

## Course guide

# 310411 - 310411 - Reduction, Reuse and Recycling in Construction

**Last modified:** 30/11/2023

**Unit in charge:** Barcelona School of Building Construction  
**Teaching unit:** 753 - TA - Department of Architectural Technology.

**Degree:** MASTER'S DEGREE IN ADVANCED BUILDING CONSTRUCTION (Syllabus 2014). (Optional subject).

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

### LECTURER

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**Coordinating lecturer:** Gómez Soberón, José Manuel Vicente

**Others:**

### PRIOR SKILLS

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1.- Generic transversal abilities.

- Ability of analysis and synthesis.
- Ability of organisation and planning.
- Work in interdisciplinary team.
- Adaptation to new environments.
- Ecological social commitment.
- Environmental interest.
- Research and inventive interest and intuition.
- Ability to apply new knowledges to the usual practice.

2.- Specific abilities:

a) Cognitive:

- Basic knowledges of the behaviour of the materials used in architecture and engineering constructions, like: environmental deterioration processes, minimum requirements.
- General mechanical behaviour and physical properties of the materials.

b) Procedural-Instrumental:

- Ability of application of second generation materials on construction processes, either for architecture or engineering elements.
- Evaluation of variations and its implication in the general behaviour of the materials used on construction.
- Quantifying of the environmental valuations of the recycled materials.

c) Abilities-Attitudes:

- Ability to adapt the current technology of the construction to new alternatives in the construction processes.
- Predisposition for the application of the recycled materials in the construction.

### REQUIREMENTS

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Technical English at basic level or reading level.

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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### Specific:

2. Capacity of innovation: identify the reasons and the mechanisms of the technologic and technical changes.

### Generical:

6. Prepare the student in the using of tools that are common in the investigation activities, like the analysis and treatment of data, just like methodology and investigation techniques.

### Transversal:

7. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.

11. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

### Basic:

1. Possess and understand knowledge which provide a basis or opportunity to be original in the development and/or application of ideas, usually in a context of research.

3. The students must be able to apply the acquired knowledges and their ability of resolution of problems in new or little known environments inside more wide environments (or multidisciplinary) related with their study field.

4. The students must be able to integrate knowledges and front to the complexity to formulate opinions from an information which, being incomplete or limited, includes reflections about the social and ethical responsibilities linked to the application of their knowledges and opinions.

5. The students must possess the learning abilities which allow them to continue studying in a way which should be to a large extent self-directed and autonomous.

9. The students must be able to communicate their conclusions and the knowledges and ultimate reasons which support to specialised and non-specialised audiences in a clear mode and without ambiguities.

## TEACHING METHODOLOGY

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Master exposition classes.

Active learning.

Autonomous learning.

Teamwork.

Cooperative learning.

Puzzle method.

Case method.

Poster.

Forum.

## LEARNING OBJECTIVES OF THE SUBJECT

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The new trending in the study of the optimal life cycle, the new specifications and environmental requirements and the current economic impositions in the construction field, make it necessary to minimise the environmental impact, design beyond the useful life and apply new materials of second generation in the construction field. For these reasons, the general objective of the course is to provide knowledge regarding to how to minimise (Reduce), how to rebuild (Reuse) and how to use alternative materials (Recycle) according to the alignment of the named Horizon 2020.

The content of this course is intended to provide a coherent response to issues of great importance for the professional who takes it. These issues are related to aspects such as: On the one hand, obtaining the knowledge that will allow him/her to adapt the new environmental requirements of today's society to construction technology, and on the other hand, to provide him/her with the skills and competences to adapt, propose, investigate and implement new applications or processes that include the component concept of reduction, reuse and recycling in their application in construction.

The students must acquire the competences, skills and abilities presented before.

