Bridge structures

Instructor: G.M. Calvi
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Lectures (L, 30 hours)

1)	November	28	10-13
2)	November	29	10-13
3)	November	30	10-13
4)	December	5	10-13
5)	December	6	10-13
6)	December	7	10-13
7)	December	12	10-13
8)	December	13	10-13
9)	December	14	10-13
10)	December	19	10-13

Tutorials (T, 30 hours)

1)	November	29	14-17
2)	November	30	14-17
3)	December	5	14-17
4)	December	6	14-17
5)	December	7	14-17
6)	December	12	14-17
7)	December	13	14-17
8)	December	14	14-17
9)	December	19	14-17
10)	December	20	10-13

Homework assignments (HA)

1)	November	29	due	December	6
2)	December	5	due	December	13

Project

	December	7	due	December	19

Exam

	December	21	9-12

Course Programme

Lectures (L)

L1) Introduction: evolution of design and construction practise
L2) Bridge types: simply supported and continuous beam, truss, arch, stayed and suspension bridges
L3) Loads on bridges: gravity, traffic, wind, earthquakes, collisions, currents, temperature
L4) Deck considerations: solution of indeterminate beams, influence lines and surfaces
L5) Deck considerations: pre-stressed beams, concrete box, steel-concrete composite
L6) Design of piers and foundations
L7) Design of bearings and joints
L8) Seismic design of bridges
L9) Design of isolated bridges
L10) Maintenance and degradation, assessment and strengthening

Tutorials (T)

(ref. L 1, 2 and 3)
T1) Review of influence lines, flexural analysis of prestressed concrete and steel-concrete sections. Presentation of HA1.
T2) Discussion of HA 1. Examples of solutions of bridge design.

(ref. L 4, 5 and 6)
T3) Analysis tools. Presentation of HA 2.
T4) Design of a bridge deck: flexure, shear, torsion, pre- and post-tensioning, steel-to-concrete connection Discussion of HA 2.

T5) Design of foundation and pier systems. Presentation of group project. Collection of HA 1.
T6) Design of bearings and expansion joints. Discussion of group projects.

(ref. L 7 and 8)
T7) Examples of construction methods. Collection of HA 2. Discussion of group projects.
T8) Case studies on degradation, assessment and strengthening.

(ref. L 9 and 10)
T9) Case studies on seismic design, assessment and strengthening.
T10) Summary of the course, Q&A, presentation of group projects.

Homework assignments (HA)

1) Structural analysis: computation of influence lines, flexural analysis of prestressed concrete and steel-concrete composite sections
2) Conceptual design of a bridge: definition of constraints, choice of a structural type, load analysis, preliminary dimensioning of elements

Project Description

Design of a two span bridge (in groups of students)

1) Detailed design of superstructure components: deck analysis (flexure, shear and torsion)
2) Detailed design of substructure components: pier, foundations, bearing, joints

Course Objective

To equip the students with a thorough understanding of design process of bridges, starting from conceptual design to detailed design of bridge components.
To help the student understanding the load flow mechanism of various applied loads, such as truck load, impact, horizontal braking/centrifugal forces, wind and seismic loads on bridges.

Course Content

Historical background of bridges and types. Review of principles reinforced concrete and prestressed concrete, steel-concrete composite structures. Design process. Construction methods. Review of applicable design codes. Structural analysis tools. Seismic performance and retrofit technologies. Investigation of bridge collapses and damages.

Course Learning Outcomes

The students are expected to be able to understand the load-carrying capacity of various types of bridges, upon learning the structural responses to different kinds of loads. They should be able to design standard short and medium span bridges, using with confidence existing codes of practice at the end of the course.

Textbook

There will be no textbook assigned for this course. Class notes and handouts will sufficient.

Reference Books

Bridge Design: Concepts and Analysis, António J. Reis and José J. Oliveira Pedro / John Wiley & Sons 2019
The Design of Prestressed Concrete Bridges: Concepts and Principles, Robert Benaim / Taylor & Francis 2008
Seismic Design and Retrofit of Bridges, M. J. N. Priestley, F. Seible and G. M. Calvi / John Wiley & Sons 1996
Displacement-based seismic design of structures, M. J. N. Priestley, G. M. Calvi and Mervyn J. Kowalsky / IUSS Press 2007
Design of Highway Bridges: An LRFD Approach, Richard M. Barker, Jay A. Puckett / John Wiley & Sons 2013
Prestressed Concrete Design to Eurocodes, Prabhakara Bhatt / Taylor & Francis 2011
Design of steel-concrete composite bridges to Eurocodes, Ioannis Vayas and Aristidis Iliopoulos / Taylor & Francis 2014
Steel-Concrete Composite Bridges: Designing with Eurocodes, David Collings / ICE Publishing 2013

Grading Policy

Homework Assignment 1: 10%
Homework Assignment 2: 15%
Project: 35%
Final Examination: 40%