250242 - EDIFPREF - Building Construction and Prefabrication

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN PUBLIC WORKS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 7,5
Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: PEDRO ROCA FABREGAT
Others: CLIMENT MOLINS BORRELL, LUCA PELA, PEDRO ROCA FABREGAT, VICENTE VILLALBA HERRERO

Degree competences to which the subject contributes

Specific:
3079. Knowledge of the different types and basis for calculating prefabricated items and its application to the manufacturing processes
3080. Knowledge of the design, calculation, construction and maintenance of building works in regard to their structure, finishes, installations and equipment.
3085. Ability to construct geotechnical works

General:
3105. Students will learn to identify, formulate and solve a range of engineering problems. They will be expected to show initiative in interpreting and solving specific civil engineering problems and to demonstrate creativity and decision-making skills. Finally, students will develop creative and systematic strategies for analysing and solving problems.
3106. Students will learn to assess the complexity of the problems examined in the different subject areas, identify the key elements of the problem statement, and select the appropriate strategy for solving it. Once they have chosen a strategy, they will apply it and, if the desired solution is not reached, determine whether modifications are required. Students will use a range of methods and tools to determine whether their solution is correct or, at the very least, appropriate to the problem in question. More generally, students will be encouraged to consider the importance of creativity in science and technology.
3107. Students will learn to identify, model and analyse problems from open situations, consider alternative strategies for solving them, select the most appropriate solution on the basis of reasoned criteria, and consider a range of methods for validating their results. More generally, students will learn to work confidently with complex systems and to identify the interactions between their components.
3111. Students will learn to plan, design, manage and maintain systems suitable for use in civil engineering. They will develop a systematic approach to the complete life-cycle of a civil engineering infrastructure, system or service, which includes drafting and finalising project plans, identifying the basic materials and technologies required, making decisions, managing the different project activities, performing measurements, calculations and assessments, ensuring compliance with specifications, regulations and compulsory standards, evaluating the social and environmental impact of the processes and techniques used, and conducting economic analyses of human and material resources.
3112. Students will develop an understanding of the different functions of engineering, the processes involved in the life-cycle of a construction project, process or service, and the importance of systematising the design process. They will learn to identify and interpret the stages in preparing a product design specification (PDS), draft and optimise specifications and planning documents, and apply a systematic design process to the implementation and operation phases. Students will learn to write progress reports for a design process, use a range of project management tools and prepare final reports, and will be expected to show an awareness of the basic economic concepts associated with the product, process or service in question.
3113. Students will learn to identify user requirements, to draft definitions and specifications of the product, process
or service in question, including a product design specification (PDS) document, and to follow industry-standard design management models. Students will be expected to show advanced knowledge of the steps involved in the design, execution and operation phases and to use the knowledge and tools covered in each subject area to the design and execution of their own projects. Finally, students will assess the impact of national, European and international legislation applicable to engineering projects.

Transversal:

586. ENTREPRENEURSHIP AND INNOVATION - Level 2. Taking initiatives that give rise to opportunities and to new products and solutions, doing so with a vision of process implementation and market understanding, and involving others in projects that have to be carried out.
589. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
594. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
584. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Teaching methodology

The course consists of 5 hours per week of presential teaching. This hours are devoted to:
(1) Lecturing on theoretical subjects, where the teacher presents the concepts and materials of the course. This aspect represents about 65% of the classroom time.
(2) Detailed presentation and discussion of practical exercises (20% of time)
(3) Evaluation including tests and practical exercises to be solved by the student (15% of time).

In addition, the student has to develop a certain number of practical assignments on different subjects of the course.

A technical visit concerning the contents of the course is also envisaged.

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.

Learning objectives of the subject

Students will acquire an understanding of the planning, calculation, construction and maintenance of buildings in terms of structure, foundation structures, finishes, installations and facilities. They will also learn about the various types of prefabricated elements, the bases for calculating them, and their application in the construction process.

