Course guide
250MEA015 - 250MEA015 - Ecomaterials, Recycling and Reuse

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

Degree: MASTER'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2024). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: MIREN ETXEBERRIA LARRAÑAGA

Others: MIREN ETXEBERRIA LARRAÑAGA, LUCIA FERNANDEZ CARRASCO

TEACHING METHODOLOGY

The course consists of 1.5 hours per week of classroom activity (large size group) and 0.8 hours weekly with half the students (medium size group).

The 1.5 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

Acquire advanced knowledge in identification technologies, manufacturing, physical-mechanical characterization, and durability, as well as the environmental impact of traditional and advanced construction materials and waste of different origins (recyclable or reusable) as new resources in construction materials.
- Learn about traditional, ecological and innovative construction materials with a very low carbon footprint.
- Know the recyclability of construction and demolition waste and differet kind of industrial wastes, such as recycled aggregate or secondary resources for sustainable construction materials.
- It has the necessary analysis elements to face the choice of waste recovery through its use in new constructions.
- Know the method of efficient Deconstruction and classification of elements for recovery and reuse.

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

INTRODUCTION

Description:
Provide a vision of the main parameters of the Construction Sector that condition your subsequent sustainability approach.
Detail the objectives of sustainable development (SDG) linked to eco-materials, eco-efficient and sustainable materials.
The description is the introduction of the two parts of the subject. Part 1: ecomaterials and alternatives to current construction materials and ecomaterials workshops and low carbon foundations. Part 2: valorització mitjançant Recycling of construction and demolition waste, industrial waste, industrial by-products and sediments in construction materials. The banks of materials and elements that can be obtained from efficient deconstruction for subsequent recovery and reuse are described.

Specific objectives:
To have a general knowledge of the main parameters of the Construction Sector that determine its subsequent approach to sustainability.
Know the activities linked to the construction materials sector that can influence the sustainable development objectives defined for 2030.
Know the different eco-materials and eco-efficient materials with a low carbon footprint and promote the circular economy.

Full-or-part-time: 5h 33m
Theory classes: 2h
Self study : 3h 33m

ECOMATERIALS AND ALTERNATIVES TO CURRENT CONSTRUCTION MATERIALS

Description:
A historical tour of the uses of traditional materials is carried out: construction with earth, chalk, and lime until reaching the industry and uses of modern cement, as well as an introduction to metal reinforcements.
Introduce the student to the use of traditional and ecological construction materials. The student will study and analyze the use of materials in construction with the objective of minimizing, from a productive point of view, energy consumption and the emission of greenhouse gases into the environment.
The student will have the necessary tools to evaluate by-products of different natures in construction materials.
The use of secondary materials (industrial by-products, etc.) makes new construction materials more sustainable, with less environmental impact. However, it is the responsibility of the industry to ensure that these new materials have similar or adequate physical-mechanical and durability properties for specific applications.
The student will achieve the necessary knowledge in the analysis and management of waste on site
The use of secondary materials (recycled aggregates, industrial by-products, sediments, etc.) make the new construction materials more sustainable, with less environmental impact. However, new construction materials must have similar or better physical-mechanical properties and durability, and they must be eco-efficient.

Specific objectives:
Describe the materials used in construction, from manufacturing to their relationship with their properties.
Introduction to current low carbon footprint cements and their uses.
Introduction to waste and other materials reuse in modern construction material systems. Analysis of properties and applications.
Identify and learn about innovative materials from the point of view of sustainability. Application Examples
to know how to describe the eco-efficiency of construction materials and be able to define the most eco-efficient materials according to their application.

Full-or-part-time: 38h 18m
Theory classes: 7h 50m
Practical classes: 4h 54m
Self study : 25h 34m

WORKSHOP OF ECOMATERIALS AND LOW CARBON FOOTPRINT CEMENTS

Description:
Carry out a concrete analysis project on the use and application of new materials with a lower carbon footprint.

Specific objectives:
Project-based analysis of lower carbon footprint materials to facilitate student learning.
Ability to identify eco-materials and cementitious materials with a low carbon footprint and main applications in the construction sector.

