Universitat de Lleida

DEGREE CURRICULUM

# MATERIALS 2

Coordination: CASTRO CHICOT, JOSE RAMON

Academic year 2021-22

# MATERIALS 2 2021-22

## Subject's general information

<table>
<tr><td>Subject name</td><td>MATERIALS 2</td></tr>
<tr><td>Code</td><td>101412</td></tr>
<tr><td>Semester</td><td>1st Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Architectural Technology and Building Construction</td><td>2</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
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</td></tr>
<tr><td>Course number of credits (ECTS)</td><td>9</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>4.5</td><td>4.5</td></tr>
<tr><th>Number of groups</th><td>1</td><td>1</td></tr>
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</td></tr>
<tr><td>Coordination</td><td>CASTRO CHICOT, JOSE RAMON</td></tr>
<tr><td>Department</td><td>AGRICULTURAL AND FOREST ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>90 class hours and 135 hours of autonomous work</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan</td></tr>
</table>

# MATERIALS 2 2021-22

| Teaching staff | E-mail addresses | Credits taught by teacher | Office and hour of attention |
|---|---|---|---|
| CASTRO CHICOT, JOSE RAMON | joseramon.castro@udl.cat | 9 | |

## Subject's extra information

Subject is developed in the 1st semester of the 2nd year of teaching. It belongs to the module "Specific training", specifically in the field "Techniques and technologies of building".

It is compulsory class attendance and organized visits. The organized visits to production plants or industrial, are part of the syllabus.

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- White laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves
- Security helmet
- Reflective vest
- **Safety footwear (*)**

All these items, with the exception of the safety footwear, can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos
Centre the Cultures i Cooperació Transfronterera

http://www.publicacions.udl.cat/

**(*) The safety footwear must be acquired by the student to any individual protection equipment provider, and must meet the requirements S1 + P (head and antiforce template) according to what is established by EN ISO 20345**

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student can not access to the laboratories or have to go out of them. The no realisation of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

**GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES**

- Keep the place of realisation of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats...
- No short trousers or short skirts are allowed in the laboratory.
- Closed and covered footwear is compulsory in the laboratory.
- Long hair needs to be tied.

- Keep the laboratoy gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter between the contact lense and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following document of the *Servei de Prevenció de Riscos Laborals de la UdL*: http://www.sprl.udl.cat/alumnes/index.html

## Learning objectives

- To introduce the student in the main composite materials that characterize the current building.
- To provide a detailed view of the transformation processes that take place in the industry to convert a material into a component with specific characteristics.
- To establish the basis that relate the properties of building materials and building systems in order to realize the building with technical criteria.
- Visiting companies from building materials to know first hand the manufacturing processes.
- Perform laboratory practice to evaluate the mechanical behavior of building materials.

## Competences

**University of Lleida strategic competences**

- **UdL3** Mastering ICT's.

**Cross-disciplinary competences**

- **EPS2**. Capacity to gather and interpret relevant data, within the area of study, to judge and think about relevant subjects of social, scientific and ethical nature.
- **EPS7**. Capacity to work in situations with a lack of information and/or under pressure.
- **EPS8**. Capacity of planning and organizing the personal work.
- **EPS13**. Capacity to consider the socioeconomic context as well as the sustainability criteria in engineering solutions.

**Degree-specific competences**

- **GEE12**. Manufactured or traditional constructive systems and materials knowledge, its varieties and physics and mechanical characteristics that define them.
- **GEE13**. Capacity to adapt the materials of construction to the typology and use of buildings; manage the reception and the quality control of the materials, its use in the building works, the execution control of the units of work and the performance of tests and final proofs.
- **GEE14**. Knowledge of the historical evolution of the techniques and constructive elements and the structural systems that have given origin to the stylistic forms.
- **GEE15**. Aptitude to identify the elements and constructive systems, define their function and compatibility, and his use in the building process. Pose and solve constructive details.
- **GEE16**. Knowledge of the specific control procedures for the building works.
- **GEE17**. Capacity to give advice on the causes and evidences of the building injuries, to be able to offer solutions to avoid or amend their pathologies, and analyse the life cycle of the elements and constructive systems.

- **GEE18**. Aptitude to take part in the rehabilitation, restoration and conservation of the built heritage.
- **GEE19**. Capacity to develop maintenance plans and handbooks and manage its implementation in the building.
- **GEE20**. Knowledge of the environmental impact evaluation for building and demolition process, of sustainability in buildings, and of the procedures and techniques to determine the energy efficiency in buildings.

