

Course guides

250834 - 250834 - Advanced Methods in Seismic Damage Evaluation

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Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2019 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: LUIS GONZAGA PUJADES BENEIT

Others: LUIS GONZAGA PUJADES BENEIT, YEUDY FELIPE VARGAS ALZATE

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

- 13308. To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
- 13309. To characterize the geological environment and its interaction with civil works.
- 13310. To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory testing programmes.
- 13312. To analyze, discriminate and integrate geological and geotechnical information in studies and projects.
- 13313. To apply the knowledge on soil and rock mechanics to the development of the study, design, construction and exploitation of foundations, excavations, embankments, tunnels and other constructions on or through the soils, regardless of their nature and state or the finality of the works under study. (Specific competence of the specializations in Geotechnical Engineering and Earthquake Engineering and Geophysics).
- 13317. To dimension civil structures in the presence of seismic forces. To dimension corrective solutions. (Specific competence of the specialization in Earthquake Engineering and Geophysics).
- 13318. To assess seismic risks. To plan and dimension risk reduction measures. (Specific competence of the specialization in Earthquake Engineering and Geophysics).
- 13324. To identify all types of structures and materials. To design, plan, implement and maintain structures and buildings in civil works. (Specific competence of the specialization in Earthquake Engineering and Geophysics).
- 13325. To analyze the structures, by applying advanced methods, design software and structural calculations, from the knowledge and understanding of the forces and their application to the structural typologies used of civil engineering. To perform structural integrity assessment. (Specific competence of the specialization in Earthquake Engineering and Geophysics).

General:

- 13300. To apply advanced knowledge in sciences and technology to the professional or research practice.
- 13301. To lead, coordinate and develop integrated projects in Geo-Engineering.
- 13302. To identify and design solutions for geo-engineering problems within ethical, social and legislative frameworks.
- 13303. To evaluate the impact of Geo-engineering on environment, sustainable social development and the significance of working within reliable and consensuous professional environment.
- 13304. To incorporate new technologies and advanced tools in Geo-engineering into profesional and research activities.
- 13305. To conceive Geo-engineering as a multi-disciplinary field that includes relevant aspects from geology, sismology, hydrogeology, geotechnical and earthquake engineering, geomechanics, physics of porous media, geophysics, geomatics, natural hazard, energy and climate interactions.
- 13306. To promote innovation for the development of methodology, analyses and solutions in Geo-engineering
- 13307. To tackle and solve advanced mathematical problems in engineering from the drafting of the problem to the development of formulation and further implementation in computer programs. Particularly, to formulate, code and apply analytical and numerical advanced computational tools to project calculations in order to plan and manage them as well as to interpret results in the context of Geo-engineering and Mining engineering.

TEACHING METHODOLOGY

The course consists of 39 hours of study sessions. 27 hours are devoted to lectures and 12 hours to practices and problems requiring the use of MatLab software. 6 hours more are devoted to directed works. Students must develop a final project of course, performing the analysis of the damage expected in a specific building. The project may be organized individually or in groups. An oral presentation of the results should be performed. The students should also realize written exam on the methods to assess the seismic damage. Supporting materials will be provided in the virtual campus of ATENEA.

LEARNING OBJECTIVES OF THE SUBJECT

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.

To characterize the geological environment and its interaction with civil works.

To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose testing programmes.

To analyze, discriminate and integrate geological and geotechnical information in studies and projects.

To apply the knowledge on soil and rock mechanics to the development of the study, design, construction and exploitation of foundations, excavations, embankments, tunnels and other constructions on or through the soils, regardless of their nature and state or the finality of the works under study (Specific competence of the specialties in Geotechnical Engineering and Earthquake Engineering and Geophysics).

To dimension civil structures in the presence of seismic forces. To dimension corrective solutions. (Specific competence of the specialization in Earthquake Engineering and Geophysics).

To assess seismic risks. To plan and dimension risk reduction measures. (Specific competence of the specialization in Earthquake Engineering and Geophysics).

To identify all types of structures and materials. To design, plan, implement and maintain structures and buildings in civil works. (Specific competence of the specialization in Earthquake Engineering and Geophysics).

To analyze the structures, by applying advanced methods, design software and structural calculations, from the knowledge and understanding of the forces and their application to the structural typologies used of civil engineering. To perform structural integrity assessment. (Specific competence of the specialization in Earthquake Engineering and Geophysics).

* To know and be able to apply the main seismic risk assessment methods and techniques.

* To know the most advanced methods and techniques to analyze and manage seismic risk, including the danger, vulnerability and damage analysis, as well as its economic evaluation.

