CIVIL-402 **Geomechanics**

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Cursus	Sem.	Type
Civil Engineering	MA1, MA3	Opt.
Civil engineering minor	H	Opt.
Mechanics		Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Written
Workload	150h
Weeks	14
Hours	**5 weekly**
Lecture	3 weekly
Exercises	2 weekly
Number of positions	

Summary

The course covers engineering applications and challenges in geomechanics, including stress-strain behavior of geomaterials in variousconditions, triaxial testing,and constitutive frameworks for elasticity and plasticity.Practical insights are gained through workshops with geomechanics professionals

Content

• Engineering applications and challenges

• Basic concepts of continuum mechanics and geomechanics

- Stress-strain behaviour of geomaterials in drained and undrained conditions
- Laboratory tests with special focus on triaxial testing

• Practical aspects in geomechanics

- In-situ stress state
- In-situ geotechnical testing
- Numerical modelling in geotechnics
- Soil-structure interaction principles

• Stress-strain constitutive frameworks

- Elasticity: Linear and non-linear elasticity; Applications of elastic models
- Plasticity: Plasticity principle and yield criteria for geomaterials;
Critical state concept; Elasto-plastic stress-strain constitutive frameworks (among others Modified Cam-Clay model)

• Mechanics of unsaturated geomaterials

- Basic concepts
- Hydraulic and mechanical behaviour
- Effective stress definition for unsaturated geomaterials

• Retaining structures in saturated and unsaturated geomaterials

- Lateral earth pressure for saturated and unsaturated soils (Rankine's theory)
- Shear strength of unsaturated geomaterials
- Darcy's law for saturated and unsaturated geomaterials

• Time dependent behaviour of geomaterials

- Time-dependent phenomena
- Viscous deformations: basic concepts and experimental evidence

- Visco-elasto-plastic models
  • Thermo-hydro-mechanical behaviour of geomaterials

- THM application in geomechanics
- Constitutive effect of temperature and experimental observations
- THM constitutive modelling
  • Concepts of soil dynamics and local seismic response

- Soil cyclic behaviour and hydro-mechanical dynamic effects
- Dynamic liquefaction
- Models for soil cyclic response
- Local seismic response
  • Advanced topics in geomechanics

- Energy related applications
- Bio-improved soils
  • Seminar series with professionals in geomechanics and geotechnical engineering

Keywords

Mechanical behaviour of geomaterial, constitutive models, elasto-plasticity, numerical modelling in geomechanics, laboratory and in-situ testing

Learning Prerequisites

Required courses

Soil mechanics and groundwater seepage

Learning Outcomes

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

- Recognize the stress path(s) to which the soil is subjected in the context of the engineering application of interest
- Use methods for evaluating the in-situ stress state
- Recognize the most suitable constitutive model for the problem of interest in relation to the soil and the problem itself
- Judge capabilities and limitations of constitutive models
- Assess / Evaluate Evaluate the geotechnical parameters governing the geomechanical problem
- Design laboratory or in-situ tests for the determination of the needed parameters
- Interpret /Process the experimental data resulting from a laboratory campaign in order to obtain the parameters of interest
- Assess / Evaluate the soils response under various environmental conditions (unsaturated, non-isothermal, dynamic)
- Use consciously a finite element software for creating a geomechanical model appropriate for the problem of interest

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Use a work methodology appropriate to the task.
- Communicate effectively with professionals from other disciplines.
- Demonstrate the capacity for critical thinking
- Use both general and domain specific IT resources and tools

- Access and evaluate appropriate sources of information.

Teaching methods

- Ex cathedra and exercices

Assessment methods

Final exam (written): 60% of the final mark
Mid-term exam (written): 20% of the final mark
Continuous assessment (workshops and projects): 20% of the final mark

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Bibliography

Lectures notes and handouts given during the course

Moodle Link

- https://go.epfl.ch/CIVIL-402