

CIVIL-511

Engineering of existing structures

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

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	4 weekly
Courses	3 weekly
Exercises	1 weekly
Number of positions	

Summary

The engineering of existing structures encompasses the examination of condition and load-carrying capacity, decision criteria, and methods for rehabilitation or strengthening. This course presents the bases necessary for this approach at the level of materials and structural response.

Content

The course principally covers reinforced and prestressed concrete structures.

E. Denarié handles parts on introduction, value of existing structures, deterioration mechanisms, condition evaluation, non-destructive testing, updating of resistances, reinforcement with new concretes, UHPFRC and external prestressing, intervention recommendations, conclusions.

A. Nussbaumer handles parts on updating of action effects, in depth examination: updating by semi-probabilistic analysis, required safety level, condition evaluation and reinforcement by means of glued CFRP lamellas. The course covers the following topics:

- Engineering of existing structures: systematic approach, built estate, range of most frequent issues, socio-economic aspects, material and immaterial value, sustainable development, requirements, terminology.
- Deterioration mechanisms in reinforced concrete: transport phenomena, corrosion due to carbonatation and chlorides, cracking, freeze-thaw, Alkali Aggregate Reaction (AAR), swelling reactions with sulfates, condition evolution and damage, deterioration curves.
- Examination according to SIA 269 Annex A: stepwise approach, updating of resistances (material properties, resistance models) and actions (dead loads, traffic loads, climatic actions), structural analysis models, accidental actions, application of probabilistic methods, required safety level.
- Condition survey and in-depth examination: visual survey, characterization of concrete cover properties (permeability, depth, resistivity), electrochemical potential measurements, impact-echo and GPR, deformation and load measurements in structures.
- Interventions: hybrid concrete members, rehabilitation; strengthening with R-UHPFRC, glued CFRP lamellas, additional prestressing.- Intervention recommendation: monitoring, strengthening, proportionality, cost-benefit ratio.

Keywords

Existing structures, value, updating of actions and resistances, deterioration of reinforced concrete, auscultation methods, inspection of structures, verification of structural safety, concretes, UHPFRC, durability, proportionality, sustainability.

Learning Prerequisites**Required courses**

Structures and materials
Bases in physics and chemistry

Learning Outcomes

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

- Detect and analyze the effects of physico-chemical and mechanical phenomena in the behavior of existing structures (bridges, buildings).
- Exploit NDT examination methods and results.
- Work out / Determine updated action effects and resistances as well as models suitable for the verification of structural safety.
- Integrate a systematic and stepwise methodology for the evaluation of an existing structure.

Transversal skills

- Take responsibility for environmental impacts of her/ his actions and decisions.
- Use a work methodology appropriate to the task.
- Communicate effectively with professionals from other disciplines.
- Demonstrate the capacity for critical thinking

Teaching methods

Ex cathedra, exercises

Expected student activities

Study of teaching material and exercises

Assessment methods

Oral exam: 20 minutes preparation, 20 minutes presentation, all documents and laptop authorized

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

SIA 269/XX standards

Ressources en bibliothèque

- [SIA standards - available online for EPFL Community](#)

Moodle Link

- <https://go.epfl.ch/CIVIL-511>

Prerequisite for

Construction and Master projects