

# Construction Materials (250124)

## General Information

<b>School</b>	ETSECCPB
<b>Departments</b>	Departament d'Enginyeria Civil i Ambiental (DECA) Escola Tècnica Superior d'Enginyeria de Camins, Canals i Ports de Barcelona (ETSECCPB)
<b>Credits</b>	6.0 ECTS
<b>Programs</b>	GRAU EN ENGINYERIA CIVIL (pla 2017) GRAU EN ENGINYERIA CIVIL (pla 2010)
<b>Course</b>	2022/23

## Main teaching language at each group

- Group 10Q1 Spanish (Q1)
- Group ENGQ1 English (Q1)

## Faculty

Responsible Faculty: Diego Fernando Aponte Hernández, Miren Etxeberria Larrañaga  
Faculty: Vicente Alegre Heitzmann, Diego Fernando Aponte Hernández, Rolando Antonio Chacón Flores, Miren Etxeberria Larrañaga, Susana Valls Del Barrio

## Objectives of Education

Students will learn to apply knowledge of construction materials in structural systems. They will also develop an understanding of the relationship between the structure of materials and the resultant mechanical properties.

Upon completion of the course, students will have acquired the ability to: 1. Relate the materials used in a construction project to their mechanical and physical properties and to the structural needs of each specific case. 2. Organise and plan an analysis of the properties of the materials used in a construction project, by means of either field tests or laboratory tests. 3. Carry out a life-cycle energy analysis of construction materials.

Data analysis; Regression models, parameter estimation; Probability and uncertainty; Random variables: definition and interpretation; Operations on random variables; Probability models: Bernoulli, Poisson and other distributions; Asymptotic probabilistic models that start with the normal distribution and end with transformations of the normal distribution; Estimation of return period; Parameter estimation, method of maximum likelihood, interval estimation; Hypothesis testing and goodness-of-fit testing; Bayesian estimation and statistical analysis of regression models

## Competencies

### Especific

Ability to apply knowledge of construction materials to structural systems. Knowledge of the relation between the structure of materials and the mechanical properties resulting from them. Understanding of the physico-chemical mechanisms that determine the stages in the lifecycle of construction materials (manufacture, use, elimination and recycling), their durability and their impact on the environment.

### Transversal

**SUSTAINABILITY AND SOCIAL COMMITMENT** - Level 1. Analyzing the world's situation critically and systemically, while taking an interdisciplinary approach to sustainability and adhering to the principles of sustainable human development. Recognizing the social and environmental implications of a particular professional activity.

**EFFICIENT ORAL AND WRITTEN COMMUNICATION** - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.

**EFFECTIVE USE OF INFORMATION RESOURCES** - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

**SELF-DIRECTED LEARNING** - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

## Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	42.0 h	63.64 %
	Medium group	3.0 h	4.55 %
	Laboratory classes	15.0 h	22.73 %
	Guided Activities	6.0 h	9.09 %
Self Study		84.0 h	

## Contents

### Impact and management of building materials

Life cycle and parameters for assessing the environmental impact

Environmental protection of soils and water: leaching study

Environmental protection of soils and water: leaching study

### Mechanical behavior of materials

Basic concepts of fracture mechanics

Fracture mechanics

### Rocks

Quarries. Products for construction. Works in stone. Properties and testing. Alterations of the stone works.

Repairs.

Aggregates for concrete.

Aggregates for bituminous mixtures.

Aggregates

### Concrete

Materials, structure and microstructure

Properties of hardened concrete

Fresh concrete

Production, transportation, placing, compacting and curing

Mix design

Mix design

Mix design

Properties of hardened concrete

Admixtures and additions

Durability. Chemical and physical deterioration of the concrete.

Interpretation and application of EHE for structural concrete

## **Metals**

Steel and castings. SAC. Forming processes. Thermal and mechanical treatments.  
Steel for reinforced and prestressed concrete  
Steels for metallic structures. Carbon steels, stainless steels and other alloy steels.  
Corrosion of steel.  
Nonferrous metals. Copper and copper alloys. Nickel and nickel alloys. Aluminum,

## **Polymers**

The polymers of general interest in construction. Properties, tests and specific regulations.

## **Bituminous mixtures**

Bituminous binders  
Mix design of bituminous mixtures.  
Dosage of bituminous mixtures. Properties and testing of bituminous mixtures  
Manufacturing, extension, compaction and control of bituminous mixtures. Properties and tests of bituminous mixtures.  
Manufacturing, extension, compaction and control of bituminous mixtures

## **Ceramics and glasses**

Glasses: Production, properties and applications in civil engineering. Introduction to ceramics. Manufacture of ceramic products. Properties. Regulations. Defects. Durability.

