Module Description, available in: EN

Material Mechanics and Plasticity in Structural and Geotechnical Engineering

General Information

Number of ECTS Credits

3

Module code

TSM_MatPla

Valid for academic year

2026-27

Last modification

2025-11-04

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge of structural analysis of frame structures and plate structures, as well as knowledge of the design and construction of load-bearing structures made of reinforced concrete and steel.
- Knowledge of soil mechanics, as well as of the calculation and design of geotechnical structures.
- Knowledge of matrix algebra and differential equations.

Brief course description of module objectives and content

1. Contents: Introduction to continuum mechanics and plasticity theory; analysis of constitutive laws for soils and construction materials in structural engineering; application of plasticity theory for ultimate load calculations in geotechnical and structural engineering.

2. Objectives: After completing this module, students should have developed an in-depth understanding of the constitutive laws governing soils and structural materials used in civil engineering. They should be able to correctly apply these laws in the calculation of ultimate loads for specific engineering structures. Furthermore, students should understand the methods for determining load-bearing capacity based on plasticity theory in both geotechnical and structural engineering and be able to apply them to appropriate practical problems.

Aims, content, methods

Learning objectives and competencies to be acquired

After completing this module, students should be able to:

a) develop an in-depth understanding of the constitutive laws of soils and structural materials used in civil engineering;

b) correctly assess which constitutive law is appropriate to apply in a given practical situation;

c) understand the purpose and significance of the limit load method and the limit theorems in plasticity theory;

d) understand and apply methods for determining load-bearing capacity using the limit load method in both geotechnical and structural engineering;

e) apply constitutive laws to calculate realistic load-bearing capacities for geotechnical structures as well as for structures in structural engineering;

f) interpret and validate the results of load-bearing capacity calculations.

Module content with weighting of different components

Introduction to Continuum Mechanics and Material Mechanics (approx. 35%)

- Introduction to static and kinematic relationships; introduction to material behavior (linear-elastic, ideally plastic behavior, plastic potential, yield criteria) (approx. 10%)
- Constitutive laws for soils (elasticity; failure criteria and plastic flow, hardening, critical state) (approx. 15%)
- Constitutive laws for structural materials used in civil engineering (steel, reinforced concrete, fiber-reinforced concrete, ultra-high-performance concrete (UHPC), glass) (approx. 10%)

2. Application of Plasticity Theory in Structural Engineering (approx. 40%)

- Limit theorems of plasticity theory
- Elastoplastic systems
- Limit load methods for frame structures, including practical examples: static and kinematic approaches
- Limit load methods for plate structures, including practical examples: simple moment fields, yield-line analysis, and the strip method

3. Application of Plasticity Theory and Nonlinear Material Behavior in Geotechnical Engineering (approx. 25%)

- Selected practical case studies of geotechnical problems (retaining walls, slope stability, shallow foundations, deep excavations)

Teaching and learning methods

- Lectures and seminar-style instruction
- Independent exercises

Literature

- Theory of Structures: Fundamentals, Framed Structures, Plates and Shells, by Prof. Dr. Peter Marti, 2013, Online ISBN:9783433602638 |DOI:10.1002/9783433602638, Wilhelm Ernst & Sohn
- "Constitutive laws for soil", Prof. Dr. Carlo Rabaiotti, OST Ostschweizer Fachhochschule Rapperswil, 2017/2025
- Further teaching materials from the lectures

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Summary of course material on ten A4 pages for the Materials course and ten A4 pages for the Plasticity course.

Additional aids as agreed upon with the instructor.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Permitted aids as agreed upon with the instructor.