Non-Linear Analysis and Behaviour of Concrete Structures (250707)

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, Noemí Duarte Gómez, Antonio Ricardo Mari Bernat, Juan Murcia Delso, Eva Maria Oller Ibars

Objectives of Education

Subject to deepen the nonlinear phenomena and their effects in reinforced and prestressed concrete structures

Deepening in the nonlinear phenomena of concrete structures . Capability to evaluate the influence of these mechanisms in their design and calculation .

Causes of nonlinearity in concrete structures. Instantaneous and long-term behaviour of materials. Rheological models. Sectional analysis. Moment-curvature diagram. Nonlinear analysis strategies: incremental and iterative calculations. Newton-Raphson and Modified Newton-Raphson methods. Nonlinear analysis of 1D structures. Finite element method. Introduction to prestressing. Generalized matrix method. Analysis of evolutive construction processes. Two-dimensional elements. Concrete biaxial constitutive equations. Simulation of cracking and tension-stiffening .

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
Introduction

Solution methods

Solution methods
Solution methods

Uniaxial behaivour

Uniaxial material behaviour
Uniaxial material behaviour

Frame element models

Frame elements models
Frame elements models

Multiaxial behaviour

Multiaxial material behaviour
Multiaxial material behaviour

Multiaxial models and applications

2D and 3D models and applications
2D and 3D models and applications

Safety assessment

Safety assessment

Seminars and workshops

Workshops and seminars

Assessment

Teaching Methodology

The course consists of 2,3 hours per week of classroom activity (large size group) and 0,3 hours weekly with half the students (medium size group).

The 2,3 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 0,3 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

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 assessment of the course is continuous consisting of homework, a workshop and a final exam. The grade of the course (G) is computed as follows:
G= 0.6 A + 0.4 E
where A is the average grade of activities carried out during the course (homework and workshop) and E is the grade in the final exam.

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

After class (Tuesdays at 19 pm), 45 minutes

Bibliography

Basic

- Bairan, J.M. Class notes of Non-linear analysis and behaviour of concrete structures.

Complementary

- Marí, A.R. Nonlinear geometric, material and time dependent analysis of three dimensional reinforced and prestressed concrete frames. Berkeley, CA: Division of Structural Engineering and Structural Mechanics, Department of Civil Engineering, University of California, Berkeley, 1984.
- Bairán, J.M. A Non-linear coupled model for the analysis of reinforced concrete sections under bending, shear torsion and axial forces. Barcelona: UPC, 2011.
- Van Mier, J.G.M. Fracture processes of concrete : assessment of material parameters for fracture models. Boca Raton: CRC Press, 1997. ISBN 0849391237.
- Ferreira, D., Bairán, J., Marí, A. Numerical simulation of shear-strengthened RC beams. ELSEVIER, 2013.
- Haussler-Combe, U. Computational methods for reinforced concrete structures. Wiley, 2015.
- Bazant, Z.P. Mathematical modeling of creep and shrinkage of concrete. Wiley, 1988.
- Chen, W.F. Plasticity in reinforced concrete. McGraw-Hill, 1982.
- Nilsen, M.P., Hoang, L. Limit analysis and concrete plasticity. Taylor and Francis. 2016.
- Lemaitre, J. A course on damage mechanics. Springer,
- Crisfield, M.A. Non-linear finite element analysis of solids and structures. Wiley,

- Bairán, J.M, Marí, A. Multiaxial-coupled analysis of RC sections subjected to combined forces. ELSEVIER, 2007.