Mixed and Composite Structures (250475)

General information

School:	ETSECCPB
Departments:	751 - Departament d'Enginyeria Civil i Ambiental
Credits:	5.0 ECTS
Programs:	1161 - MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012), 872 - MÀSTER UNIVERSITARI EN ENGINYERIA DE CAMINS, CANALS I PORTS (pla 2012), 1140 - MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ (pla 2015)
Course:	2015/2016
Course language:	Castellano

Faculty

Responsible faculty: Enrique Mirambell Arrizabalaga

Teachers: Antonio Ricardo Mari Bernat, Enrique Mirambell Arrizabalaga

Generic objectives

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.

Skills

Specific skills

Knowledge of all kinds of structures and materials and the ability to design, execute and maintain structures and buildings for civil works.

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.

Generic skills of subject

INNOVATION, EMPLOYABILITY, DEVELOPMENT AND RESEARCH: The ability to develop one's creative and innovative tendencies with the ultimate aim of serving the development and

progress of society. The ability to work on a research topic. Employability in managerial posts in all types of companies and public authorities, coupled with initiative and decision-making abilities. The ability to develop one's creative and innovative tendencies with the ultimate aim of serving the development and progress of society. The ability to work on a research topic. Employability in managerial posts in all types of companies and public authorities, coupled with initiative and decision-making abilities.

SUSTAINABILITY AND THE ENVIRONMENT: The capacity for engineering development in the framework of globalisation, sustainability and environmental protection. The ability to analyse the entire life cycle of an engineering project.

KNOWLEDGE DEVELOPMENT: The ability to develop new analytical methods and processes at all levels: conception, design and development. The ability to propose and develop specifications, regulations and rules in engineering following safety and efficiency criteria and using sustainable resources.

ECTS credits: total hours of student work

		Dedication	
		Hours	**Percent**
Supervised Learning	**Theory**	29.00	64.4%
	Assignments	7.00	15.6%
	Laboratory	3.00	6.7%
	Supervised activities	6.00	13.3%
Self-Learning		80.00	

Contents

Overview

Dedication

3.0h. Theory

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

Dedication

2.0h. Theory + 1.0h. Assignments

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

Dedication

2.0h. Theory + 1.0h. Assignments

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.

Serviceability limit states

Dedication

2.0h. Theory + 1.0h. Assignments

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

Dedication

2.0h. Theory + 1.0h. Assignments

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

Dedication

2.0h. Theory + 1.0h. Assignments

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

Composite columns

Dedication

2.0h. Theory + 1.0h. Assignments

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

Dedication

2.0h. Theory + 1.0h. Assignments

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

Dedication

3.0h. Theory

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.

Composite structures with different types of concrete

Dedication

9.0h. Theory

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

Dedication

3.0h. Laboratory

Activities

Activity 1

Dedication

1.5 h. Supervised activities

Description

Design of a composite bridge subjected to thermal action-homogeneous distribution with discontinuity-

Activity 2

Dedication

1.5 h. Supervised activities

Description

Determination of ultimate strength in bending failure of a composite section, when the reinforcing steel is increased

Activity 3

Dedication

1.5 h. Supervised activities

Description

Calculation of deflections in a composite beam, considering the construction process and the effect of cracking.

Activity 4

Dedication

1.5 h. Supervised activities

Description

Resolution of concrete-concrete composite structure

Grading rules (*)

(*) The evaluation calendar and grading rules will be approved before the start of the course.

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.

Test rules

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

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.

Office hours

The consultations will take place on appointment.

Basic bibliography

- Comisión permanente del Hormigón. **Instrucción de Hormigón Estructural EHE-08**. Ministerio de Fomento. Madrid. 2008.
- Comisión Permanente de Estructuras de Acero. **Instrucción del Acero Estructural EAE**. Ministerio de Fomento. Madrid. 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**. Ministerio de Fomento. Madrid. 1995.
- Enrique Mirambell Arrizabalaga. **Apuntes de estructuras mixtas**. ETSECCPB. 2000.
- Julio Martinez Calzón, Jesús Ortiz. **Construcción mixta**. Rueda. Madrid. 1978.
- Asociación Técnica Española del Pretensado. **Varios artículos**. Revista Hormigón y Acero 185. Madrid. 1992. ISBN 0439-5686.
- Jose Luiz Rangel y Enrique Mirambell. **Pilares mixtos**. ETSECCPB. 2008.
- Johnson RP. **Composite Structures of Steel and Concrete**. Blackwell Publishing . 2004.
- Hubert Bachmann, Alfred Steinle. **Precast concrete structures**. Ernst & Sohn. Berlin. 2011. ISBN 978-3-433-02960-2.
- A. Ghali, R. Favre, M. Elbadry. **Concrete Structures: Stresses and Deformations: Analysis and Design for Serviceability**. Taylor and Francis. New York. 2002. ISBN 0-203-98752-7.
- R. I. Gilbert, G. Ranzi. **Time dependent behaviour of concrete structures**. Taylor and Francis. New York. 2011. ISBN 0-203-87939-2.