Course guide
250708 - 250708 - Non-Linear Analysis of Steel Structures

Last modified: 20/06/2024

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 2015). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: ROLANDO ANTONIO CHACÓN FLORES

Others: ITSASO ARRAYAGO LUQUIN, ROLANDO ANTONIO CHACÓN FLORES, ENRIQUE MIRAMBELL ARRIZABALAGA

PRIOR SKILLS

Students must have knowledge of linear analysis of structures and the design of steel structures following basic guidelines. This knowledge is essential to successfully follow the course content and understand the advanced concepts that will be covered. A prior review of these topics is recommended to ensure a solid foundation for optimal learning.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13364. To conceive and design civil and building structures that are safe, durable, functional and integrated into its surroundings.
13365. Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum, shape memory alloys?).
13366. To evaluate, maintain, repair and strengthen existing structures, including the historic and artistic heritage.
13369. To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

Generical:
13360. To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.
13361. To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.
13362. To define construction processes and methods of organization and management of projects and works.

TEACHING METHODOLOGY

The course consists of 2.3 hours per week of face-to-face classes in the classroom (large group) and 0.3 hours per week with half of the students (medium group).

2.3 hours are dedicated to theoretical classes in the large group, where the faculty presents the basic concepts and materials of the subject, shows examples, and conducts exercises.

0.3 hours (medium group) are dedicated to problem-solving with greater interaction with the students. Practical exercises are conducted to consolidate the general and specific learning objectives.

The rest of the weekly hours are dedicated to conducting a validation benchmark of the tools used.

Support material is provided in the form of a detailed teaching plan through the virtual campus ATENEA: content, scheduling of assessment and directed learning activities, and bibliography.

Although most sessions will be conducted in the language indicated in the guide, sessions with the support of other guest experts may occasionally be conducted in another language.

LEARNING OBJECTIVES OF THE SUBJECT

Subject to deepen the nonlinear phenomena and their effects in steel structures

Capability to recognize and understand the tough and tense - deformational mechanisms of steel structures in nonlinear behavior. Ability to evaluate the influence of these mechanisms in their design and calculation

Causes of nonlinearity in steel structures. Geometric nonlinearity. Structural analysis: sway structures criteria. Equivalent geometric imperfections. Elastic analysis. Nonlinearity Material Analysis. Algorithms for solving nonlinear problems. Plate buckling theory. Patch loading and nonlinear analysis of steel structures using the finite element method (Schedule C of EN1993-1-5). Presentation of calculation programs. Advanced Methods : General method, CSM and DSM.

STUDY LOAD

Type	Hours	Percentage
Hours large group	25,5	20.38
Hours small group	9,8	7.83
Self study	80,0	63.95
Hours medium group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

Introduction

Description:
In this session the principles of nonlinear behavior of steel structures are presented

Full-or-part-time: 1h 24m
Self study : 1h 24m

Geometric nonlinearity

Description:
Description of the basic principles of the effects of geometric nonlinearity on steel structures
Introduce a software for instability chek in steel elements

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

Structural analysis

Description:
This session will define the criteria for determining whether a frame should be classified as sway or non-sway, and the equivalent imperfections to be used for analysis in second order.
In this session, the different methods of analysis to be used depending on the degree of sway for the present structure are presented
In this session the software to be used for solving practical 2 and 3 are presented.

Full-or-part-time: 2h
Theory classes: 2h

Material nonlinearity

Description:
In this session elastoplastic methods and overall plastic nonlinear analysis of steel structures are presented

Full-or-part-time: 8h
Theory classes: 6h
Self study : 2h

Introduction to seismic analysis of steel structures

Description:
In this session the basic principles of seismic analysis in steel structures are presented

Full-or-part-time: 4h 30m
Theory classes: 3h
Self study : 1h 30m

GMNIA

Description:
This session introduces the geometrical and material nonlinear analysis

Full-or-part-time: 8h
Theory classes: 6h
Self study : 2h

Plate buckling

Description:
The basic principles of plate buckling are introduced and special mention to the phenomenon of shear buckling and patch loading is done

Full-or-part-time: 4h 30m
Theory classes: 3h
Self study : 1h 30m

Joints

Description:
We present the differences between the frames design with rigid and semi-rigid joints.
Some computer programs to analyze frames with semi-rigid joints are presented
Example for design of a frame with semi-rigid joints using a software

Full-or-part-time: 20h 46m
Theory classes: 2h
Practical classes: 4h
Self study : 14h 46m

Advanced methods

Description:
In this session some advanced analysis methods that are being developed in various research fields are presented

Full-or-part-time: 7h
Theory classes: 2h
Self study : 5h

Final Exercise

Description:
this session is for working on the different final course workdeveloped by the students

Full-or-part-time: 16h 39m
Practical classes: 16h 39m

GRADING SYSTEM

The course grade is obtained from the grades of a final exam and the corresponding continuous assessment.

The continuous assessment consists of different individual practices of an additive and formative nature, carried out during the course (inside and outside the classroom).

The assessment tests consist of a part with questions about concepts associated with the learning objectives of the course regarding knowledge or understanding.

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

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:
- Galambos, T.V.; Surovek, A.E. Structural stability of steel: concepts and applications for structural engineers. Hoboken: John Wiley & Sons, 2008. ISBN 9780470037782.
- Ziemian, R.D. (ed.). Guide to stability design criteria for metal structures. 5th ed. Hoboken, New Jersey: John Wiley & Sons, 2010. ISBN 9780470085257.
- Simões da Silva, L.; Simões, R.; Gervásio, H. Eurocode 3: design of steel structures: Part 1-1: General rules and rules for buildings. Brussels: European Convention for Constructional Steelwork, 2010. ISBN 9783433029732.
- Trahair, N.; Nethercot, D.; Gardner, L. The behaviour and design of steel structures to EC3. 4th ed. London ; New York: Taylor & Francis, 2008. ISBN 9780415418669.