250830 - Sismology

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: LUIS GONZAGA PUJADES BENEIT
Others: LUIS GONZAGA PUJADES BENEIT

Opening hours
Timetable: Thursday, since 11 AM till 13 PM and by appointment.

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 profesional 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 conscienosus profesional environment.
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13304. To incorporate new technologies and advanced tools in Geo-engineering into professional 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 45 hours. 27 hours are devoted to theoretical lectures and 12 hours to problems and practices. 6 hours are set apart for other activities. The student must perform four practical exercises. Support materials are provided through 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.
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To perform studies of seismic hazard. (Specific competence of the specialization in Earthquake Engineering and Geophysics).

* To understand, speaking of advanced use, the theoretical and practical concepts in seismology.
* To know and be able to deal with the different seismic wave recording procedures at a global, regional and local level, as well as the tools used in the near and far field and the instrumentation of buildings and structures.
* To know the risk assessment methods and techniques and to be able to develop studies applied to seismic risk.
* To know and apply soil surveying techniques using non-destructive geophysical tools and techniques.
* To have a global vision on how to address the main problems falling to seismology for engineering and earthquake engineering.

- The seismic phenomenon: causes and effects.
- Principal waves and seismic phases.
- Mechanism of earthquakes.
- Size of earthquakes: magnitude and intensity.
- Empirical formulas.

To introduce students to the concepts, methods and applications of seismology, with special emphasis on those aspects related to engineering seismology and earthquake engineering.

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<thead>
<tr>
<th>Study load</th>
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<tbody>
<tr>
<td><strong>Total learning time:</strong> 125h</td>
<td>Theory classes:</td>
<td>19h 30m</td>
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<td>Practical classes:</td>
<td>9h 45m</td>
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<td></td>
<td>Laboratory classes:</td>
<td>9h 45m</td>
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<td></td>
<td>Guided activities:</td>
<td>6h</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
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## Content

### 01 Introduction

**Description:**
Historical aspects. Seismology in the world. Associations and scientific institutions. Seismological observatories. Seismological Service institutions in Spain, in Catalonia and in the world.

**Specific objectives:**
To know seismology in the history and in the world.

**Learning time:** 4h 48m
- Theory classes: 2h
- Self study: 2h 48m

### 02 The seismic phenomenon

**Description:**

**Specific objectives:**
Understanding the causes of earthquakes in different tectonic environments. Know the main characteristics of earthquakes and their effects.

**Learning time:** 10h 48m
- Theory classes: 4h 30m
- Self study: 6h 18m
### 03 Seismic phases

**Learning time:** 20h 24m  
Theory classes: 5h 30m  
Practical classes: 3h  
Self study: 11h 54m

**Description:**  
Main seismic phases observed in the Earth. Internal waves: near, far and shadow zone earthquakes near, far and shaded area. Reflected and refracted waves. Phases of deep earthquakes. Surface Rayleigh and Love waves.  
Other seismic waves. Anatomy of seismograms.  
Geometry of the arrival of internal waves: SV, SH, SVV, SVH, PV, PH, angles of incidence of the P wave, azimuth, angle of polarization of the wave S.  
To determine an epicenter with data from a single station, using the polarities and amplitudes of the P wave, arrivals of P and S waves and travel time tables of internal waves. Three approaches are suggested: graphic, velocity models and seismological tables. Determine the geographical coordinates of the epicenter and origin time. Discusse the problem of determining the depth of the earthquake.  
Detailed analysis of the ground motion caused by a Rayleigh surface wave. Determine the station-epicenter azimuth.  

**Specific objectives:**  
To know the main waves propagating in continuous infinite, semi-infinite and stratified media.  
To know the main seismic phases observed on Earth.  
To study the geometry of the arrival of the internal waves P and S.  
Learn how to make a determination epicentral.  
Characterize the ground motion caused by seismic shocks.

### 04 The size of earthquakes

**Learning time:** 21h 36m  
Theory classes: 5h  
Practical classes: 2h  
Laboratory classes: 2h  
Self study: 12h 36m

**Description:**  
Concept of macro-seismic intensity. Main scales. The MM'56 and the EMS'98 scales.  
Seismic magnitude, seismic moment and energy. Magnitude of internal and surface waves. Standard formulas.  
Local magnitude formulas. Empirical equations and formulas.  
Determine the magnitude of an earthquake from a Rayleigh wave. Using empirical formulas for estimating the other parameters that define the size of the earthquake: intensity, magnitude of internal waves, seismic moment and energy.  

**Specific objectives:**  
To know the macro-seismic quantification of the size of earthquakes.  
To know, at an applied level, the main parameters used to determine the size of earthquakes.  
To learn to estimate the magnitude of an earthquake and other parameters associated with it.
<table>
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<tr>
<th>Course</th>
<th>Learning time</th>
<th>Description</th>
<th>Specific objectives</th>
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| **05 Seismic and macroseismic attenuation** | 9h 36m | **Learning time:** 9h 36m  
Theory classes: 4h  
Self study: 5h 36m | **Description:**  
Isoseismal zones. Variation of intensity with distance. Laws attenuation laws. Applications to seismic hazard analysis.  
**Specific objectives:**  
To learn about macro-seismic attenuation laws.  
To know about attenuation laws of other instrumental parameters. |
| **06 The mechanism of earthquakes** | 19h 12m | **Learning time:** 19h 12m  
Theory classes: 4h 30m  
Laboratory classes: 3h 30m  
Self study: 11h 12m | **Description:**  
Determine a mechanism from the first P wave arrivals.  
**Specific objectives:**  
To know and to understand the fundamentals of the mechanism of the source of earthquakes.  
Learn estimate focal mechanisms from the polarities of the arrivals of the waves P.  
To learn how to determine a focal mechanism and associated parameters. |
| **07 Other topics.** | 7h 11m | **Learning time:** 7h 11m  
Theory classes: 1h 30m  
Laboratory classes: 1h 30m  
Self study: 4h 11m | **Description:**  
Seismic damage. Earthquake-resistant design.  
Realization and discussion of problems.  
**Specific objectives:**  
To introduce students to earthquake engineering.  
Realization and discussion of selected problems. |
Qualification system

The course evaluation is based on the assessment of the problems and practices carried out by the students but it also takes into account the attendance and an exam. The final grade is a weighted average of the marks of the continuous assessment of problems and practices and of the grade of the exam.

Regulations for carrying out activities

If not done any of the scheduled activities, it will be considered as a zero score.

Bibliography

**Basic:**


**Complementary:**


