Course guide
250470 - ESTREDIF - Building Structures

Last modified: 03/10/2023

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Optional subject). MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: PEDRO ROCA FABREGAT

Others: ANASTASIOS DROUGKAS, LARISA GARCIA-RAMONDA ESTEVEZ, LUCA PELA, PEDRO ROCA FABREGAT, MIQUEL RODRIGUEZ NIEDENFÜHR

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
8162. Knowledge of all kinds of structures and materials and the ability to design, execute and maintain structures and buildings for civil works.
8228. Knowledge of and competence in the application of advanced structural design and calculations for structural analysis, based on knowledge and understanding of forces and their application to civil engineering structures. The ability to assess structural integrity.

Transversal:
8559. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
8560. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

8561. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

TEACHING METHODOLOGY

The course consists of 1,8 hours per week of classroom activity (large size group) and 0,8 hours weekly with half the students (medium size group).

The 1,8 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 0,8 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.

LEARNING OBJECTIVES OF THE SUBJECT

Specialization subject in which knowledge on specific competences is intensified.

Knowledge and skills at specialization level that permit the development and application of techniques and methodologies at advanced level.

Contents of specialization at master level related to research or innovation in the field of engineering.

Specialty subject in which knowledge in specific skills is intensified. Knowledge at the level of specialization that must allow the development and application of techniques and methodologies at an advanced level. Master's level specialization contents related to research or innovation in the field of engineering.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	9,8	7.83
Self study	80,0	63.95
Hours large group	25,5	20.38
Hours small group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

Functions and systems of the building

Description:
Functions relating to building stability, protection and conditioning. Analysis of the subsystems. Relationship between subsystems and functions. Introduction to the protective system. Elements of the exterior of the building envelope (walls and roof) and specific functions. The compartmentalization of the interior spaces. Coatings. Devices to regulate. Introduction to system facilities and equipment. General layout of a network and differentiation between individual or centralized systems. General scheme of evacuation network. Introduction to the main facilities. Introduction to the structural system. Basic conditions that the structure must satisfy. Fundamental structural elements. Global View of the resistance mechanisms of actions against vertical and horizontal.

Specific objectives:
Knowledge of the functions, elements and systems that make up the building. Knowledge of structural systems and subsystems to the horizontal and vertical actions, and the main elements involved.

Full-or-part-time: 7h 11m
Theory classes: 3h
Self study : 4h 11m

Structural system: floor slabs

Description:
Fundamental types of concrete slabs. Analysis of resistant characteristics with constructive aspects, specific types and common uses. Elements of composite slabs and conditions to be fulfilled. Geometric conditions required. Methods based on the distribution of plastic moments. Concept deformation and check the active deformation. Construction details eg supports, types of support elements. General lay-out of the reinforcement.
Presentation on the practical process of designing and verifying of a complete one way composite slab.
General types and range of use in terms of span and loading. Approach the method of virtual frames. Edge beams: important features and criteria for sizing. General criteria for reinforced two-way slabs. Punching: description of the mechanism of failure..
Presentation of the process on the practical design and verification of a two-way slab.
Composite steel and concrete slabs: basic characteristics. Types. Major structural possibilities and applications. Strength analysis. Details for the improvement of acoustic and fire behavior. Calculation of basic criteria. Construction details.
Presentation of an example of sizing of a composite slab.
Capacity and construction advantages of the use of post-tensioned slabs. Types of post-tensioned slabs. Design and analysis post-tensioned slabs. Specific technology for post-tensioned slabs of buildings. Solutions and specific construction details.
Presentation of the process on the practical design and verification of a post-tensioned slab.

Specific objectives:
Knowledge of the types of slabs of reinforced concrete or prestressed concrete. Familiarization with the criteria and the calculation process in service and ultimate conditions. Knowledge of detailng.
Practical demonstration of the design process and verification of a one way composite slab.
Knowledge of the types of two-way reinforced concrete slabs. Presentation of the criteria and verification process in service and ultimate conditions. Knowledge of construction details. Analysis of the resistance to punching of column slab connections.
Practical demonstration of the design process and verification of a two-way slab.
Knowledge of the main characteristics and applications of composite slabs of steel or timber and concrete. Structural analysis and sizing.
Knowledge of the process of sizing of a composite slab.
Knowledge of the advantages of ppost-tensioned in the formation of slabs for buildings. Design of post-tensioned slabs for buildings. Knowledge of technological aspects and construction.
Practical demonstration of the design process and verification of a post-tensioned slab.

Full-or-part-time: 28h 47m
Theory classes: 8h
Practical classes: 4h
Self study : 16h 47m

Building physics

Description:
The envelope of the building with different systems of closures and roofs with a combination of materials and thicknesses is studied. In particular, the energetic behavior is studied from the review of key concpetes of thermodynamics. Analysis of the thermal resistance of walls and roofs and their hygrometric behavior. Prescriptions on such elements.
Thermal behavior example
Nature and effects of the action of fire. Levels of activity before the occurrence of fires. Characterization of the action "fire" and the response of buildings and their elements. Effects and response to fire of different materials and structural elements. Presentation of the protective conditions. General and simplified methods for testing the fire resistance of structures. Treatment and prescriptions set out in regulations. Retardant coatings. Division in the building sector and analysis of the conditions of evacuation of the building in case of fire
Practice developed in the classroom on the practical implementation of methods and normative criteria related to the verification of the fire resistance of structural elements of the building.