## Subject contents

The course Materials II consists of five areas:

· **BLOCK I: CONCRETE**

1.-CONCRETE

- 1.1.-Historical. Definition
- 1.2.-Components of concrete
- 1.3.-Bàsics concepts
- 1.4.-Classification

2.-PROPERTIES OF FRESH CONCRETE. TESTS

- 2.1.-States of concrete
- 2.2.-Requirements of fresh concrete
- 2.3.-Physical properties
- 2.4.-Rheological properties
- 2.5.-UNE. Fresh concrete tests.

3.-PROPERTIES OF HARDENED CONCRETE. TESTS

- 3.1.-Phisycal properties
- 3.2.-Durability of concrete: mechanical actions, physical actions, chemical actions and biological actions.
- 3.3.-Mechanical properties
- 3.4.-Rheological properties
- 3.5.-UNE. Hardened concrete. Tests.

4.-GRANULOMETRY OF AGGREGATES

- 4.1.-General concepts
- 4.2.-Series of sieves
- 4.3.-Graphical representation of granulometry analysis
- 4.4.-Fineness modulus, grading module. Minimum and maximum size. Particle size fraction.
- 4.5.-Curves theoretical: Fuller parabola and Bolomey parabola
- 4.6.-Type granulometries: continuous and discontinuous.
- 4.7.-Filler size in the concrete.
- 4.8.-Composition of aggregates.

5.-PROPORTIONING OF CONCRETE. PRINCIPLES AND METHODS

- 5.1.-The dosification in the concrete

5.2.-Characteristic resistance

5.3.-Consistency of concrete

5.4.-Maximum size of aggregate

5.5.-Proportions Water / cement

5.6.-Characteristics of components

5.7.-Conditions of durability

5.8.-Dosage concrete weight

5.9.-Dosage concrete volume

5.10.-Methods dosage: method Fuller, method Bolomey, method Carlos de la Peña and ACI method

6.-FABRICATION, TRANSPORT AND PUTTING IN WORK

6.1.-Manufacture of concrete

6.2.-Transport concrete

6.3-Dumping and compaction

6.4.-Compaction methods

6.5.-Precautions in vibrated

6.6.-Type vibrators: needles and vibrating tables

6.7.-Concreting in cold weather

6.8.-Concreting in hot weather

6.9.-Cured concrete

7.-QUALITY CONTROL OF CONCRETE

7.1.-Production control

7.2.-Reception control

7.3.-Consistency control

7.4.-Previous tests

7.5.-Tests control

7.6.-Statistical control

7.7.-Decisions derived from control

8.-SPECIAL CONCRETE

8.1.-High-strength concrete. Components and dosage

8.2.-Concrete autocompactan. Composition. Classification. Tests.Condicions general of execution.

8.3.-Recycled aggregate concrete. Precautions in the use of recycled aggregates.Granulometry control.Chemical control. Durability control.

8.4.-Lightweight aggregate concrete. Docility. Durability. Execution.

8.5.-Concrete fibers. Fiber type steel, polymer and inorganic. Characterization of concrete with fibers. Dosage.

8.6.-Shotconcrete. Components.

8.7.-Stamped concrete. Materials. Moulds. Resin finish. Putting in work.

· **BLOCK II: METAL MATERIALS**

1.-EXTRACTION PROCESS AND TREATMENTS

2.-METALS. GENERALITIES

2.1.-Unions atoms. Covalent bond. Ionic bond. Metallic bond. Van der Waals forces.

2.2.-Crystalline solids. Networks of crystalline metallic materials.

3.-METAL ALLOYS

3.1.-Solidification of metals and alloys. Curves solidification. Speed solidification.

3.2.-Size of grain.

3.3.-Phase diagrams or balance.

4.-PHASE DIAGRAMS: IRON - CARBON (STEEL)

4.1.-Heat treatment of steel: annealed, normalized, tempering, annealing

4.2.-Carbon steels and alloy steels. Iron foundries.

4.3.-Methods of forming metallic materials. Merger and molding processes, forming, rolling, forging, extrusion, drawing, bending.

5.-WELDING ALLOYS. WELDING TECHNIQUES

6.-STEEL CONSTRUCTION. PRODUCTS FINISHED. PRODUCTS PROCESSED.

6.1.-Processed products. Passive reinforcement. Active reinforcement. Rolled steel.

6.2.-Passive reinforcement. Corrugated bars. Welded.

6.3.-Active reinforcement. Steels alleged. Wires. Chord. Bars.

6.4.-Diagrams stress - deformation reinforcement passive and active.

6.5.-Corrosion of steel reinforcement in concrete.

7.-NON-FERROUS METALS. ALUMINUM. COPPER. LEAD. ZINC

7.1.-Aluminum. Aluminium alloys. Heat treatment of aluminum.

7.2.-Copper, lead, zinc. Architectural applications.

7.3.-Corrosion.Corrosion gases. Electrochemical corrosion.

