Module Description, available in: EN

Bridge Design and Assessment

General Information

Number of ECTS Credits

3

Module code

TSM_Bridge

Valid for academic year

2026-27

Last modification

2026-06-19

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

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Deep knowledge of structural mechanics and the basis of reinforced and prestressed concrete design. Basic knowledge of coding (MathWorks MATLAB) and FEM modeling would be an advantage.

Brief course description of module objectives and content

The federal road network comprises more than 4500 highway bridges, 66% of which were built in the 1980s or earlier. As a result, practitioners increasingly face the challenge of assessing and, when necessary, strengthening these structures in response to rising traffic demands and the evolving impacts of climate change.

This module introduces students to the multifaceted domain of bridge design and assessment following current standards and design recommendations. The focus is placed on the structural behavior of box girder and multi girder bridges in reinforced and prestressed concrete, which represent the most common typologies in Switzerland. The objective is to familiarize students with the relevant design situations and verifications that support subsequent detailing (beyond the scope of the course) or strengthening interventions, with particular emphasis on UHPFRC technology.

In the first part of the module, we examine established models for analyzing the longitudinal and transverse behavior of bridges, highlighting the suitability of analytical and numerical methods for different typologies. We then explore how the general principles governing the safety assessment of existing structures influence the application of these well-established methods.

The second part of the module introduces the fundamental maintenance strategies adopted by the Federal Road Office (FEDRO). Topics include the bearing capacity and ductility of girders and columns eventually strengthened. Through additional autonomous readings, students will also investigate the emerging challenges that climate change poses to bridge design and assessment. The course adopts an engineering-oriented approach and features numerous examples drawn from the Swiss road network.

Aims, content, methods

Learning objectives and competencies to be acquired

At the end of the course, you will be able to:

- Describe the conceptual design and structural behavior of the main bridge typologies with a specific focus on Swiss practice Critically evaluate the suitability of different bridge typologies in relation to specific design situations
- Apply the key technical provisions and design standards governing bridge design and assessment Identify the primary design constraints influencing the choice of girder-bridge typologies
- Select the most appropriate analytical or numerical methods of analysis for a given bridge typology Recognize the potential impact of climate change on bridge design and assessment
- List the monitoring and maintenance strategies adopted by road authorities Assess the structural behavior of girder bridges under different load cases
- Determine the updated traffic load values required for the assessment of existing bridges
- Communicate effectively with specialists and stakeholders involved in bridge management, design, and construction

Module content with weighting of different components

PART 1: BASIC CONCEPTS – Foundation and insights from practice (10%)

- Bridge typologies, conceptual design, and key challenges in bridge assessment, including the role of digitalization in bridge management Overview of the Swiss road network: asset portfolio and condition state
- Standards for bridge design, assessment, and maintenance currently in force in Switzerland

PART 2: DESIGN OF GIRDER BRIDGES (60%)

- **LONGITUDINAL BEHAVIOR**: Influence line and influence surface theory for analyzing global and local effects on deck slabs
- **TRANSVERSE BEHAVIOR**: Bridge-deck modeling techniques, including orthotropic plate analysis, grillage models and frame models; transversal load distribution theory (Engesser, Courbon and Massonet methods).
- **BRIDGE ACCESSORIES AND SPECIFIC DESIGN ASPECTS**: Bearing layouts, expansion joints, and notes on skew, curved and integral bridges

PART 3: BRIDGE ASSESSMENT (30%)

- **OVERVIEW**: Principles for assessing existing structures and their implications for bridges; updating traffic actions and consequence for structural analysis.
- **STRENGTHENING**: UHPFRC technology in bridge engineering in Switzerland and abroad; bearing capacity and ductility of UHPFRC–RC elements; case studies

Teaching and learning methods

- Lectures, case studies, and exercises
- Field trip and guest lectures (to be confirmed)
- Students will receive reading assignments on bridge construction procedures and management systems to supplement the lecture notes.

Literature

- Course notes and slides
- Menn, C., “Prestressed Concrete Bridges“, Birkhäuser Basel, 1990
- Structural design codes SIA 260-267 & 269 (with emphasis on 260-262 and 269-269/1-269/2-269/3) Eurocodes, EN 1990-1999 (with emphasis on 1990, 1991-2, 1992-2)
- FEDRO technical provisions, standards, methodologies, examples and studies, with emphasis on:
    - ASTRA 12004 Details de construction de ponts: directives
    - ASTRA 82001 Évaluation de ponts routiers existants avec un modèle de charge de trafic actualisé ASTRA 82001 Web-Tool https://astra-82001.epfl.ch/#/
    - ASTRA 82002 CFUP pour la maintenance et la construction d’ouvrages d’art de l’infrastructure routiere
    - ASTRA 84011 Technologien zur überwachung der infrastruktur
- Training and professional updating (with emphasis on FEDRO and IABSE webinars) Scientific papers (additional readings will be announced in class).

Note: Since part of the module content is based on Swiss standards, some literature is provided in German/French only.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Assignments during the semester (exercise/project) count as 30% of the final grade.

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

No aids permitted

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

No aids permitted