## STUDY LOAD

Type	Hours	Percentage
Hours small group	5,0	4.00
Guided activities	10,0	8.00
Self study	90,0	72.00
Hours medium group	5,0	4.00
Hours large group	15,0	12.00

**Total learning time:** 125 h

## CONTENTS

### M1 Reduction (minimization).

#### Description:

- 1.1 The environment and the sustainable development.
- 1.2 The wastes, its generation and its typologies.
- 1.3 Waste treatment policies.
- 1.4 The recycling and the cycle of life of the materials.
- 1.5 Management of wastes.
- 1.6 The Analysis of the Cycle of Life (LCA) of the materials.

Planning: The previous module will be taught during the weeks 1, 2, 3, 4 and 5 of the course.

#### Specific objectives:

At the end of the module, the student should be able to:

- 1. Identify and correlate in writing the environmental deterioration and the generation of wastes.
- 3. Express and explain the contaminating vectors.
- 3. Explain in writing which are the main atmospheric contaminants.
- 4. Define the concept of waste, correlate it with the PNB and with the products of the countries of our context.
- 5. Define and apply the concepts of reducing (minimisation), valuation and treatment.
- 6. Establish in writing the economic and environmental actuation limits.
- 7. Establish flow charts to define the LCA of the materials.
- 8. Evaluate and define by means of the LCA optimal alternatives in the construction.

#### Related activities:

Activities inside class:

M1A1 Class. Active learning and evaluation of equals.

M1A2 Class. Individual work.

Activities out of class:

M1 A1 at home. Reading/synthesis/expression.

M1 A2 at home. Positive interdependence.

Test:

RRR M1. Evaluation of questionnaire with multiple choice.

Class forum.

Work of Real Cases.

**Full-or-part-time:** 45h 50m

Theory classes: 5h

Practical classes: 1h 50m

Laboratory classes: 1h 40m

Guided activities: 4h

Self study : 33h 20m

## M2 Reuse.

### Description:

- 2.1 General concepts of reuse.
- 2.2 Foundations and containment elements.
- 2.3 Structural elements.
- 2.4 Elements surrounding the building.
- 2.5 Interior elements of a building.
- 2.6 Electrical and mechanical facilities of the building.
- 2.7 Practical cases documented.

Planning: This module will be done during the weeks 6, 7, 8, 9 and 10 of the course.

### Specific objectives:

Upon completion of the module, the student will be able to:

- 1. Explain in written or verbal form the advantages of reusing construction materials, taking into account the environmental aspects, advantages induced in the project, and advantages for the companies that use it.
- 2. Select, on the basis of the advantages indicated, between in situ reuse or remote processing of materials.
- 3. Will be able to discern which types and in which situations it is applicable to reuse elements of foundations.
- 4. Will be able to discern in which situation the reuse of a structure or parts of it is applicable.
- 5. Will be able to discern which types and in which situations the reuse of elements of a building envelope is applicable.
- 6. Will be able to discern what types and in what situations the reuse of elements of a building interior is applicable.
- 7. Will be able to discern what types and in what situations the reuse of electrical and mechanical service elements is applicable.

### Related activities:

Activities inside class:

M2 A1 Class. Teamwork, Make a Poster, Evaluation of equals.

Activities out of class:

M2 A1 at home. Individual work out of class.

M2 A2 at home. Group work out of class, Positive Interdependence.

Test:

RRR M2. Evaluation of questionnaire with multiple choice.

Class forum.

Work of Real Cases.

**Full-or-part-time:** 47h 10m

Theory classes: 5h

Practical classes: 3h 10m

Laboratory classes: 1h 40m

Guided activities: 4h

Self study : 33h 20m

### M3 Recycled.

#### Description:

- 3.1 Production of materials from waste.
- 3.2 Recycled concrete sands for new concretes.
- 3.3 Use of drosses as construction materials.
- 3.4 Ashes originating from incineration.
- 3.5 Wastes for the production of thermal and acoustic insulation.
- 3.6 Application of muds of purification systems.
- 3.7 Mining wastes.
- 3.8 Application of sands coming from the demolition in highways.
- 3.9 Recycling of tyres as elements of paving surfaces.

