and underground climate change mitigation projects (the latter include for instance hydrogen and carbon storage projects). These boreholes are pivotal during both the exploration phase, for site selection, and the operational phase, for activities like injection. The construction of deep boreholes alters the original condition of the geological formations. This alteration can significantly affect the accuracy of measurements taken within the boreholes and the efficacy of injection activities conducted during the operational phase. Understanding the effects of borehole construction on the sub-surface's initial state is crucial. This study seeks to address this knowledge gap using suitable modeling tools.

Keywords

Geo-energy applications, numerical study, shales, damage zone, sensitivity analyses

Goal of the project

The anticipated results of this project include:

- The determination of the extent of the damage/disturbed zone when excavating conventional deep boreholes in selected geomaterials
- The assessments of the key parameters influencing the damage/disturbed zone's extent

To achieve these outcomes, numerical analyses and sensitivity studies regarding these parameters will be conducted.

Tasks and work to carry out

The student is expected to perform the following tasks:

- Calibrate a numerical model to simulate the drilling of a deep borehole
- Identify and categorize the main parameters that influence the extent and characteristics of the damage/disturbed zone
- Implement sensitivity analysis to evaluate the impact of each parameter on the material's response
- Prepare detailed documentation of the methodology, analyses, and findings.

Deliverables

- **Report**

The student will have to prepare a technical report containing the introduction and motivation for the project, the description of the accomplished work and related results as well as conclusions. The technical report will have to be prepared in an electronic format and send to the supervisors by the end of the semester.

- **Final Presentation**

The student will have to present his work during a presentation at the end of the semester. The day and the place of the presentation will be communicated to the student.

Planning

- **Meetings and presentations**

A weekly meeting (on Friday pm) with one of the supervisors is suggested to discuss the progress of the project. One meeting per month will be organized with Prof. Laloui (dates will be communicated to the student).

During the meetings, the student will have to present (i) the progress of the work, (ii) possible questions and remarks, and (iii) a summary of the next steps for the project. During these meetings, the supervisors may vary the foreseen goals of the project, if necessary. The student will have to prepare all the possible questions before the meeting in written form and a summary of each meeting for the next fixed meeting.

- **Report**

The report will be written in English. Graphs will be built with the Grapher software, Matlab, or with the aid of Microsoft Excel. Particular attention will be given to the writing of the report. In the document, the student will have to introduce the topic, highlight the hypotheses made, present the considered methodology, discuss the obtained results, and draw related conclusions.

- **Electronic files**

At the end of the project, the student will have to send to the supervisors a folder containing a clear classification of all the electronic files developed during the project, including those related to the reports, obtained data, presentations, posters, and graphs.

Grading

The final grade will be assigned considering the following proportions of contribution:

- Implication and initiative during the semester 30%
- Technical report 50%
- Oral presentation 20%

The evaluation will also consider the work methodology, discipline, and resourcefulness of the student.

General rules of the project

The schedule of the project is defined by the EPFL Academic Calendar:

<https://memento.epfl.ch/academic-calendar/?period=180>

The student signature on the submitted report certifies that the work is original and developed by him/herself. This work is property of the EPFL and cannot be disseminated without the approval of the considered Institution.

Contacts

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