Civil construction pathway

Elements and systems of a building; Concept of building; Functions and conditions; Subsystems; Introduction to protective systems (building envelopes and finishes); Introduction to installation systems and equipment; Introduction to the structural system; Global analysis and interaction between subsystems; General considerations regarding sustainability and building life-cycle analysis; Building physics; Interior and exterior environment; Thermal and hygroscopic conditioning factors; Saving energy; Acoustic insulation; Conditioning factors for lighting; Natural lighting; Protection against fire; Building protection; General considerations regarding building exteriors; Façades; Roofs; Other elements; Electrical installations; Artificial lighting; Hydraulic installations, sanitation, and rainwater and sewage disposal; Climate control; Other installations; Building structure; Basic load-bearing elements; Gravitational forces in buildings; Major types of building slabs; One-way concrete framing systems; Two-way concrete framing systems; Metal and mixed framing systems; Load-bearing masonry walls; Building foundations; Building structure II; Stability and lateral stiffening; Characteristics of horizontal forces and their effect on buildings; Behaviour of basic types of structures under horizontal forces; Lateral stiffening by means of walls and cores; Special solutions for very tall buildings; Techniques for analysing...
buildings under horizontal forces; Building structure III: General details of construction; Details of construction in special elements and areas; Formation of construction joints, expansion joints and settlement; Special cases: very tall buildings, highly illuminated buildings, buildings in areas of seismic activity.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Theory classes: 51h</th>
<th>27.20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical classes:</td>
<td>15h</td>
<td>8.00%</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>9h</td>
<td>4.80%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>7h 30m</td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>105h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Content

### THE BUILDING AND ITS SUBSYSTEMS

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 19h 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functions of a building concerning stability, protection and conditioning. Analysis of the subsystems.</td>
<td>Theory classes: 7h</td>
</tr>
<tr>
<td>Introduction to the protective system. Elements of a building envelope (façades and roofs) and specific functions. The partition of interior space. Coatings. Control devices.</td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Introduction to the installation systems. General outline of a supply installation and differentiation between centralized and individual networks. General outline of an evacuation installation. Introduction to the main installation in the building.</td>
<td>Self study: 11h 12m</td>
</tr>
<tr>
<td>Introduction to the structural system. Basic requirements to be satisfied by the structure. Fundamental structural elements. Global resisting mechanisms against vertical and horizontal actions. Main structure types.</td>
<td></td>
</tr>
<tr>
<td>Analysis of the interaction between subsystems. Conditions introduced by the protective system and the installations on the structure. Acceptable impact on the different structural elements (slabs, beams and pillars).</td>
<td></td>
</tr>
<tr>
<td>General considerations on maintenance and life cycle of the building.</td>
<td></td>
</tr>
</tbody>
</table>

### Specific objectives:

Knowledge of the functions, elements and systems that make up the building.

Analysis of the problems arising from the interaction between the different subsystems (closures, installations and structure) and the main solutions for their optimal combination in the building.

Knowledge of basic aspects of the life cycle of the building.
PHYSICS OF THE BUILDING

Learning time: 26h 24m
- Theory classes: 8h
- Practical classes: 3h
- Self study: 15h 24m

Description:
The interior environment. Characteristics and common values of environmental parameters in the interior of buildings. Effect of seasonal variation of climatic agents.


Practical exercise solved in the classroom on the thermal behavior and possible water vapor condensation in an interior environment.


Division of the building into sectors and analysis of the conditions of evacuation in case of fire.

Exercise presented in the classroom on the practical implementation of methods and criteria given by current regulations for the verification of the fire resistance of structural members of the building.


Specific objectives:
Knowledge of the characteristics and parameters of the indoor environment of buildings.

Analysis of thermal conditions and thermal insulation of the building. Presentation thermal insulation elements materials and construction elements.

Analysis of the hygrothermal behavior of the building and the possible production of water vapor condensation.

