CIVIL-496

Rock mass characterization for engineering design

Violay Marie

Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Civil engineering minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	1 weekly
Lab	1 weekly
Number of positions	

Summary

This course advances geomechanics knowledge, focusing on lab tests, in situ & geophysical investigations for interpreting geotechnical projects. Practical modules cover rock physics, mechanics, borehole & subsurface geophysics.

Content

Long Summary

The evaluation of the geomechanical parameters of rock masses in large projects is a topic of great importance given the geological complexity of these masses and the difficulties in their evaluation. These difficulties are related to the uncertainties associated with the rock mass, whose characterization is normally carried out through in situ and laboratory tests. In this course, the students will learn practical skills to analyse rock masses affected by geological structures, such as discontinuities, folds, fracture and faults at both lab and site scales and understand how rocks deform in geo-engineering projects.

In a first part, we show the fundamental techniques for laboratory measurements of rock physical (i.e., density, permeability, elastic properties, electrical and thermal properties) and mechanical (i.e., USC, triaxial strength, shear strength, frictional properties, fracture toughness) properties.

In a second part, we introduce the most common (borehole and large scale) geophysical methods for site investigation and survey. The methods represent a primary tool for investigation of the subsurface and are applicable to a wide range of problems (e.g., prospecting for natural resources, geological surveying, and engineering investigations).

This course involves student groups conducting laboratory experiments that significantly enhance student understanding of rock mechanics and physics.

Content

The objective of this course is to advance student knowledge in geo-mechanics, and discuss the utility of laboratory tests and in situ and geophysical investigation in the interpretation of large scale geotechnical projects. Lectures will alternate with laboratory demonstrations.

The detailed course structure is the following:

Lectures (~3 hours/week)

- *Experimental rock physics*: hydraulic, electrical, and seismic methods (~10 hours)
- *Experimental rock mechanics*: behavior of natural discontinuities (~10 hours)
- *Borehole geophysics*: nuclear, electrical, and seismic methods (~10 hours)
- *Subsurface geophysics*: seismic, electrical, and electromagnetic methods (~10 hours)

Laboratory sessions (~1 hour/week)

- **Lab 1**: Permeability, porosity, and density (~2.5 hours)
- **Lab 2**: Seismic properties (~2.5 hours)

- **Lab 3**: Electrical properties (~2.5 hours)
- **Lab 4**: UCS and triaxial testing (~2.5 hours)
- **Lab 5**: Direct shear and friction (~2.5 hours)
- **Lab 6**: Fracture mechanics (~2.5 hours)

Keywords

Experimental rock mechanics, physics, laboratory test

Learning Prerequisites

Required courses

Géologie (CIVIL-211) ; Soil mechanics and groundwater seepage (CIVIL-203), Mécanique des roches et ouvrages souterrains (CIVIL-308), Ouvrages géotechniques (CIVIL-306)

Recommended courses

Mécanique des milieux continus (CIVIL-225)

Important concepts to start the course

Genesis and nature of dominant geological formations. Force, tension, stress, strain, pressure, mean/deviatoric/differential stress, total and effective stress, pore pressure, flow, hydraulic potential and fluid pressure. Fracture criteria (Mohr coulomb, Hoek and Brown, Griffith), inhomogeneity, anisotropy, alteration. Elasticity theory. Shear strength of joints.

Learning Outcomes

By the end of the course, the student must be able to:

- Characterize the mechanical and physical properties of rocks, factures, faults and rock masses.
- Plan standard and state of the art rock mechanics and physics laboratory and in situ tests and apply them to large scale geotechnical projects.
- Solve problems using cross-disciplinary approaches, in particular using their knowledge in engineering geology, rock mechanics, and soil mechanics.
- Characterize the mechanical and physical properties of rocks, factures, faults and rock masses.
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- Solve problems using cross-disciplinary approaches, in particular using their knowledge in engineering geology, rock mechanics, and soil mechanics.

Transversal skills

- Collect data.
- Take responsibility for environmental impacts of her/ his actions and decisions.
- Access and evaluate appropriate sources of information.

Teaching methods

Lectures, laboratory tests, class exercises, assignments. The course is evaluated by a reference group

Expected student activities

Compulsory assignment: Attendance to all lectures. Participate actively in discussions and ask questions to clarify any

doubts. Participate in all classroom exercises. Attend all laboratory sessions (travaux pratiques, TP). Presence is compulsory. Write a detailed lab report for each TP session. Study the theoretical aspects of rock mass characterization methods

Assessment methods

Lab report (30% + oral), written exam (70%) during semester, possibility of mid term exam.

Supervision

Office hours	No
Assistant.e.s	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

Mussett et al., 2000, Gover et al, 1995

Prerequisite for

Computational geomechanics
Energy geostructures
Engineering geology for geo-energy
Géologie de la construction et de l'environnement
Geothermal resource development
Innovation for construction and the environment
Slope stability
Travaux souterrains