- Review of intensity scales.
- Statistical distributions : binomial, lognormal, beta and others.
- Spectra of capacity and demand.
- Methods based on vulnerability indexes.
- Methods based on capacity spectrum.
- HAZUS and EU-Risk methods.
- Case studies and examples.

To Achieve the ability of performing studies to assess the damage expected in urban areas, in case of earthquake.

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

01 Introduction

Description:

Course objectives. Description of topics. Description of the type of evaluation. Description of the final course work. Delivery of the materials for the course.

Binomial, beta, normal, lognormal and other probability distributions. Probability density functions (pdf) and cumulative distribution functions (cdf).

Concepts of hazard, vulnerability, damage and risk. Damage functions.

Specific objectives:

Define the specific conditions related to the methodology of classes and type of evaluation. Description of the course contents and course work as well as the progress of follow-up requests.

To review the main probability distributions used in the seismic damage assessment methods.

Define the terminology and main concepts related to seismic risk.

Full-or-part-time: 12h

Theory classes: 5h

Self study : 7h

02 Background

Description:

Background of intensity scales. Scales in use. Its importance in the methods of damage assessments.

Methods based on expert opinion. ATC-13 ATC-25.

MSK'64 and scales and EMS'98. vulnerability classes. Damage probability matrices. Level 0 methods.

Specific objectives:

To know the historical way of defining the size of earthquakes as well as its validity and importance in the current context. To know, at a practical level, the most important macroseismic scales.

To review and to apply, at practical level, damage assessment methods based on expert's opinion.

To learn, at a practical level, methods based on vulnerability classes.

Full-or-part-time: 16h 48m

Theory classes: 7h

Self study : 9h 48m

03 Macroseismic methods.

Description:

Methods based in the rating of strength parameters; the Italian method.

The vulnerability index method. The Risk-UE proposal.

Specific objectives:

To know, at an applied level, the methods based on the rating of strength parameters.

To know and to apply the vulnerabilityindex based method. Level I methods.

Full-or-part-time: 12h

Theory classes: 5h

Self study : 7h



04 Capacity spectrum based methods

Description:

Response spectra, capacity spectra and demand spectra General concepts.
Capacity-spectrum-based methods. Fragility curves and damage probability matrices. Mean damage grade.

Specific objectives:

Review of the basics of response spectra, capacity spectra and demand spectra. The performance point.
To know, at applied level, capacity-spectrum-based methods.

Full-or-part-time: 14h 23m

Theory classes: 6h

Self study : 8h 23m

05 Other damage-related issues.

Description:

Induced damage to the population: homeless, injured people and casualties. Economic damage.
Other indexes and damage models. Probabilistic methods. Incremental dynamic analyses.

Specific objectives:

To know, at a practical level, the socio-economic impact of an earthquake.
To introduce students to current issues and advanced topics related to seismic damage assessments.

Full-or-part-time: 9h 36m

Theory classes: 4h

Self study : 5h 36m

06 practices and problems.

Description:

To propose and to solve problems.
Practical exercises.

Specific objectives:

To learn to pose and solve specific problems.
To deepen on the applied aspects of the damage assessment methods.

Full-or-part-time: 28h 47m

Practical classes: 5h

Laboratory classes: 7h

Self study : 16h 47m

GRADING SYSTEM

Evaluation will consider the following aspects: practical exercises (15%), course work (30%), public presentation (15%), written exam (40%). Attendance to class will be taken into account too.

EXAMINATION RULES.

The exercises and exams not performed, will be evaluated with zero points.



BIBLIOGRAPHY

Basic:

- Applied Technology Council. Earthquake damage evaluation data for California: ATC-13. Redwood City: Applied Technology Council, 1985.
- Applied Technology Council. Seismic vulnerability and impact of disruption of lifelines in the conterminous United States: ATC-25. Redwood City: Applied Technology Council, 1991.

Complementary:

- Applied Technology Council. Redwood City. California. 1996.. Seismic evaluation and retrofit of concrete buildings: vol 1: ATC-40. Applied Technology Council. Redwood City: Applied Technology Council, 1996.
- Milutinovic, Z.V.; Trendafiloski, G.S.. WP4: vulnerability of current buildings [on line]. 2003. Skopje, Macedonia: Institute of Earthquake Engineering and Engineering Seismology (IZIIS), 2003 [Consultation: 12/05/2020]. Available on: http://www.civil.ist.utl.pt/~mlopes/conteudos/DamageStates/Risk%20UE%20WP04_Vulnerability.pdf.