## **Composite materials**

Organic matrices. Fibers. Properties. Applications in Construction

## **Paints and varnishes**

Paints and varnishes applied in the construction. Tests of paintings and films

## **Wood**

Wood. Structure and properties. Type of wood used in construction. Essays and regulations. Durability.

## **Activities**

### **Environmental impact**

Literature review of the values of energy production, emissions and environmental impact through leaching of building materials.

#### **Dedication**

4h

### **Implementation problems of fracture mechanics**

#### **Dedication**

4h 30m

### **Testing of aggregates.**

#### **Dedication**

5h

### **Report of laboratory activity and technical visit**

**Dedication**

3h

**Interpretation of the recommendations of the EHE**

**Dedication**

2h

**Alloy steel**

**Dedication**

3h

**Welding**

**Dedication**

2h

**Galvanic corrosion: study of real cases.**

**Dedication**

3h

**Non-ferrous metal applications in building**

**Dedication**

4h

**Examen E2**

Exam about the topics: Metals, Polymers, bituminous mixtures, ceramics and glass, composites, paints and wood.

**Dedication**

1h 30m

**Applications of polymers in construction**

**Dedication**

3h

**Report lab bituminous mixtures**

**Dedication**

3h

**Brick walls**

**Dedication**

3h

**Applications of composites in repair and reinforcement**

## Dedication

3h

## Recommendations based on the substrate

### Dedication

2h

## Timber structures

### Dedication

2h

## Classroom activity evaluated E2

Quiz and exercises

### Dedication

1h 30m

## Teaching Methodology

The course consists of: 42 hours of theory classes, 4 hours of troubleshooting and 8 hours laboratory (small group), a technical visit and 4 hours of classroom exam.

It involved 42 hours of lectures (large group), in which the teacher explains the concepts and discusses the questions prepared by students at home.

4 hours are dedicated to solving specific problems of fracture mechanics, and mix design of concrete.

Practical exercises to consolidate learning objectives.

8-hour practices are held at the Materials Laboratory (B1 basement), divided into four sessions:

- \* 2 hours dedicated to the characterization of aggregates.
- \* 2 hours dedicated to the manufacture of concrete and study their properties in the fresh state.
- \* 2 hours dedicated to the study of the properties of hardened concrete.
- \* 2 hours dedicated to the study of bituminous mixtures.

Support materials used in the form of detailed educational plan through the virtual campus ATENEA: content, programming and evaluation activities directed learning and literature.

Although most of the sessions will be given in the language indicated, sessions supported by other invited experts may be held in other languages. The language may change due to force majeure.

## Grading Rules

*(\* The evaluation calendar and grading rules will be approved before the start of the course.*

The mark of the course is obtained from continuous assessment and their corresponding laboratory.

Continuous assessment consist in several activities, both individual and group additive and training characteristics, carried out during the course (both in and out of the classroom)

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions on concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

Grade mark:

$$\text{Grade mark} = 0,75 \times ((E1 + E2) / 2) + 0,25 \times ((P1 + P2 + P3 + P4 + V) / 5)$$

2 Exam: (E1 and E2)

1 Activity: (V)

4 Laboratory practices: (P1, P2, P3 and P4)

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 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.

## 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

Tuesdays from 16:00 to 18:00

## Bibliography

### Basic

- Callister, W.D. [Materials science and engineering: an introduction](#). 10th ed. Reino Unido (Inglaterra): John Wiley & Sons, 2020. ISBN 9781119453918.
- Neville, A.M. [Properties of concrete](#). 5th ed. Reino Unido (Inglaterra): Addison Wesley Longman, 2011. ISBN 9780273755807.
- Fernández Cánovas, M. [Hormigón](#). 9a ed. Madrid: Colegio de Ingenieros Caminos Canales y Puertos. Servicio de Publicaciones, 2011. ISBN 9788438003640.
- Kraemer, C ... [et al]. [Carreteras, vol. 2. Explanaciones, firmes, drenaje, pavimentos](#). Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos, 1999. ISBN 8438001491.
- Collepari, M.; Collepari, S.; Troli, R. [Concrete mix design](#). Villorba: Grafiche Tintoretto, 2007. ISBN 8890146982.
- Smith, M.R.; Collins, L. (eds.). [Aridos: áridos naturales y de machaqueo para la construcción](#). 2a ed. Madrid: Colegio Oficial de Geólogos de España, 1994. ISBN 8492009705.
- Domone, P.; Illston, J.M. [Construction materials: their nature and behaviour](#). 4th ed. London ; New York: Spon Press, 2010. ISBN 9780415465151.

### Complementary

- Bye, G.C. [Portland cement](#). 3rd ed. London: ICE Publishing, 2011. ISBN 9780727736116.