CERTIFICATE OF ADVANCED STUDIES

Advanced geotechnics to face the new challenges of construction, environment and energy

Targets

The course is intended for construction professionals, civil and environmental engineers, geologists and laboratory technicians wishing to improve their skills and broaden their fields of study.

The course is delivered in English.

Prerequisites

Basic knowledge of continuous media mechanics and soil mechanics.

If possible, participants should bring their own laptop computer (to be used during digital excitations).

References

Mécanique des sols et des roches.
Vulliet L., Laloui L., J. Zhao.
Presses Polytechniques Universitaires Romandes, 624 pages, 2016
ISBN : 978-2-88074-961-3

Certification

A Certificate of Advanced Studies (CAS) is delivered at the end of the course (14 ECTS).

Overview

State-of-the-art geotechnics provides scientific and technical answers to the new challenges of construction (increasingly poor terrain, higher loads, climate change and drought, etc.), the environment (natural hazards, polluted soils, etc.) and energy (energy geostructures).

Participants in this CAS will have the basics of the physical mechanisms that govern these different engineering problems and the tools to apply them to geotechnics structures.

The laws of behavior of geomaterials (elastoplasticity, viscosity, non-saturation, temperature, etc.) are the foundations of advanced geotechnics. They will be addressed in connection with the establishment of experimental programs for the determination of material parameters.

The numerical analysis with the finite element method and the other pillar of competences which will be developed through examples of geotechnics problem solving. A particular focus will be put on multiphysical coupled problems in saturated and unsaturated conditions.

The participants will receive a finite element calculation code from the public domain that will allow them to continue their deepening of the subject after the course.

Objectives

- Understand and analyze the physical processes that define the multi-physical behavior of soils
- Be able to interpret and use advanced behavioral laws for the description of non-linear responses of geomaterials
- Learn how to analyze the results of experimental campaigns to guide the choice of behavioral laws and define their calibration
- Be able to define a coupled finite element analysis of a geotechnics problem
- Critically examine some practical examples of the application of advanced geotechnics around the world.

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Trainers

Prof. Lyesse Laloui
École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Dr. Aldo Madaschi
Nesol - Numerical Engineering Solutions, Switzerland

Methods

- Optimal balance between theory and practice (numerical exercises on the computer)
- The course makes extensive use of finite element analysis to validate theoretical concepts.
- The training is based on cutting-edge scientific achievements

Format

- Intensive course
- Duration: 3 months
- Presence: 14 days (including 1 full week and 4 weekends on site) + Remote learning

Program

PART A – Introduction

- Definition of course objectives and methodology
- The role of advanced geotechnics in new technologies for sustainable development
- Geotechnics and extreme environmental conditions

PART B - Multiphysical Characteristics of Geomaterial Response

- Laws of non-linear mechanical behavior
- Viscous phenomena and their modeling
- Hydromechanical coupling and the role of non-saturation
- Influence of temperature and thermo-hydro-mechanical coupling (THM)
- Experimental programs for the determination of geomaterial parameters

PART C - Numerical Analysis of Coupled THM Problems

- Finite element modeling in geomechanics
- Definition of the domain and boundary conditions
- Choice of behavior laws and their calibration
- The specificities of a coupled thermo-hydro-mechanical analysis
- Analysis and discussion of several coupled geomechanical problems Practical examples on the computer

PART D - Case Study Analysis of Advanced Geotechnical Problems

- Analysis of several case studies of complex numerical analyses from international geomechanical projects
- Discussion of case studies and critical evaluation of modeling approaches around the world

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