Course guide
250806 - 250806 - Groundwaves Generation and Propagation

Last modified: 25/01/2024

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). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: ALBERTO LEDESMA VILLALBA

Others: JOSE ORIOL CASELLES MAGALLON, ALBERTO LEDESMA VILLALBA, ENRIQUE EDGAR ROMERO MORALES

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13308. To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
13310. To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory testing programmes.
13311. To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.

Generical:
13300. To apply advanced knowledge in sciences and technology to the profesional or research practice.
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 3 hours per week of classroom activity. That includes theory classes and solving of practical problems, according to the programme.

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.

Some laboratory sessions are also planned: tests on soil dynamic properties and geophysical equipments.

Three activities are planned as homework that eventually may need support from lecturers.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

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 laboratory testing programmes.
To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.

* To apply the theoretical concepts of flow and transportation on porous media.
* To characterize soils.
* To apply the theoretical concepts of deformation and flow in soils.
* To characterize rock massifs and their discontinuities.
* To apply the concepts of mechanical stability and flow in cracks.
* To apply the theoretical problems of elastic and electromagnetic wave propagation in soils and rocks.
* To interpret and process wave signals.

- Introduction to wave propagation in a continuum Time and frequency responses. Lineal and non-lineal systems.
- Generation and propagation of elastic waves. Measuring techniques. Spectral analysis.
- Elastic waves in soils. Material behaviour under dynamic loads. Laboratory tests to determine dynamic properties.
- Analysis of soil dynamic response. Analysis in total and effective stress.
- Analysis of a real case.
- Basic concepts of soil-structure interaction.

Generation and propagation of electromagnetic waves in the soil.

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

Waves in the ground

Description:
Description of the generation of seismic waves in the ground. Earthquakes.

Specific objectives:
Understanding the origin of the seismic waves and types of waves.

Full-or-part-time: 7h 11m
Theory classes: 3h
Self study : 4h 11m

Tools for wave analysis

Description:
Introduction to wave analysis tools based on the Fourier transform.
Exercises about the subject.

Specific objectives:
Understanding the spectral representation of a seismic signal.
To help understanding the concepts and practicing the tools explained the subject.

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Resonance. Wave propagation

Description:
Presentation of the wave equation and associated aspects, such as resonance and conservation of energy flow.
Application examples
Introduction to the application of wave propagation in soil and rock characterization

Specific objectives:
Understanding resonance phenomenon and the wave equation in a continuous medium.
To illustrate the concepts with examples of application.
Brief description of survey techniques based on the principle of wave propagation in the ground.

Full-or-part-time: 19h 12m
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Self study : 11h 12m

Introduction to Soil Dynamics

Description:
Introduction to soil dynamics. Dynamic behavior of soils in the laboratory and in the field.

Specific objectives:
Understanding the behavior of the ground when receiving a seismicwave.

Full-or-part-time: 9h 36m
Theory classes: 4h
Self study : 5h 36m

Soil liquefaction

Description:
Introducing the concept of soil liquefaction. Study in the laboratory and determining the risk of liquefaction in the field.
Visit to the Geotechnical Laboratory. Presentation of Soil Dynamics equipments.

Specific objectives:
Understanding the concept of soil liquefaction due to a seismic signal and to learn the tools available for their study.
To know the equipments available to study the dynamic properties of soils.

Full-or-part-time: 12h
Theory classes: 3h
Laboratory classes: 2h
Self study : 7h

Dynamic response of the soil

Description:
Introducing methodologies for the analysis of wave propagation at local level in a soil deposit.
Application examples

Specific objectives:
Understanding the different methodologies available for analyzing the response of the ground locally.
Examples to illustrate the concepts of the subject

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Applications in Geotechnical Engineering

Description:
Present some applications of the concepts worked in the field of Geotechnical Engineering (geotechnical works, soil-structure interaction) and Geological Engineering (slopes), etc.
Application examples and Problems

Specific objectives:
Illustration of the concepts presented in the course.

Full-or-part-time: 19h 12m
Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Evaluation

Full-or-part-time: 7h 11m
Laboratory classes: 3h
Self study : 4h 11m

GRADING SYSTEM

The mark of the course is obtained from a final exam (50% of the mark) and three assignments (10%, 10% and 30% of the mark). This exam consists of several questions and/or short exercises that must be answered without using any support material.

There are guided activities that are marked: an assignment on signal filtering (10%), an assignment on liquefaction (10% of the final mark) and an assignment on seismic response of a soil layer using Deepsoil software (30% of the final mark).

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:
- Kramer, Steven Lawrence. Geotechnical earthquake engineering. Upper Saddle River, NJ: Prentice Hall, 1996. ISBN 0133749436.
- Ben-Menahem, Ari; Singh, Sarva Jit. Seismic waves and sources. 2nd ed. Mineola, New York: Dover, 2000. ISBN 0486404617.
- Das, Braja M. Fundamentals of soil dynamics. New York: Elsevier, cop. 1983. ISBN 0444007059.
- Colindres Selva, Rafael. Dinámica de suelos y estructuras. 2ª ed. México D.F. [etc.]: Limusa, 1993. ISBN 9681847210.

Complementary:
- Aki, Keiiti; Richards, Paul G. Quantitative seismology. 2nd ed. Sausalito: University Science Books, cop. 2002. ISBN 0935702962.
- Kennett, B.L.N. The seismic wavefield. Cambridge University Press, 2002. ISBN 9780521006637.
- Ishihara, Kenji. Soil behaviour in earthquake geotechnics. Oxford: Clarendon Press, 1996. ISBN 0198562241.