Course guides
250475 - ESTMIXCOMP - Mixed and Composite Structures

Last modified: 06/10/2020

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 2009). (Optional subject).
MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Optional subject).
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MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2020 **ECTS Credits:** 5.0 **Languages:** Catalan, English, Spanish

LECTURER

Coordinating lecturer: ENRIQUE MIRAMBELL ARRIZABALAGA

Others: ANTONIO RICARDO MARI BERNAT, ENRIQUE MIRAMBELL ARRIZABALAGA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
8162. Knowledge of all kinds of structures and materials and the ability to design, execute and maintain structures and buildings for civil works.
8228. Knowledge of and competence in the application of advanced structural design and calculations for structural analysis, based on knowledge and understanding of forces and their application to civil engineering structures. The ability to assess structural integrity.

Transversal:
8559. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
8560. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

8561. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

TEACHING METHODOLOGY

The course consists of 3 hours per week of classroom activity during 13 weeks.

In the theoretical lectures, the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

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.

LEARNING OBJECTIVES OF THE SUBJECT

Specialization subject in which knowledge on specific competences is intensified.

Knowledge and skills at specialization level that permit the development and application of techniques and methodologies at advanced level.

Contents of specialization at master level related to research or innovation in the field of engineering.

STUDY LOAD

Type	Hours	Percentage
Hours large group	19,5	15.59
Hours medium group	9,8	7.83
Self study	80,0	63.95
Hours small group	9,8	7.83
Guided activities	6,0	4.80

Total learning time: 125.1 h

CONTENTS

Overview

Description:
Introduction to the subject. Concept of structure and composite construction. Presentation of the agenda. Evaluation method. Bibliography. Advantages and disadvantages of building in steel and concrete. Advantages and characteristics of composite construction. Possibilities in design and construction: construction process relevance.
Materiales: Structural steel, steel reinforcement, concrete

Full-or-part-time: 7h 11m
Theory classes: 3h
Self study : 4h 11m

Structural behavior. Time dependent effects

Description:
Qualitative structural behavior of composite structures. Differential equation of the interaction. Full interaction: Method of the reduced cross-section. Longitudinal shear force. Transverse reinforcement of the concrete slab. Effective width: Statement of the effective width according to EC3 and EC4. Time dependent effects: Shrinkage: Structural effects in isostatic and indeterminate structures. Analysis considering cracking: Non-linearity of the problem. Creep: The nature of the phenomenon. Approaching the problem with the ageing coefficient. The method j. Analysis of continuous composite beams considering creep. Thermal effects in composite structures and composite bridges. Design temperature distributions. Generalized deformations.
Calculation of a composite structure subjected to a differential action type as shrinkage.

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

The prestressed composite structures.

Description:
The prestressed composite structures: Prestressed pre-connection and post-connection. Instantaneous and delayed study. Efforts flush of localized nature.
Resolution of exercise for determining the ultimate moment of a section subjected to bending mixed positive and negative, considering linear elastic and plastic theory.

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Ultimate limit states. Bending and shear

Description:
Ultimate limit states. Classification of composite sections. Ultimate strength of the cross sections of a composite beam. Ultimate bending moment: Bases. Plastic bending moment of a section with total connection. Plastic bending moment of a section with partial connection. Ultimate bending moments response in classes 1, 2, 3 and 4 to positive and negative bending. Resistance of the composite section to shear in sections class 1 and 2. Bending-shear interaction.
Exercise

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Serviceability limit states. Deformability and cracking

Description:
Serviceability limit states: General. Limit state deformations: effects of the construction process, the shear lag, incomplete interaction of shrinkage and creep, cracking of concrete and structural steel lamination. Limit state of cracking: Approach to EN 1992-1-1 and Instruction EHE. Simplified method of EN 1994-1-1.
Resolution of exercise of verification of the limit state of cracking in an intermediate support cross-section of a continuous composite beam.

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Construction process

Description:
Construction process. Influence of the construction process. Influence of preloads. Sequences isostatic concrete beams. Influence of the construction process in continuous composite beams: Sequences of concretecast and bearing systems. Metal piece fully assembled or not, before executing the concrete slab.
Resolution of an exercise related to the construction process of a steel-concrete composite structures

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Connection in composite structures

Description:
Connectors. Connection concept. Vs. total connection. partial connection. Justification for the partial connection. Vs ductile connectors. rigid connectors. Strain capacity of the connectors. Connections tested with push tests. Flush effort calculation: Beams with past efforts and calculated according to elastic theory under plastic theory. Total and partial connection connection with connectors dúctiles.Capacidad resistant ductile or last of the connectors: Pin connectors. Other types of connectors. Distribution connectors along the element. Limitations. Construction layout. Transverse reinforcement in the connection area. Resolution of exercise related to the design of connection in composite beam

