

Course guide

250833 - 250833 - Seismic Hazard Assessment

Last modified: 18/02/2021

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: 2020 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: YEUDY FELIPE VARGAS ALZATE

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).
- 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).
- 13327. To perform studies of seismic hazard. (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 consciensous profesional 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 subject consists of 39 class hours; 27 hours to theoretical classes and 12 hours to solve problems, practices and evaluation, that include the use of the latest versions of the CRISIS program. 6 hours are dedicated also to guided works using this computer platform. Students must develop a course project, performing seismic hazard analysis for a particular area of study (assigned by the teacher). The project can be done individually or in group. An oral presentation of the results of the project will be carried out, as well as a written (individual) test about the basic concepts of the study of seismic hazard. Support material will be used through the ATENEA virtual campus.

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 understand, as to advanced applications, the theoretical and practical concepts in seismology.

* To know and be able to treat the different ways to record the seismic waves at a global, regional and local level, as well as the instrumentation used in the near and far fields and also the instrumentation of buildings and structures.

* To know the seismic risk assessment methods and techniques and to be able to carry out studies applied to seismic risk.

* To know and apply subsoil survey techniques by means of destructive geophysical tools and techniques.

* To have a global vision of how to deal with the main problems regarding engineering seismology and earthquake engineering.

- Natural and induced seismicity.

- Seismogenic areas: characterization. Laws for truncated and not truncated occurrence.

- Seismic Attenuation: predictive laws of ground motion.

- Deterministic and probabilistic methods.

- Random and epistemic uncertainties.

- Tree diagrams.

- Probability of occurrence and return periods.

- Maps of seismic hazard.

- Local effects.

- The program CRISIS. Realization of a practical case.

Learning to conduct a study of seismic hazard.

STUDY LOAD

Type	Hours	Percentage
Practical classes	9,8	7.83
Self study	80,0	63.95
Guided activities	6,0	4.80
Theory classes	19,5	15.59



Type	Hours	Percentage
Laboratory classes	9,8	7.83

Total learning time: 125.1 h

CONTENTS

01 Introduction

Description:

Course objectives. Description of issues to span. Description type of evaluation. Description final course project.
Basic concepts required for understanding more complex concepts addressed in the course.
PHSA 2: characterization of the path from the source to the site: attenuation laws and logical trees.

Specific objectives:

Define the specific conditions related to the methodology of lectures and type of assessment to be made. Description of the final course project and the follow-up of the progress requested.
Basic concepts to deal with during the whole course; attenuation issues, type of faults and overall classification of earthquakes by distance, depth and magnitude.
Revision of attenuation laws, their determination and application. New trends in the computation of attenuation laws. To show the use of logical trees, as well as examples of actual cases.

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

Theory classes: 6h

Self study : 8h 23m

02 Deterministic seismic hazard

Description:

DHSA 1: Deterministic seismic hazard study: Concepts over deterministic parameters and application to a particular case.
DHSA 2: Deterministic seismic hazard study: Application to the seismic hazard analysis for regions.

Specific objectives:

To evaluate basic attenuation laws of and to combine them with deterministic parameters to assess the seismic hazard for a region or a specific site.
Case study evaluation of seismic hazard for a region by using deterministic approaches.

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

Theory classes: 6h

Self study : 8h 23m

03 Probabilistic seismic hazard

Description:

PHSA 1: basic concepts of probability applied to seismic hazard analysis; analysis and debug of databases of historical earthquakes. Application to Gutenberg-Richter law.

PHSA 3: Integration of seismic hazard. Using the CRISIS computer program and example (1/2) of assessment of seismic hazard .

PHSA 3: Integration of seismic hazard. Using CRISIS and example of assessment of seismic hazard (1/2).

Theoretical and applied aspects of the CRISIS program. Program Learning session.

Parameters used in seismic design codes. Application of results of seismic hazard to structural analysis.

Specific objectives:

Apply basic elements of probability: probability distributions, cumulative function and truncated functions. Examine direct applications to the law of Gutenberg-Richter.

To review the methods currently used for determining the probabilistic seismic hazard. Showing a case study by using the 2007 CRISIS 2007 computer program and explaining the use of this tool step by step.

To know the different results of the analysis and their proper interpretation. Application to engineering case studies.

To know, at a theoretical and applied level, the CRISIS program.

Introduce the use of the results of the seismic hazard for the structural analysis. To know the relationship between the seismic demand as defined in seismic codes and results obtained from the seismic hazard analysis.

Full-or-part-time: 36h

Theory classes: 15h

Self study : 21h

04 Practices and Laboratory

Description:

Search database of historical earthquakes.

Determination of attenuation laws for calculation of acceleration response spectra.

Determination of parameters for Gutenberg-Richter law.

Least squares and maximum likelihood fits.

Selection of attenuation laws for study areas.

Development of logical trees for probabilistic seismic hazard analysis.

Exercises and problems related to the contents of the subject and with the work of the course.

Specific objectives:

To learn to identify the different parameters required for the analysis of the seismic hazard of a civil structure, whether in a deterministic or probabilistic way, understanding the influence of the relevant parameters.

To delve into specific aspects of the subject.

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

Practical classes: 5h

Laboratory classes: 7h

Self study : 16h 47m

GRADING SYSTEM

The assessment of the course takes into account the following aspects: realization of exercises and works (20%); completion of a course work (25%); oral presentation of the work (20%); written exam (35%). Attendance will also be considered.



BIBLIOGRAPHY

Basic:

- McGuire, R. Seismic hazard and risk analysis. Oakland, CA: Earthquake Engineering Research Institute, 2004. ISBN 0943198011.
- Wyss, M.; Shroder, J.. Earthquake hazard, risk and disasters. Academic Press, 2014. ISBN 9780123948489.
- Steidl, Jamison H.. "Site Response in Southern California for Probabilistic Seismic Hazard Analysis". Bulletin of the Seismological Society of America [on line]. 2000;; 90 (6B): S149-S169 [Consultation: 04/03/2021]. Available on: <https://pubs.geoscienceworld.org/ssa/bssa/article-abstract/90/6B/S149/147022/Site-Response-in-Southern-California-for?redirectedFrom=fulltext>.

Complementary:

- Cornell, C. Allin. "Engineering seismic risk analysis". Bulletin of the Seismological Society of America [on line]. 1968;; 58 (5): 1583-1606 [Consultation: 04/03/2021]. Available on: <https://pubs.geoscienceworld.org/ssa/bssa/article-abstract/58/5/1583/116673/Engineering-seismic-risk-analysis?redirectedFrom=fulltext>.
- Benito M.B, Fernández, T. Amenaza sísmica en América Central. ENTINEMA, 2010. ISBN 9788481988147.
- Douglas, John. Ground motion prediction equations 1964-2020 [on line]. Glasgow, UK: University of Strathclyde, 2021 [Consultation: 26/03/2021]. Available on: <http://www.gmpe.org.uk/gmpereport2014.pdf>.
- Lantada. N., Irizarry J., Barbat A.H. [et al]. "Seismic hazard and risk scenarios for Barcelona, Spain. using the Risk-UE vulnerability index method". Bulletin of Earthquake Engineering. 8, 201-229 (2010).