Seismic Design and Assessment of Structures (250712)

General information

School:	ETSECCPB
Departments:	751 - Departament d'Enginyeria Civil i Ambiental
Credits:	5.0 ECTS
Programs:	1140 - MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)
Course:	2015/2016
Course language:	Castellano

Faculty

Responsible faculty: Jesús Miguel Bairán García

Teachers: Alfredo Bernardo Arnedo Pena, Jesús Miguel Bairán García, Climent Molins Borrell, Eva Maria Oller Ibars, Luca Pela, Pedro Roca Fabregat

Generic objectives

Subject to learn how to design and conceive structures in environments of high seismicity

Capability to acquire knowledge and skills for the project and design of building structures, bridges and other public structures in civil engineering in high seismic areas

Knowledge about seismic behaviour of different structures systems: concrete, steel and masonry structures under seismic loads. Advanced methods for seismic assessment of existing structures and for optimization of new designs. Apply design procedures based on performance through methods based on displacement and damage control. Desing seismic repairs and retrofitting structures ..

Acquire knowledge and skills for the analysis and design of building, bridges and other civil engineering structures in areas of high seismic risk. To understand the seismic behaviour of different structural systems made of concrete, steel and masonry. To know methods for the assessment of existing structures and optimization of new designs. To apply procedures of performance-based-design through displacement-based and damage control methods. To design seismic retrofit.

Skills

Specific skills

To conceive and design civil and building structures that are safe, durable, functional and integrated into its surroundings.

Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum,

shape memory alloys?).

To evaluate, maintain, repair and strengthen existing structures, including the historic and artistic heritage.

To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

Generic skills of subject

To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.

To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.

To define construction processes and methods of organization and management of projects and works.

ECTS credits: total hours of student work

		Dedication	
		Hours	**Percent**
Supervised Learning	**Theory**	32.00	71.1%
	Assignments	7.00	15.6%
	Laboratory	6.00	13.3%
	Supervised activities	0.00	0.0%
Self-Learning		105.00	

Contents

Basis of structural dynamics

Dedication

3.0h. Theory + 1.0h. Assignments

Description

Review concepts of MDOF and SDOF systems. Concept and types of damping. Harmonic, impulsive and general loads. MDOF methods. Generalized coordinates. Modal decomposition. Modal and spectral analysis. Step by step solutions. Examples and exercise.

Examples and exercises

Seismic action and structural effects

Dedication

7.0h. Theory + 2.0h. Laboratory

Description

Origin of earthquakes. Characteristics of the seismic signal. Definition of action. Histogram, spectra, spectra relationship between acceleration, velocity and displacement. Earthquake source near and far. Spectrum floor concept and calculation.

Practical work or simulation Lab

Design criteria for capacity. Existing structures. Fabrica armed, manufactures confined

Nonlinear modeling of structures. Damage assessment: drifts, pastic rotations damage index. Incremental Dynamic Analysis (IDA). Selection and scaling accelerograms. Push-over methods. Capacity spectrum. Methods ATC-40 and N2. Exercises.

Training

Seismic behavior of structures and design philosophy

Dedication

3.0h. Theory + 1.0h. Assignments

Description

Ductility. Nonlinear behavior. Plastic and plastic hinge length, Moment-curvature and Moment-rotation diagrams. Concept of equivalent damping. Typical seismic damage in differnet tructures. Performance based design. Return periods. Capacity design. Force-based design. Displacement-based-design.

Training

Seismic design of buildings

Dedication

2.0h. Theory + 1.0h. Assignments + 1.0h. Laboratory

Description

Seismic performance of buildings. Concept of rigid diaphragm. Centers of mass and stiffness. Conceptual design (structural elements organization). Structural systems for buildings.

Exercise.

Seismic design of concrete structures

Dedication

5.0h. Theory + 1.0h. Assignments + 1.0h. Laboratory

Description

Materials behavior in cyclic loading. Confinement. Ductility levels. Frames: Concept of column-strong beam-weak. Beams, columns, joints. Second order effects. Walls: slender, short coupled. Coupling beams. Difragmas rigid design. Prefabrication in seismic areas. Exercises.