This module will be done during the weeks 11, 12, 13, 14 and 6 of the course.

#### Specific objectives:

At the end of the module, the student should be able to:

- 1. Define the applications of the garbage from various wastes.
- 2. Explain the different techniques of processing of the wastes.
- 3. Define the applications of the recycled materials with content of recycled material.
- 4. Apply the current regulations of the recycled materials, similarities and differences regarding to the used materials, and reference values of their calculation constants.
- 5. Identify the variations of the properties of the recycled materials regarding to their different phases or processes, their mechanical behaviour or performances.
- 6. Identify the variations of the properties of the recycled materials regarding to their durability in general terms.
- 7. Determine the application of design of dosage or incorporation of recycled materials, taking into account the peculiarities of their composition and mechanical capacity.

#### Related activities:

Activities inside class:

M3 A1. Active learning.

Test:

RRR M3. Evaluation of questionnaire with multiple choice.

Class Forum.

Work of Real Cases.

**Full-or-part-time:** 32h

Theory classes: 5h

Laboratory classes: 1h 40m

Guided activities: 2h

Self study : 23h 20m

## ACTIVITIES

### M1 A1 Class: Active Learning equal archive evaluation

**Description:**

It will be done during the course at least one activity which will be suppressed to evaluation by the students, this evaluation will have a stepped system which will allow the students to count with the criteria of an evaluation of the work of an equal. There will be rigorously examined the criteria of professional ethics, correct proceed and impartiality of the own evaluation by the faculty.

**Specific objectives:**

Objectives related 6 and 7 of M1.

**Material:**

Document of the activity, article facilitated in Atenea, pencil and paper.

**Delivery:**

At class.

**Full-or-part-time:** 1h 05m

Practical classes: 1h 05m

### M1 A2 Class: Individual project.

**Description:**

There will be done 5 learning activities which will promote the teamwork, the leadership, the self-learning and the research potential; all these activities will be evaluated in scales from 1 to 100, delivered by the Virtual Campus and developed during the course. There will be taken into account the compliance of the specifications given in each activity: the quality of the information provided or generated, the technical lexical used, the diagrams and graphical details generated, the innovation of the developed content, the currently of the used references, the synthesis ability, etc.

**Specific objectives:**

Objectives related 1, 2, 3, 4, 5, 6 and 7 of M1.

**Material:**

Document of the activity in the Campus of the Subject, pencil and paper.

**Delivery:**

At class.

**Full-or-part-time:** 0h 45m

Practical classes: 0h 45m

### **M1 A1 House; Reading/synthesis/expression.**

**Description:**

There will be done 5 learning activities which will promote the teamwork, the leadership, the self-learning and the research potential; all these activities will be evaluated in scales from 1 to 100, delivered by the Virtual Campus and developed during the course. There will be taken into account the compliance of the specifications given in each activity: the quality of the information provided or generated, the technical lexical used, the diagrams and graphical details generated, the innovation of the developed content, the currently of the used references, the synthesis ability, etc.

**Specific objectives:**

Objectives related 1 and 2 of M1.

**Material:**

Document of the activity, the article facilitated in the campus of the subject, pencil and paper.

**Delivery:**

In the virtual campus of the subject (upload in the class forum).

**Full-or-part-time:** 6h

Guided activities: 1h

Self study: 5h

### **M1 A2 House: Positive interdependence**

**Description:**

There will be done 5 learning activities which will promote the teamwork, the leadership, the self-learning and the research potential; all these activities will be evaluated in scales from 1 to 100, delivered by the Virtual Campus and developed during the course. There will be taken into account the compliance of the specifications given in each activity: the quality of the information provided or generated, the technical lexical used, the diagrams and graphical details generated, the innovation of the developed content, the currently of the used references, the synthesis ability, etc.

**Specific objectives:**

Objectives related 3, 4 and 5 of M2.