Full-or-part-time: 14h 23m
Theory classes: 3h
Practical classes: 3h
Self study : 8h 23m

Composite columns

Description:
Composite columns. Overview. Structural types. General and simplified method. Assumptions for the simplified method. Resistance of the cross-section. Flexure-compression strength in straight sections. NM interaction diagram. Influence of shear. Resistance to instability of pillars under biaxial bending in the general case. Influence of second-order effects. Study of the area of load introduction area. Shear at the intreface and connection in the steel-concrete interface.
Resolution of exercise of the verification of a composite column under axial load and biaxial bending

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Composite bridges

Description:
Composite bridges. Introduction. About composite bridges. Common types of cross sections. Design conditions of composite bridges. Presentation of structural types of composite bridges. Some aspects of their calculation.

Full-or-part-time: 7h 11m
Theory classes: 3h
Self study : 4h 11m

Composite slabs with profiled sheet

Description:
Composite slabs with profiled sheet. Introduction. Behaviour of the composite slab. Basis of calculation. Structural analysis. Checking sections. Checking the serviceability limit states.
Resolution of exercise of composite slab with profiled sheet

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Composite structures with different types of concrete

Description:
Time dependent effects. Longitudinal shear force. Shear-friction model.
Exercise

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Evaluation

Full-or-part-time: 7h 11m
Laboratory classes: 3h
Self study : 4h 11m

GRADING SYSTEM

The mark of the course is obtained from the continuous assessment.

It consists of five activities and a final exam.

The final mark (F) is obtained from the exam mark (E) and the activities directed (AD)

F = 0.7E+0.3AD

The maximum score assigned to each activity will be the same.

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:
- Comisión Permanente del Hormigón. EHE-08: Instrucción de Hormigón Estructural: con comentarios de los miembros de la Comisión Permanente del Hormigón [on line]. 5a ed. Madrid: Ministerio de Fomento, Centro de Publicaciones, 2011 [Consultation: 11/11/2020]. Available on: http://www.ponderosa.es/docs/Norma-EHE-08.pdf.
- Espanya. Comisión Permanente de Estructuras de Acero. EAE: instrucción de acero estructural: con comentarios de los miembros de la Comisión Permanente de Estructuras de Acero [on line]. Madrid: Ministerio de Fomento, Secretaría General Técnica, 2011 [Consultation: 11/11/2020]. Available on: https://www.mitma.es/recursos_mfom/1903100.pdf. ISBN 9788449809040.
- Comité Européen de Normalisation (CEN). Eurocode 2: design of concrete structures: ENV 1992. Brussels: European Comittee for standardization, 1995.
- Comité Européen de Normalisation (CEN). Eurocódigo 4: proyecto de estructuras mixtas de hormigón y acero: parte 1-1: Reglas generales y reglas para edificación: parte 2: puentes mixtos. Madrid: AENOR, 2001.
- Dirección General de Carreteras. Recomendaciones para el proyecto de puentes mixtos para carretereras: RPX-95. Madrid: Ministerio de Fomento. Secretaría de Estado de Infraestructuras y Transportes. Dirección General de Carreteras, 1996. ISBN 8449802245.
- Mirambell Arrizabalaga, E. Apuntes de estructuras mixtas. Barcelona: ETSECCPB, 2000.
- Martinez Calzón, J.; Ortiz Herrera, J. Construcción mixta: hormigón-acero. Madrid: Rueda, 1978. ISBN 8472070107.
- "Varios artículos". Revista Hormigón y Acero [on line]. Vol. 43 Núm. 185 (1992) [Consultation: 11/11/2020]. Available on: http://www.hormigonyacero.com/index.php/ache/issue/view/225.
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- Johnson, R.P.; Wang, Y.C. Composite structures of steel and concrete: beams, slabs, columns and frames for buildings. 4th ed. Blackwell, 2018. ISBN 9781119401438.
- Steinle, A.; Bachmann, H.; Tillmann, M. Precast concrete structures [on line]. 2nd ed. Berlin: Wilhelm Ernst & Sohn Verlag fur Architektur und Technische, 2019 [Consultation: 11/11/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5652251. ISBN 9783433609033.
- Ghali, A.; Favre, R.; Elbadry, M. Concrete structures: stresses and deformations: analysis and design for sustainability. 4th ed. London ; New York: Spon Press, 2012. ISBN 9780415585613.
- Gilbert, R.I.; Ranzi, G. Time dependent behaviour of concrete structures [on line]. New York: Spon Press, 2011 [Consultation: 11/11/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=592944. ISBN 9780203879399.