Training

Seismic design of steel structures

Dedication

3.0h. Theory + 1.0h. Assignments

Description

Sections features and elements. Design systems porches. Ductile connections. Concentric and eccentric systems frameworks. Training

Training

Facilities and non-structural elements

Dedication

2.0h. Theory

Description

Heavy installations. Not estrucuturales elements. Sensitive installations. Requirements and requests.

Foundations and retaining walls

Dedication

3.0h. Theory + 1.0h. Assignments

Description

Design criteria for capacity. Dynamic thrusts. Soil-structure-interaction. Project foundations. Project of retaining walls.

Training

Seismic design of bridges

Dedication

3.0h. Theory + 1.0h. Assignments

Description

Seismic behavior of bridges. Design criteria. Second order effects in stacks. Soil-structure interaction. Spatial variability of the seismic action. Structural modelling of bridges. Deck joints. Design of piers. Design of bearings.

Traingin and simulation

Retrofitting techniques

Dedication

1.0h. Theory

Description

Strengthening methods. Improved strength, stiffness or ductility. Concrete enlargement. Use of metal and FRP laminated plates. Failure modes. Foundations strengthening. Examples

Tests

Dedication

2.0h. Laboratory

Activities

Grading rules (*)

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The course will be assessed continuously by performing work deliverables and seminars (approximately 2 papers and 2 seminars will be held) and a written test at the end of the course.

The course grade will be computed as follows:

40% exercises and practical work.

20% coursework

40% written test.

The minimum mark to pass the course is 5 over 10.

Test rules

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Teaching methodology

The course consists of 3 hours lectures per week during one semester, where concepts are discussed together with problems, exercises and other supervised activities.

Along the course, the students will perform deliverable coursework or seminars. The students will require approximately 60 hours of personal work along the semester for personal study and development of deliverable work.

Classes may be complemented with laboratory practices (physical or virtual simulation of tests) and visits to the Structural Technology Laboratory of the UPC to assist to experimental testing, according to availability.

Support material will be available through ATENEA, as the guide of the course, the lectures programed schedule, content, evaluation, supervised activities material, bibliography and other support material.

Office hours

Thursday from 10:00 to 12:00. Office: C1-201

Basic bibliography

- T Paulay and MJN Priestley. **Seismic design of reinforced concrete and masonry buildings** . Wiley. 1992. ISBN 978-0-471-54915-4.

- MJN Priestley, F Seible, M Calvi. **Seismic design and retrofit of bridges**. Wiley. 1996. ISBN 978-0-471-57998-4.
- Y Bozorgnia, V Bertero (Eds). **Earthquake engineering. From engineering seismology to performance-based design.**. CRC Press. 2004. ISBN 0-8493-1439-9.
- NM Newmark, F Rosemblueth. **Fundamentos de ingeniería sísmica**. Diana. 1982. ISBN 968-13-0408-X.

Complementary bibliography

- R. Park y T. Paulay. **Estructuras de hormigón reforzado**. John Wiley and Sons, Inc.. 1994. ISBN 968-18-0100-8.
- L. Petrini, R. Pinho, G.M. Calvi. **Criteri de progettazione antisismica**. IUSS Press. 2004.
- J. Moehle. **Seismic design of reinforced concrete buildings**. Mc Graw Hill. 2015. ISBN 978-0-07-183944-0.
- fib. **Displacement-based seismic design of reinforced concrete buildings. fib Bulleting 25.** . fib. 2003.
- fib. **Seismic bridge design and retrofit - structural solutions. fib bulleting 39.**. fib. 2007.
- R Meli. **Diseño Estructural**. Limusa. 1987.
- MJN Priestley, GM Calvi, MJ Kowalsky. **Displacement-based seismic design of structures**. IUSS Press. 2007. ISBN 978-8861980006.
- Mario Paz. **Structural dynamics**. Springer. 1997.
- A Chopra. **Dynamics of structures**. Prentice Hall. 2012.