**Material:**

Articles and document of the activity facilitated in the campus of the subject.

**Delivery:**

In the virtual campus of the subject.

**Full-or-part-time:** 6h

Guided activities: 1h

Self study: 5h



### RRR M1 Multiple answer test.

**Description:**

At the end of each module there will be done a questionnaire with multiple choice with at least 10 questions and 3 answer options; in these questionnaires there will be evaluated the correct answers and the mistakes occurred during its resolution; in the same way, there will be taken into account the number of attempts needed to solve each question and the time invested on it. These questionnaires, could be solved individually or by pairs established in advance in each particular case (encourage the dialogue, express the knowledge and increase the reasoning argued of the topic). There will be done at class (personal systems of answers) or virtually by means of the Virtual Campus of the Subject.

**Specific objectives:**

Objectives of M1.

**Material:**

Guide notes and material of the subject available in the virtual campus of the same.

**Delivery:**

Realisation of the virtual questionnaire in the campus of the subject.

**Full-or-part-time:** 10h 30m

Guided activities: 0h 30m

Self study: 10h

### M2 A1 Class: Group project, make a poster, equal evaluation.

**Description:**

It will be done during the course at least one activity which will be suppressed to evaluation by the students, this evaluation will have a stepped system which will allow the students to count with the criteria of an evaluation of the work of an equal. There will be rigorously examined the criteria of professional ethics, correct proceed and impartiality of the own evaluation by the faculty.

**Specific objectives:**

Objectives related 10, 11, 12, 13 and 14 of M2.

**Material:**

The eight printed documents which are facilitated in the Campus of the subject, English dictionary or translator, the document of the activity, markers, colour felt pens, scissors, tape or glue and a A2 paper.

**Delivery:**

At class.

**Full-or-part-time:** 1h 30m

Practical classes: 1h 30m

### M2 A1 House: Individual work outside the class.

**Description:**

There will be done 5 learning activities which will promote the teamwork, the leadership, the self-learning and the research potential; all these activities will be evaluated in scales from 1 to 100, delivered by the Virtual Campus and developed during the course. There will be taken into account the compliance of the specifications given in each activity: the quality of the information provided or generated, the technical lexical used, the diagrams and graphical details generated, the innovation of the developed content, the currently of the used references, the synthesis ability, etc.

**Specific objectives:**

Objectives related 10 and 11 of M2.

**Material:**

To have the Cype software, access to internet, document of the activity.

**Delivery:**

In the virtual campus of the subject (upload the information in the portal of the activity).

**Full-or-part-time:** 6h

Guided activities: 1h

Self study: 5h

### M2 A2 House: Group project outside the class, positive interdependence.

**Description:**

There will be done 5 learning activities which will promote the teamwork, the leadership, the self-learning and the research potential; all these activities will be evaluated in scales from 1 to 100, delivered by the Virtual Campus and developed during the course. There will be taken into account the compliance of the specifications given in each activity: the quality of the information provided or generated, the technical lexical used, the diagrams and graphical details generated, the innovation of the developed content, the currently of the used references, the synthesis ability, etc.

**Specific objectives:**

Objectives related 12, 13 and 14 of M2.

**Material:**

To have access to internet and use the documents attached to the activity (book of the building, budgets, measurings, etc.).

**Delivery:**

In the virtual campus of the subject (upload the information in the portal of the activity).

**Full-or-part-time:** 6h

Guided activities: 1h

Self study: 5h

### RRR M2 Multiple answer test.

**Description:**

At the end of each module there will be done a questionnaire with multiple choice with at least 10 questions and 3 answer options; in these questionnaires there will be evaluated the correct answers and the mistakes occurred during its resolution; in the same way, there will be taken into account the number of attempts needed to solve each question and the time invested on it. These questionnaires, could be solved individually or by pairs established in advance in each particular case (encourage the dialogue, express the knowledge and increase the reasoning argued of the topic). There will be done at class (personal systems of answers) or virtually by means of the Virtual Campus of the Subject.