Full-or-part-time: 21h 36m
Theory classes: 3h 55m
Laboratory classes: 4h 54m
Self study : 12h 47m

CONSTRUCTION AND DEMOLITION WASTE (CDW)

Description:
Analysis of obtaining construction and demolition waste (CDW) and its treatment. Description of its on-site and off-site treatment, as well as the typology of existing recycling plants.
Classification of typologies of recycled aggregates produced and their properties. Existing regulations according to their composition and regulated applications.
Due to the limiting properties of recycled aggregates to be used in high-performance materials, work has been done (and is currently being worked on) to improve their properties through surface treatments.
A bibliographic analysis of the real cases carried out will be carried out. A visit to a recycling plant will also be carried out.
A huge percentage of CDW can be recovered through recycling or reuse and used as resources in the manufacture of construction materials and elements

Specific objectives:
To know and evaluate the most common types of construction and demolition waste to be recovered through recycling as well as the elements considered to be reused.
Know the existing technologies for the treatment of RCD to obtain adequate quality recycled aggregates, filler and supplementary cementitious material (MCS).
Identify different types of recycled aggregates and their properties in addition to MCS.
Visit real works carried out and become aware of possible applications.

Related activities:
- Analysis of scientific articles
- Visit a recycling plant and work site
- Laboratory work

Full-or-part-time: 21h 08m
Theory classes: 3h 55m
Practical classes: 1h 54m
Laboratory classes: 3h
Self study : 12h 19m

Recycling of industrial waste and sediments in Materials

Description:
Due to growing environmental awareness as well as stricter regulations on industrial waste management, the world is increasingly turning to researching the properties of industrial waste and finding solutions for the use of its valuable components.
The metallurgical industry, a significant contributor to waste generation, is actively striving to recycle and utilize all its byproducts. This commitment is crucial in closing the loop of sustainable production and fostering a circular economy.
Likewise, in Europe, large volumes of sediment are dredged yearly to maintain port activities. With the new European Union directives, port administrators are encouraged to find environmentally sound solutions for these materials, with applicability as a "new" resource for the manufacture of new construction materials being a good option.
The valuation of waste from incinerators, bottom ash and fly ash from incinerators will be studied, too.

Specific objectives:
To know the identification and characterization technologies according to leaching tests and categorize waste.
To know the most abundant waste produced by the metallurgical industry, including electric furnace slag, blast furnace slag, foundry slag, and copper slag. Describe their characteristics and the possibility of their valorization as materials.
To know the properties of sediments and their applicability as materials.
To know the properties of incinerator waste and the accessible treatments to be used in construction materials.

Related activities:
- Session in the laboratory of characterization of industrial waste as Inert, Non-hazardous or dangerous waste according to the availability by leaching test.
- Real-scale experience talk on the use of industrial waste in construction materials
- Analysis of research papers

Full-or-part-time: 22h 36m
Theory classes: 3h 55m
Practical classes: 3h
Self study : 15h 41m

SELECTIVE DEMOLITION: REUSE

Description:
Currently, it is mandatory to classify non-hazardous CDW generated on-site. The classification must be carried out according to the following categories: wood, mineral fractions (concrete, bricks, tiles, ceramics and stone), metals, glass, plastic and plaster. Elements susceptible to reuse, such as tiles, toilets or structural elements, must also be classified, with the aim of carrying out a circular economy and producing zero waste.
Demolition methods, systems for designing material banks as well as the reuse of the elements obtained will be analyzed.

Specific objectives:
To know the characterisation methods of the materials and elements existing in the construction before demolition.
Recognise the systems for creating and analysing banks of materials and elements for reuse.
To learn about the digital books of materials: the digitisation of the sector
To know recyclable waste and its management.

Related activities:
- Review a demolition and its materials book
- Laboratory work on the digitalization of materials analysis

Full-or-part-time: 16h 10m
Theory classes: 3h 55m
Laboratory classes: 1h 54m
Self study : 10h 21m

EVALUATION

Description:
ENGLISH

Full-or-part-time: 4h
Laboratory classes: 4h

GRADING SYSTEM

The final grade is the arithmetic average of the grades obtained in part 1 and part 2 of the subject.
Part 1: ecomaterials and alternatives to current construction materials and workshops on ecomaterials and low carbon footprint cements.
Part 1 is dedicated to Ecomaterials: attendance and participation in class (15%), preparation and presentation of proposed projects (30%), attendance at technical visits (10%), submission of workshop/laboratory projects will be evaluated (30%), and completion of proposed exercises/tests (15%).

Part 2: recovery through recycling of construction and demolition waste, industrial waste, industrial by-products and sediments in construction materials. The banks of materials and elements obtained from efficient deconstruction for recovery and reuse will be described.
The grade for part 2 is obtained with the evaluations of 45% of activities (3 activities will be carried out, one for each topic), 25% of laboratory practices and 30% extended work on one of the topics studied.

EXAMINATION RULES.

If any of the scheduled or continuous evaluation activities are not carried out in the scheduled period, the activity will be valued with a zero. 80% of the activities/work need to be carried out for the subject to be evaluated

BIBLIOGRAPHY

Basic:
- Professors. Es donarà en cada sessió específica. 2014.