Last update: 04-11-2015

250475 - ESTMIXCOMP - Mixed and Composite Structures

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering

Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering

Academic year: 2015

Degree: MASTER'S DEGREE IN CIVIL ENGINEERING (RESEARCH TRACK) (Syllabus 2007). (Teaching unit Optional)
MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN CIVIL ENGINEERING (RESEARCH TRACK) (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN STRUCTURAL AND CONSTRUCTION ENGINEERING (Syllabus 2015). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: ENRIQUE MIRAMBELL ARRIZABALAGA

Others: ANTONIO RICARDO MARI BERNAT, ENRIQUE MIRAMBELL ARRIZABALAGA

Opening hours

Timetable: The consultations will take place on appointment.

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.

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.

Last update: 04-11-2015

250475 - ESTMIXCOMP - Mixed and Composite Structures

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

Total learning time: 125h	Theory classes:	19h 30m	15.60%
	Practical classes:	9h 45m	7.80%
	Laboratory classes:	9h 45m	7.80%
	Guided activities:	6h	4.80%
	Self study:	80h	64.00%

Last update: 04-11-2015

250475 - ESTMIXCOMP - Mixed and Composite Structures

Content

Overview

Learning time: 7h 11m

Theory classes: 3h
Self study : 4h 11m

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

Structural behavior. Time dependent effects

Learning time: 7h 11m

Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

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.

The prestressed composite structures. Ultimate limit states

Learning time: 7h 11m

Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

Description:
The prestressed composite structures: Prestressed pre-connection and post-connection. Instantaneous and delayed study. Efforts flush of localized nature. Ultimate limit states. Classification of mixed sections. Ultimate strength of the cross sections of a composite beam. Ultimate bending moment: Basis. Plastic moment resistance of a section with total connection. Plastic moment resistance of a section with partial connection. Response last time classes 1, 2, 3 and 4 with positive and negative bending moment. Resistance of the composite section for shear in sections 1 and 2 class. Bending-shear interaction.
Resolution of exercise for determining the ultimate moment of a section subjected to bending mixed positive and negative, considering linear elastic and plastic theory.

Last update: 04-11-2015

250475 - ESTMIXCOMP - Mixed and Composite Structures

Serviceability limit states

Learning time: 7h 11m

Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

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.

Shear connection

Learning time: 7h 11m

Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

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

Construction process

Learning time: 7h 11m

Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

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

Last update: 04-11-2015

250475 - ESTMIXCOMP - Mixed and Composite Structures

Composite columns	Learning time: 7h 11m Theory classes: 2h Practical classes: 1h Self study : 4h 11m

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

Composite slabs with profiled sheet	Learning time: 7h 11m Theory classes: 2h Practical classes: 1h Self study : 4h 11m

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

Composite bridges	Learning time: 7h 11m Theory classes: 3h Self study : 4h 11m

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.

250475 - ESTMIXCOMP - Mixed and Composite Structures

Composite structures with different types of concrete	Learning time: 21h 36m Theory classes: 9h Self study : 12h 36m

Description:
Composite structures for different concretes. Time dependent behavior. Effects of: shrinkage and creep of the concrete, and relaxation of the prestressing steel. Time dependent analysis. General procedure and method of the coefficient of ageing.
Evolutive construction procedures. Phases of concrete cast at transversal and longitudinal level. Structural continuity. Redistribution of stresses and forces along time. Interaction with the cracking of concrete.
Interfacial shear stresses between different concrete elements. Shear friction model. Internal steel rebars at the joint. Screed of elements. Prefabricated bridges with structural continuity.

Evaluation	Learning time: 7h 11m Laboratory classes: 3h Self study : 4h 11m

Qualification system

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

It consists of four 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.

Regulations for carrying out activities

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Last update: 04-11-2015

250475 - ESTMIXCOMP - Mixed and Composite Structures

Bibliography

Basic:

Comisión permanente del Hormigón. Instrucción de Hormigón Estructural EHE-08. Madrid: Ministerio de Fomento, 2008.

Comisión Permanente de Estructuras de Acero. Instrucción del Acero Estructural EAE. Madrid: Ministerio de Fomento, 2011.

Comité Européen de Normalisation (CEN). EN 1992. Eurocode 2: Design of Concrete Structures.. Laussanne, 2004.

Comité Européen de Normalisation (CEN). Eurocódigo 4. Proyecto de estructuras mixtas de hormigón acero. Parte 1-1: Reglas generales y reglas para edificación. Parte 2: Puentes. Laussanne,

Dirección General de Carreteras. Recomendaciones para el proyecto de puentes mixtos para carretereras RPX-95. Madrid: Ministerio de Fomento, 1995.

Enrique Mirambell Arrizabalaga. Apuntes de estructuras mixtas. ETSECCPB, 2000.

Julio Martinez Calzón, Jesús Ortiz. Construcción mixta. Madrid: Rueda, 1978.

Asociación Técnica Española del Pretensado. Varios artículos. Madrid: Revista Hormigón y Acero 185, 1992. ISBN 0439-5686.

Jose Luiz Rangel y Enrique Mirambell. Pilares mixtos. ETSECCPB, 2008.

Johnson RP. Composite Structures of Steel and Concrete. 3rd. Blackwell Publishing, 2004.

Hubert Bachmann, Alfred Steinle. Precast concrete structures. Berlin: Ernst & Sohn, 2011. ISBN 978-3-433-02960-2.

A. Ghali, R. Favre, M. Elbadry. Concrete Structures: Stresses and Deformations: Analysis and Design for Serviceability. 3rd. New York: Taylor and Francis, 2002. ISBN 0-203-98752-7.

R. I. Gilbert, G. Ranzi. Time dependent behaviour of concrete structures. New York: Taylor and Francis, 2011. ISBN 0-203-87939-2.