**Specific objectives:**

Objectives of M2.

**Material:**

Guide notes and material of the subject available in the virtual campus of the same.

**Delivery:**

Fulfilment of the virtual questionnaire in the campus of the subject.

**Full-or-part-time:** 10h 30m

Guided activities: 0h 30m

Self study: 10h

### M3 A1 Class: Active learning.

**Description:**

5 learning activities will be done, which will promote the teamwork, the leadership, the self-learning and the research potential; all these activities will be evaluated in scales from 1 to 100, delivered by the Virtual Campus and developed during the course. There will be taken into account the compliance of the specifications given in each activity: the quality of the information provided or generated, the technical lexical used, the diagrams and graphical details generated, the innovation of the developed content, the currently of the used references, the synthesis ability, etc.

**Specific objectives:**

Related objectives of M3.

**Material:**

Both articles printed which are given using the subject campus, english dictionary or translator, activity document, pencil and paper.

**Delivery:**

At class.

**Full-or-part-time:** 1h 40m

Practical classes: 1h 40m

### RRR m3 Multiple answer test.

**Description:**

At the end of each module a questionnaire will be done, with multiple choice with at least 10 questions and 3 answer options; in these questionnaires there will be evaluated the correct answers and the mistakes occurred during its resolution; in the same way, there will be taken into account the number of attempts needed to solve each question and the time invested on it. These questionnaires, could be solved individually or by pairs established in advance in each particular case (encourage the dialogue, express the knowledge and increase the reasoning argued of the topic). There will be done at class (personal systems of answers) or virtually by means of the Virtual Campus of the Subject.

**Specific objectives:**

Objectives of M2.

**Material:**

Guide notes and material of the subject available in the virtual campus of the same.

**Delivery:**

Fulfillment of the virtual questionnaire in the campus of the subject.

**Full-or-part-time:** 10h 30m

Guided activities: 0h 30m

Self study: 10h

### Real case project (TCR) and presentation real case project (ETCR)

**Description:**

Cases of Reduction, Reuse or Recycling in construction by the students will be presented in class; these cases will be proposed by the teaching staff. It will be valued to provide information not contained in the initial documentation provided, that the presentation encourages dialogue between those present, that in the presentation the content is transmitted in the three communication media (visual, auditory and synergistic). That is, to achieve effective communication and that allows in a reasonable way to be able to apply this technique or process presented as a topic of debate in the professional environment itself. The originality of the presentation, the inventiveness of the technique or process presented or documented, the ability to research unconventional references will be valued (basic sources such as books should not be used in this work), the use of Information sources such as articles in technical journals and conference proceedings with an antiquity of no more than five years (unpublished work experiences will therefore be eliminated).

**Specific objectives:**

Objectives from M1, M2 and M3, as well as the subject's transversal competencies.

**Material:**

Documents, WEB links and articles given in the subject campus.

**Delivery:**

In the subject's virtual campus the final document and the presentation will be delivered.

**Full-or-part-time:** 44h 30m

Guided activities: 4h 30m

Self study: 40h

#### name english

##### Description:

It consists of participation in the class forum, taking into account the thematic content proposals related to the subject (at least 10 proposals for discussion by the students will be required). Proposals must contain technical documentary and contribution bases. Similarly, it will be necessary to have at least 15 arguments or participatory responses to the thematic content proposed by another participant in the debate (the arguments may refute, support, synthesize or expand the thematic content discussed). The work must be developed continuously throughout the semester in which the subject is taught.

##### Specific objectives:

Objectives of M1, M2 and M3, as well as transversal competences of the subject.

##### Material:

Arguments made by the teacher within the subject forum.

##### Delivery:

The contributions of the participations will be counted by uploading them in the subject forum.

