Performance Based Seismic Design and Assessment of Structures (250727)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)
Course	2024/25

Main teaching language at each group

- Group 10EN2 English (Q2)

Faculty

Responsible Faculty: Jesús Miguel Bairán García
Faculty: Jesús Miguel Bairán García, Juan Murcia Delso, Luca Pela

Objectives of Education

1. Comprensió general per aplicar enfocaments de disseny basats en el rendiment en el context de perills sísmics i altres.
2. Comprendre els fonaments de les incerteses i els mètodes per avaluar la fiabilitat estructural.
3. Definir els objectius de rendiment en els projectes de disseny i la seva quantificació.
4. Comprendre el comportament i el disseny d'edificis i ponts davant terratrèmols i altres accions extremes per mitigar els danys.
5. Avaluació del rendiment de les estructures mitjançant models adequats i realistes.
6. Comprendre i quantificar les conseqüències dels danys.1. Comprensión general para aplicar enfoques de diseño basados en el desempeño en el contexto de peligros sísmicos y de otro tipo.
2. Comprender los fundamentos de las incertidumbres y los métodos para evaluar la confiabilidad estructural.
3. Definir los objetivos de rendimiento previstos en los proyectos de diseño y su cuantificación.
4. Comprender el comportamiento y diseño de edificios y puentes ante sismos y otras acciones extremas para mitigar daños.
5. Evaluación del desempeño de estructuras utilizando modelos adecuados y realistas.
6. Comprender y cuantificar las consecuencias del daño.1. General understanding to apply performance-based design approaches in the context of seismic and other hazards.
2. Understand the fundamentals of uncertainties and methods to assess structural reliability.
3. Define target performance objectives in design projects and their quantification.
4. Understand the behaviour and design of buildings and bridges under earthquakes and other extreme actions for mitigating damage.
5. Performance assessment of structures using adequate and realistic models.
6. Understand and quantify the consequences of damage.

Competencies

Especific

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

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.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	25.5 h	56.67 %
	Medium group	9.75 h	21.67 %
	Laboratory classes	9.75 h	21.67 %
	Guided Activities	0.0 h	0.00 %
Self Study		80.0 h	

Contents

Introduction

Introduction

Fundamentals aspects

Basis of structural dynamics
Basis of structural dynamics
Basis of probability and random processes
Basis of probability and random processes
Structural reliability
Structural reliability

Performance engineering framework

Performance objectives
Consequence and damage measures

Hazard and actions

Hazard and actions

Structural behaviour under seismic and extreme actions

Structural behaviour under seismic and extreme actions

Design methods

Design methods based on forces, displacement, energy and damage control.
Design methods

Performance assessment through non-linear models

Performance assessment through non-linear models
Workshop non-linear assessment

Seismic devices

Seismic devices
Seismic devices

Tests

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.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

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:
60% Exercises and coursework.
40% Exam

The minimum mark to pass 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.

Office Hours

Office hours will be informed at the beginning of the course and posted on ATENEA.

Bibliography

Basic

- Bozorgnia, V.; Bertero, V.V. (eds.). Earthquake engineering: from engineering seismology to performance-based engineering. Boca Raton: CRC Press, 2004. ISBN 0849314399.
- Paulay, T.; Priestley, M.J.N. Seismic design of reinforced concrete and masonry buildings. New York: Wiley & Sons, 1992. ISBN 0471549150.
- CEN. EN 1998-1. Eurocode 8: Design of structures for earthquake resistance. Parts 1: General rules. Brussles: European Committee for Standarization, 2011.
- CEN. EN 1998-2. Eurocode 8: Design of structures for earthquake resistance. Parts 2: Bridges. Brussles: European Committee for Standarization, 2012.

- Seismic bridge design and retrofit - Structural solutions. Lausanne, Switzerland: Federation Internationale du beton, 2007. ISBN 9782883940796.

Complementary

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- Priestley, M.J.N.; Calvi, G.M.; Kowalsky, M.J. Displacement-based seismic design of structures. Pavia: IUSS Press, 2018. ISBN 978-8885701052.
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- Park, R.; Paulay, T. Estructuras de concreto reforzado. México D.F: Limusa, 1979. ISBN 9681801008.
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- CEN. EN 1998-5. Eurocode 8: Design of structures for earthquake resistance. Parts 5: Foundations, retaining structures and geotechnical aspects. Brussles: European Committee for Standarization, 2011.
- Rosenblueth, E.; Newmark, N.M. Fundamentos de ingeniería sísmica. México: Diana, 1976. ISBN 968130408X.
- Der Kiureghian, A. Structural and system reliability. Cambridge University Press, 2022.
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