Course guide
250721 - 250721 - Advanced Materials in Construction

Last modified: 28/03/2024

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

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

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

LECTURER

Coordinating lecturer: IGNACIO SEGURA PEREZ

Others: ANTONIO AGUADO DE CEA, ALBERTO DE LA FUENTE ANTEQUERA, EDUARDO GALEOTE MORENO, EVA MARIA OLLER IBARS, IGNACIO SEGURA PEREZ, NIKOLA TOSIC

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13365. Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum, shape memory alloys?).
13367. To apply innovative and sustainable technological aspects in the management and implementation of projects and works.
13370. To analyze the multiple technical and legal conditions arising in the construction of public works, and use proven methods and proven technologies with the aim of achieving greater efficiency in construction while respecting the environment and protecting the safety and health of workers and users of public works.

Generical:
13361. To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.
13362. To define construction processes and methods of organization and management of projects and works.
13363. To design plans for safety, quality and environmental and socioeconomic impacts related to the construction process.

TEACHING METHODOLOGY

The subject consists of 3.0 hours a week of classroom classes (large group). During these classes, the concepts of the subject are explained in a master class format and through case studies. Sessions are complemented on each topic by lectures from industry experts.

In a complementary way, laboratory sessions are held so that students can verify specific aspects of the different subjects taught in the laboratory.

Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of evaluation and directed learning activities and biography.

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

Subject to know the properties of new materials in construction

- Knowledge of building materials associated with certain less standardized building systems . Knowledge of new materials through an integrated approach of the material within the entire construction process (planning, design, execution, operation and reintegration) - Ability to analyze future perspectives in the design of new materials and their possible applications in civil and building construction.

Design of materials under the requirements of the application and the construction technique . Hydraulic base materials: conglomerants , additions , additives , granular skeletons (natural aggregates , artificial , recycled), different kinds of fibers. Special concretes : high flow , high performance , with metal and plastic fibers , shotcrete, self-compacting , light, heavy , in marine environment, under extreme temperatures, prefabricated, translucent. Organic based materials . Nature of organic matrices. Granular structures. Polymeric concrete. Polymers in construction. Metallic high-performance materials : stainless steel, titanium .

The generic objective of the course is to provide students with an overview of different advanced materials used in the civil engineering and construction sector, as well as new materials currently in research and development.

The course seeks to provide basic knowledge about different materials, addressing an integral and transversal vision that considers both the design process and the construction process in its entirety, from the point of view of the different properties and characteristics of the materials studied.

The course begins with the study of different cementitious-based materials (fiber-reinforced concrete, shotcrete, concrete with industrial by-products, other special concretes) to advance to new additive construction techniques (3D concrete printing) and continue with new materials (intelligent concretes with new functionalities) and end with the application of composite materials and FRP in civil engineering

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

Introduction

Description:
Presentation of the subject. Guidance on papers and presentations

Full-or-part-time: 2h 24m
Theory classes: 1h
Self study : 1h 24m

Special concretes

Description:
This session will address aspects related to the use, structural design and properties of fiber-reinforced concrete. The study of different types of fibers (micro and macro fibers, plastic and metallic) will be addressed, also addressing aspects related to durability, regulations and characterization methods.
In this session it will be addressed the use of shotcrete as a support element (secondary or primary) will be addressed. Dosage aspects, additives used, characterization at early and long ages, durability and regulatory aspects will be analyzed.
This session will address aspects related to the use, structural design and properties of selfcompacting concrete and shrinkage compensated concrete
In this session, aspects related to use, dosage, properties and structural design will be addressed using different types of high-performance concrete, with high and ultra-high mechanical resistance.
This session will address the incorporation of different types of industrial by-products to the manufacture of concrete. Among others, the use, dosage, properties and design of concrete using recycled aggregates, iron and steel aggregates and other industrial by-products incorporated as aggregates or as a replacement for cement will be discussed.
This session will address the use, dosage, properties and applications of porous concretes. Special attention will be paid to the characterization methods and the main problems that these materials can present.
Special Concrete Seminars

Full-or-part-time: 36h
Theory classes: 10h
Practical classes: 5h
Self study : 21h

Other advanced materials

Description:
This session will present the development of geopolymer concrete, a material that is beginning to be widely used in the civil engineering sector. This concrete is obtained from the alkaline activation of certain materials or industrial by-products, such as fly ash, blast furnace slag, etc. The precursors to be used as well as aspects of use, dosage, properties and structural design with these materials will be analyzed.
This session will address the use, dosage, manufacture, properties and applications of controlled low resistance materials. This type of materials are very interesting in various applications related to urban engineering
This session will present the most recent advances in relation to additive concrete manufacturing, or 3D printing. The different techniques currently used, aspects related to material dosage, types of materials to be used, mechanical properties, characterization techniques and structural design using this new technology will be studied. Different applications will be seen using this emerging technology.
This session will address a multidisciplinary field of study, for the development of new concretes that address biology - concrete interactions. Aspects related to the design of concretes with improved bioreceptivity will be dealt with, for the manufacture of new types of green facades. The development of materials with biocidal properties for application in hydraulic infrastructures will also be studied.
This session will introduce the new developments made in the development of intelligent and multifunctional concretes. Aspects related to concretes with new properties will be presented, such as self-repair, self-heating, stress and strain sensorization, information transmission or energy generation. Special attention will be paid to the development of intelligent concretes from the incorporation of electrically conductive additions in cementitious matrices.
This session will address the use of FRP for the reinforcement of structures, both new and existing construction. The potential applications, criteria of use as well as aspects of structural design using these materials will be analyzed.
Seminars on other advanced materials
Practical laboratory sessions to address in a practical way the aspects discussed in the theory sessions

Full-or-part-time: 55h 12m
Theory classes: 10h
Practical classes: 5h
Laboratory classes: 8h
Self study : 32h 12m

Final work of the course

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

GRADING SYSTEM

La qualificació de l'assignatura s'obté mitjançant avaluació continuada considerant la realització d'activitats a l'finalitzar cada tema (seminaris), les activitats de laboratori i participació a l'aula i la realització i presentació d'un treball final de l'assignatura.

En relació als seminaris, a l'finalitzar cada tema es penjarà a Atenea un seminari que planteja qüestions relacionades amb el tema tractat i enfocades a l'aplicació en exemples reals d'enginyeria.

Addicionalment, es valorarà la participació de l'alumne durant les classes (preguntes, comentaris, etc.), i les pràctiques de laboratori.

Cada alumne haurà de realitzar un treball final de l'assignatura i presentar-lo a classe, que ha de versar sobre algun dels temes a tractar. El treball ha de realitzar un estudi actualitzat de l'estat de la tècnica en el tema en qüestió i analitzar críticament un cas real d'aplicació.

La qualificació final de l'assignatura és una mitjana ponderada de les diferents activitats indicades.

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:

- Aïtcin, P.-C. High performance concrete. London: E & FN Spon, 1998. ISBN 0419192700.
- Loukili, A. (ed.). Self compacting concrete [on line]. London: ISTE; Wiley, 2011 [Consultation: 28/04/2020]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118602164. ISBN 9781118602164.
- Varios. Sprayed concrete technology. Simon Austin. London [etc.]: E & FN Spon, 1996. ISBN 0419222707.
- Gjorv, O.E.; Sakai, K. (eds.). Concrete technology for a sustainable development in the 21st century. London: E & FN Spon, 2019. ISBN 9780367864088.