##### Full-or-part-time: 5h

Laboratory classes: 5h

#### name english

##### Description:

Visits will be made to waste management factories and energy processors. The dates for its realization will be subject to the availability of the companies, but it is planned to take place on Fridays.

Attendance is mandatory and will be counted in the final grade for the course based on the number of visits you make. Mobility or travel to them will require that students subscribe to the university insurance that protects them when enrolling in the subject.

##### Delivery:

At the end of each visit, a report worked in groups will be delivered.

##### Full-or-part-time: 1h 30m

Guided activities: 1h 30m

## GRADING SYSTEM

1. Evaluation of Equals (EI).
2. Positive Active Involvement (PAP).
3. Work Inside Class (TDA).
4. Work Out of Class (TFA).
5. Questionnaire with Multiple Choice (TRM).
6. Work of Real Cases (TRM).
7. Exposition of the Work of Real Cases (ETCR).

Final Mark of the Course =  $(EI \times 5\%) + (PAP \times 15\%) + ((TDA + TFA) \times 25\%) + (TRM \times 30\%) + ((TCR + ETCR) \times 25\%)$

##### SPECIAL NOTE:

Since the subject is evaluated continuously, it can only be evaluated in the scheduled deliveries, there will NOT be a recovery exam for the same.

## EXAMINATION RULES.

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It will be necessary to pass with a mark higher or equal to five in two of the five evaluation methods described here; the two evaluation methods with minimum mark to pass are the 6 and 7.

The works or activities delivered out of the deadlines established at the beginning of the course will cause the reduction of their marks. The final individual mark of each student will be the result of the arithmetic mean of the evaluation methods mentioned before.

### NOTE:

Visits will be made to waste management and energy processing factories. The dates for these visits will be subject to the availability of the companies, but they are expected to take place on Fridays.

Attendance is mandatory and will be counted in the final grade of the course depending on the number of visits made. The mobility or travel to them will require that students subscribe the university insurance that protects them when registering for the course.

At the end of each visit, a report will be handed in and worked on in groups.

## BIBLIOGRAPHY

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### Basic:

- Goumans, J. J. M. Waste materials in construction : WASCON 2000 : proceedings of the International Conference on the Science and Engineering of Recycling for Environmental Protection. Amsterdam: Perdamon, 2000. ISBN 0080437907.
- Addis, Bill. Building with reclaimed components and materials: a design handbook for reuse and recycling. London: Earthscan, 2006. ISBN 1844072746.
- Zaragoza Bernal, Amparo. Reutilización de los residuos generados en obra para la obtención de hormigones. Alicante: Universidad de Alicante, 2000. ISBN 8479085150.
- Cheremisinoff, Nicholas P. Handbook of solid waste management and waste minimization technologies [on line]. Amsterdam; Boston: Butterworth-Heinemann, 2003 [Consultation: 14/07/2014]. Available on: <http://www.sciencedirect.com/science/book/9780750675079>.
- Environmental aspects of construction with waste materials: Proceedings of the International Conference. Amsterdam: Elsevier, 1994. ISBN 0444818537.

### Complementary:

- Elías Castells , Xavier. Reciclaje de residuos industriales: aplicación a la fabricación de materiales para la construcción. 2a. Madrid: Díaz de Santos, 2000. ISBN 978-84-7978-437.
- Gómez Soberón, J. M.; Vázquez, E.; Agulló, L. Hormigón con áridos reciclados : una guía para el diseño del material. Barcelona: CIMNE, 2001. ISBN 84-89925-80-1.
- Gómez Soberón, J. M. Comportamiento tenso deformacion, instantáneo y diferido de hormigón con árido reciclado. Barcelona: Tesis Doctoral UPC, 2002.

## RESOURCES

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### Computer material:

- Cype Arquímedes. Gestión y Control de Obra.. Resource
- BEES : Building for Environmental and Economic Sustainability. Resource
- Athena. Sustainable Materials.. Resource

### Hyperlink:

- Campus de la Asignatura.. Resource