7.4.-Protection. Methods change process: Structural design and cathodic protection. Protection through non-metallic coatings. Metallic coatings.

· **BLOCK III: POLYMERS**

1.-POLYMERS

1.1.-Components of plastics. Thermoplastic polymers. Thermostable polymers

1.2.-Additives. Reinforcements. Charges

2.-PROPERTIES

2.1.-Physical properties. Optical properties. Mechanical properties. Chemical properties. Behavior against fire.

3.-MANUFACTURING PROCESSES

3.1.-Machining processes: extrusion and injection

4.-APPLICATIONS IN THE CONSTRUCTION ARCHITECTURAL

4.1.-Polyvinyl chloride -PVC

4.2.-Polyethylene -PE

4.3.-Polypropylene -PP

4.4.-Polystyrene -PS

4.5.-Polyurethane -PU

· **BLOCK IV: THE EARTH**

1.-Historical background
2.-Advantages and disadvantages of land as a building material
3.-Basic physical properties for the study of the earth.
4.-Soil components
5.-Specific weight or actual density; specific dry weight or bulk density; apparent specific weight with natural moisture, specific weight of submerged soil, porosity, pore index, moisture.
6.-Identification of granular soils. Granulometry.
7.-Identification of fine soils. Plasticity.
8.-Limits of Atterberg. Consistency, cohesion and adhesion.
9.-Soil compaction. Proctor Essay.

**BLOCK V: CERAMIC**

1.-Generalities on the manufacture of ceramics.
2.-Clay as a raw material for ceramic brick.
3.-Modeling and manufacture of ceramic pieces.
4.-Extraction and transport of clay, preparation of clay, molding by extrusion, drying and firing.
5.-Regulations, nomenclature and types.
6.-Physical characteristics, dimensions and tolerances.

## Methodology

- **Master class**. Explanations and Power Point presentations, made in the classroom.
- **Visits to companies** manufacturing construction materials sector. The tours are guided by company staff explaining to students the different processes by which they pass materials into a finished and ready to work suministarse product.
- **Team work**. Made a visit to the factory, students have to make an exercice in groups of 2 or 3 people.
- **Laboratory practice**. Students do laboratory practices in groups of 2 or 3 people.

## Development plan

| Week | Methodology | Temary | Teaching hours | Hours of personal work |
|---|---|---|---|---|
| 1 | Master class | **Block 1. Concrete**<br>Properties of fresh concrete | 6 | 9 |
| 2 | Master class | Aggregates. Granulometric curves<br>Aggregates and concrete dosing. | 4<br>2 | 9 |
| 3 | Laboratory practice<br>Master class | Practice 1.Concrete I. Preparation of concrete, seat cone Abrams and manufacture of test specimens.<br>The dosage concrete. Fuller method, Bolomey, Carlos de la Peña, ACI ... | 4<br>2 | 9 |
| 4 | Master class | Manufacturing and transportation of concrete. Puting, compaction and curing of concrete.<br>Special concretes: self-compacting, recycled, printed.<br>Concrete reinforced with steel fibers. | 6 | 9 |
| 5 | Visit production plant<br>Master class | Visit Prefabricados Pujol. Miralcamp. Production of concrete, scrap metal processing assembly, prestressed concrete, terrazzo floor.<br>Reinforced concrete: stony material (compression) + ductile material (traction) | 4<br>2 | 9 |

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| 6 | Master class | **Block 2. Metallic materials**<br>Extraction processes.<br><br>Crystallographic networks metals.<br><br>Metal alloys Fe-C. The characteristics of the steel through the phase change diagrams. | 6 | 10 |
| 7 | Laboratory practice<br><br>Master class | Practice 2. Concrete II. Density of hardened concrete, broken specimens: compressive strength, indirect tensile strength and flexural strength.<br>Steels in the building. Steel arm. Prestressing steels. | 4<br><br>2 | 10 |
| 8 | Master class | Non-ferrous metals. Aluminum, copper, lead and zinc.<br>Protection of metals. Galvanization. | 2<br><br>4 | 10 |
| 9 | PA1. Written exam | | | |
| 10 | Laboratory practice<br><br>Master class | Visual identification of the corrugated steel, measurement of geometric characteristics, tensile strength.<br><br>**Block 3. Polymeric materials**<br>Nature of the polymeric materials. Carbon chemistry.<br>The physics of polymers.<br>Polymers in construction.<br>Thermoplastic and thermostable polymers. | 2<br><br>4 | 10 |
| 11 | Master class | **Block 4. Raw earth as a building material**<br>Basic physical properties<br>Soil components. Actual specific gravity, dry specific gravity, porosity, pore index, moisture<br>Identification of granular soils. Granulometry.<br>Identification of fine soils. Plasticity | 9 | 10 |
| 12 | Laboratory practice | Granulometry of a soil<br><br>Soil compaction. Proctor Essay | 3 | 10 |