Practical application of the concepts and the theoretical formulation concerning the verification of thermal conditions and condensation of water vapor.

Knowledge of the effects of fires in buildings and levels and solutions that are applicable for protection.

Knowledge of the behavior of various structural materials when subjected to fire. Presentation of the basic techniques for the analysis of the fire response of building structures.

Presentation of the conditions and requirements for evacuation in case of fire and the resulting requirements for the the design of the buildings.

Demonstration of the practical application of concepts and methods for the fire resistance verification of the structure of buildings.

Knowledge of the acoustic behavior of buildings and solutions to improve privacy and comfort levels. Approach the problem from the physical point of view. Compliance with current regulations and familiarity with solutions for improvement.
THE PROTECTIVE SYSTEM

Description:
General considerations on the exterior of the building envelope. Morphology and function of the outer envelope. Order of envelopes and contact between resistant and protective layers. Problems related to the contact between the envelopes: incompatibilities and formation of thermal bridges.


Roofs. Functions and specific problems. Geometric and watertight solutions. Type, geometry and materials requirements. Differentiation between hot and cold deck solutions.

Partitions walls. Functions and specific problems. Masonry wall partitions. In each case, conditions of use and stability.

Specific objectives:
Understanding of the problems resulting from the contact between the structural and protective layers. Presentation of the problems of conventional solutions proposal of alternative and optimal solutions.

Presentation of the main types of solutions for façades, roofs and partitions, with their advantages and disadvantages.
### Structural Elements

<table>
<thead>
<tr>
<th>Learning time: 72h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theory classes:</strong> 21h</td>
</tr>
<tr>
<td><strong>Practical classes:</strong> 7h</td>
</tr>
<tr>
<td><strong>Laboratory classes:</strong> 2h</td>
</tr>
<tr>
<td><strong>Self study:</strong> 42h</td>
</tr>
</tbody>
</table>

#### Description:

- Nature of different types of dead loading. Gravitational live loads.
- Fundamental types of one-way slabs, including ceramic, wood, steel, composite and reinforced or prestressed concrete ones. Devices used to enhance the floor slab monolithism and its connection to the rest of the structure (compression topping and edge beams).
- Main concrete slabs types. Analysis of resistant features along with constructive aspects. Elements that compose concrete floor-slabs and conditions to be met. Geometric conditions required.
- Analysis and verification. Methods based on plastic redistribution. Concept of active deflection and deformability verification. Construction details for the supports of floor-slabs on various types of vertical structural members.
- Detailed presentation in classroom of the practical design and verification process of a one-way floor slab. General type and range of use depending on span and overload. Specific aspects of strength response. Method of the virtual frame. Edge beams: importance, functions and design criteria. General criteria reinforcement detailing. Punching: description and verification of the resisting mechanism. Punching reinforcement.
- Detailed presentation in classroom of the process leading to the practical design and verification of two-way slab. Construction and resistant advantages of post-tensioned floor slabs. Post-tensioned floor-slab types. Specific technological issues. Specific construction details and solutions. Introduction to the design.
- Introduction to the foundations of the building. Main elements and structural types. Design of footings and foundation slabs. Use and design of centering and tying beams on footings and pilea. Use and design of basement containment walls. Specific construction details.
- Detailed presentation in the classroom of the practical application of the criteria and methods relating to resistant design and testing of structural elements of building shallow foundations.
- Introduction to deep foundations of the building. Main members and structural types. Use and design of piles, caps and tying beams. Specific construction details.
- Detailed presentation of the practical application of methods and criteria for the design of building deep foundations.

#### Specific Objectives:
Assessment of the actions likely to act on floor-slabs. Knowledge of various types of floor slabs as well as the devices used to ensure adequate roof-slab monolithism and satisfactory connection to the vertical structure of the building.

Knowledge of the types of reinforced or prestressed concrete floor-slabs. Familiarization with the calculation criteria and process, at both the service and ultimate conditions. Knowledge of construction details.