Specific objectives:
Review the basics of thermodynamics to study the energy performance of edificis.Capacity to apply different types of enclosures and covers for buildings.knowledge of the code requirements and checkings. Analyze the energy performance of buildings. Understanding the effects of fires in buildings and levels and solutions that are applicable for protection. Knowledge of the behavior of various structural materials resistant to fire. Presentation of the basic techniques of analysis of the buildings before the fire. Approach the conditions and requirements avacuació derived for the design of the building.
Demonstration of practical application of concepts and methods related to verification of the fire resistance of the structure of buildings.

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Structural system: lateral stability

Description:
Characteristics of horizontal wind and earthquake actions and impact on the building. Basic behavior of structural systems against horizontal actions: building with wall systems and buildings with frame structure. Stiffening by walls and cores. Nonsway systems provided by cross steel ties and reinforeced concrete walls. Problems arising from the interaction between frames and walls. Provision of walls and cores in plant. Characteristics of work and criteria for the calculation of cores. Special solutions for tall buildings. Coupled walls. Stiffenning beams. Megaframes. Outer tubes. Tube in tube solutions. Analysis system consisting of simple walls constant in height.
Practical application of methods for analysis of building systems horizontally braced through simple RC walls. Determination of center of torsion of the plant structure and distribution of the forces between the different walls.

Specific objectives:
Discussion of the behavior of buildings against horizontal actions. Knowledge of various specific solutions to improve the capacity of the building facing horizontal actions and their use depending on the height of the building. Methods for calculating the structural system to horizontal actions
Knowledge and practical application of available methods for the analysis of structural systems based on simple walls of constant height. Analysis of the efficiency of different systems depending on the geometrical arrangement of the walls.

Full-or-part-time: 14h 23m
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 1h
Self study : 8h 23m

Earthquake resistant design of buildings

Description:
Characteristics of the seismic action. Effects of earthquakes on buildings. Definition and importance of ductility of structures. Considerations on the seismic behavior of concrete constructions, metal and composite walls and masonry. Conception and design of buildings in seismic zone. Construction details specific beams, pillars, frame connections, walls and concrete slabs. Seismic failures. Seismic isolation. Application of regulations. Analysis of the seismic action.
Determination of the seismic action to be considered for the design and verification of a resistant building located in a certain area of seismicity. Determination of the seismic acceleration calculation based on the seismic zone, importance of building and ground. Determination of equivalent static seismic forces and the forces generated in the structure of the building. Selection of appropriate construction details.

Specific objectives:
Knowledge of the effects of earthquakes on structures and aspects to consider when designing a building earthquake resistant.
Ability to check the earthquake resistance of a building structure.
Demonstration of the practical application of the current earthquake resistant regulations for determining the seismic action to be considered in designing a building.

Full-or-part-time: 21h 36m
Theory classes: 6h
Practical classes: 3h
Self study : 12h 36m

Special Buildings

Description:
In tall buildings and in buildings with some aspects that are unimportant in conventional buildings, acquire great importance. Such aspects as: the effect of natural frequencies of vibration on the dynamic behavior under the action of wind on tall buildings, importance of vertical transport, structural systems for buildings of great light and its main application.

Specific objectives:
Knowledge of the specific aspects of tall buildings or high light, which are different from conventional buildings.

Full-or-part-time: 7h 11m
Practical classes: 2h
Laboratory classes: 1h
Self study : 4h 11m

GRADING SYSTEM

The grade for the course is obtained from the continuous assessment grades to be carried out in the classroom and those corresponding to the assignments to be carried out by the student outside the classroom.

The exams include a series of questions on concepts associated with the learning objectives of the subject in terms of knowledge or understanding. Exams may also include application exercises. In total, 2 exams are planned. These exams consist of a series of questions about concepts related to the different topics of the course.

On the other hand, the student must solve and hand in a set of evaluable practical exercises related to the practical application of the concepts associated with different topics or blocks of the course. These exercises are part of the directed and evaluable activities to be carried out outside the classroom. It is expected that the student must solve and deliver about 4 exercises (or activities) of this type. The delivery of all these exercises is mandatory.

The grade for the course (N) results from the following calculation: N = 0.25 P + 0.40 A + 0.35 E where P is the grade of the partial evaluation test carried out in the classroom, A is the average grade of the directed activities (or exercises) to be carried out outside the classroom and E is the grade obtained in the comprehensive test N, P, A and E are evaluated on a scale from 0 to 10. To pass the subject, the student must obtain a grade N equal to or greater than 5.0.

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:

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- Marí, A.R.; Molins, C.; Bairán, J.M.; Oller, E. Formigó armat i pretensat: exercicis curts de bases de càlcul i estats límits, adaptat a la Instrucció EHE-08. 2a ed. Barcelona: Edicions UPC, 2009. ISBN 978-84-9880-390-7.
- Bozzo, L.M., Barbat, A.H. Diseño sismorresistente de edificios: técnicas convencionales y avanzadas. Barcelona: Reverté, 1999. ISBN 8429120114.
- Ministerio de Fomento, Secretaría General Técnica. EHE-08: instrucción de Hormigón Estructural: con comentarios de los miembros de la Comisión Permanente del Hormigón [on line]. Madrid, 2008 [Consultation: 27/01/2020]. Available on: http://www.ponderosa.es/docs/Norma-EHE-08.pdf. ISBN 9788449808999.
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