| | | | | |
|---|---|---|---|---|
| 13 | Master class<br><br>Visit to production plant | **Block 5. Ceramics**<br>General information on the manufacture of ceramics. Clay as a raw material for ceramic brick. Modeling and manufacture of ceramic pieces.<br><br>Visit to La Coma-Balaguer Ceramics. Production of thermoclay, brics, etc. | 2<br><br>4 | 10 |
| 14 | Master class<br><br>Laboratory practice | Extraction and transport of clay, preparation of clay, molding by extrusion, drying and firing. Regulations, nomenclature and types. Physical characteristics, dimensions and tolerances.<br><br>Development of a BTC compressed soil block. Compression breakage of ceramic bricks and BTC | 4<br><br>4 | 10 |
| 15 | Master class | "Fine ceramics": tiles and pavements | 4 | 10 |

## Evaluation

| Evaluation activities | % | Dates |
|---|---|---|
| PA 1. Written exam. | 40 | Week 9 |
| PA 2. Written exam. | 35 | Weeks 16 or 17 |
| Laboratory and visits to production and industrial centers | 25 | Along the course |
| Recovery exam. | 50 | Week 19 |

**Exams:**

- The subject is passed from 5.
- Two tests (PA1 and PA2) are scheduled in weeks 9 and 16/17. The test PA1 has a weight of 40% and PA2 has a test weight of 35% over the final mark.
- Tests (PA1 i PA2) with a mark lower than 3 are not considered in the calculation of the final mark (test with mark equal to 3 is considered).
- Following the guidelines of the Academic Framework of Degrees in EPS, a recovery examn will take place in the week 19. It will be possible to recover / improve one test (PA1 and PA2) or the complete subject. The recovery will be done through a written exam. The mark of the recorvery exam should be equal or greater than 3 in order to be considered in the final mark.

**Laboratory and visits to production and industrial centers?**

- Five laboratory practices as well as three visits to production and industrial centers will be carried out during the course. Each of these activities will imply the delivery of the reports. The mark corresponding to lab and visits represent the 25% of the final mark.
- Attendance to the laboratory and visits as well as delivery of reports is mandatory.
- Laboratory and visits cannot be recoverd by performing any other activity.

- Not presenting an exercise or later delivery behaves mark 0 in the corresponding exercise.

## Bibliography

**Building materials: general bibliography**

- Arcos Molina, J; Los materiales básicos de la construcción. Progensa. 2003.

- Crespo Escobar, S; Materiales de construcción para edificación y obra civil. ECU. 2010.

- Bustillo Revuelta, Manuel; Materiales de construcción. Fueyo. Madrid. 2005.

**Block I: Concrete**

- Garcia Meseguer, A; Moran Cabre, F; Arroyo, JC; Jiménez Montoya. Hormigón Armado.15ª edición. Gustavo Gili. Barcelona 2010.

- Garcia Meseguer, A; Hormigón Armado. 3 volums. Uned 2001.

**Block II: Metal materials**

- Galvan Llopis, Vicente; Materiales metálicos. UPV. Valencia. 2005.

- Pero-Sanz, José Antonio; Aceros, metalurgia física. Selección y diseño. Cie Dossat.2004.

- Aceros para pretensado en la EHE. Calidad Siderúrgica. 2002.

**Block III: Polymers**

- Balart Gimeno, Rafael; Introducció als materials polimèrics i compostos. UPV.Valencia. 2003.

- Fernández Cánovas, Manuel; Materiales bituminosos. ETSICCP. Madrid. 1990.

- Salán Ballesteros, M.Nuria; Tecnologia de processos y transformación de materiales. Edicions UPC. 2005.

**Block IV: Earth**

-Muzás Labad, Fernando; Mecánica del suelo y cimentaciones. Vol 1. Escuela de la Edificación. Madrid. 2007.

-Gernot Minke; Manual de construcción de tierra. Editorial fin de siglo. Uruguay. 2005.

-Jimenez Salas J.A; de Justo Alpañes, J.L. Geotecnia y cimientos. Rueda. Madrid. 1975.

**Block V: Ceramics**

- Arredondo Verdú, Francisco; Piedras, cerámica y vidrio. UPM. Madrid.1991.

- AENOR; UNE-EN771-1 Especificaciones de piezas para fábrica de albañilería. Madrid. 2003.

- Guía de la baldosa cerámica. Instituto Valenciano de Edificación. Valencia. 2006.

- Valiente Soler, Juan Manuel; Materiales de construcción: Pétreos artificiales,cerámicos y vidrios. UPV. Valencia. 1992.