Practical demonstration of the design process and verification of a one-way floor slab.

Knowledge of the types of two-way reinforced concrete slabs. Introduction of criteria and verification process both in service and ultimate conditions. Presentation of construction details. Analysis of the resistance to shear punching on pillars and presentation of specific reinforcement details.

Practical demonstration of the design and verification process of a two-way floor-slab.

Discussion of the benefits of post-tensioned floor slabs. Presentation of construction and technological specific aspects.

Presentation of the main characteristics and applications of composite slabs.

Presentation of the types of masonry walls and the characteristics of the component materials. Knowledge of basic resisting mechanisms and possible failure modes at the level of small ensamblage, structural element (wall) and entire masonry building.

Presentation of the practical implementation of concepts and methods for verification of a resilient structural system based on bearing walls.

Presentation of specific construction elements and types of building shallow foundations.

Detailed presentation of the practical application of the criteria and methods for the design of structural members for building deep foundations.

Practical demonstration on the design and verification of a building deep foundation.

### Description:
Industrialisation and prefabrication in building construction. Precast concrete as material and as a construction technique. Considerations on manufacturing, transportation and assembly. Main elements and techniques.

Application of precast concrete to civil works. Applications the above-ground structures, foundations, retaining walls, pipes and others.

Application to prefabricated buildings. Construction elements for buildings. Skeletal structural systems, large panels systems and systems composed of three-dimensional cells.

### Specific objectives:
Presentation of precast concrete as a construction material and construction technology. Discussion of the main technological aspects of precast concrete.

Discussion of the main applications of precast concrete structures for the construction of public works and buildings. In each case, presentation the main elements and systems.
# GLOBAL CONSTRUCTION DETAILS

**Description:**

**Specific objectives:**
Discussion on the role and formation of different types of joints in the structure of buildings.

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>4h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
<td>2h 48m</td>
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</tbody>
</table>

# INSTALLATIONS

**Description:**


**Specific objectives:**
Understanding the essential aspects of different types of installations. The session focuses mainly on installations that may affect significantly the structure of the building.

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>9h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>4h</td>
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<tr>
<td>Self study:</td>
<td>5h 36m</td>
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</table>

# OTHER ACTIVITIES

**Description:**

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>14h 23m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical classes:</td>
<td>5h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Self study:</td>
<td>8h 23m</td>
</tr>
</tbody>
</table>

## TECHNICAL VISIT

**Description:**

- Discussion on the role and formation of different types of joints in the structure of buildings.
- Understanding the essential aspects of different types of installations. The session focuses mainly on installations that may affect significantly the structure of the building.
Qualification system

The course grade is obtained through continuous assessment within the classroom by evaluation tests, plus a number of assignments to be developed outside the classroom.

The evaluation tests include a series of questions on concepts associated to the learning objectives of the course, both in terms of knowledge and understanding. These tests may also include application exercises. The tests are developed throughout the course and refer to its various topics or units.

A number of 2 tests of this type are envisaged. These tests consists of a series of questions about concepts related to the various topics of the course.

Furthermore, the student must solve and deliver a number of exercises related to the practical application of concepts on different subjects of the course. These exercises are part of the evaluable activities to be performed outside the classroom. It is expected that the student will have to solve and deliver about 4 assignments of this type. The delivery of these exercises is mandatory.

The grade of the course (N) results from the following calculation:

\[ N = 0.4 \times A + 0.6 \times E \]

where

A is the average rating of the assignments to perform outside the classroom.

E is the grade obtained in final global test

N, A and E are graded in a 0 to 10 scale. The student will pass the subject if the final grade N is equal or larger than 5.0

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

Regulations for carrying out activities

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

The activities or assignments to be performed outside the classroom are mandatory and need to be delivered so that the student can be graded from the course.
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Bibliography

Basic:


Complementary:


