250833 - Seismic Hazard Assessment

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)
MASTER'S DEGREE IN GEOTECHNICAL AND EARTHQUAKE ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: Spanish

Teaching staff
Coordinator: LUIS GONZAGA PUJADES BENEIT
Others: LUIS GONZAGA PUJADES BENEIT, YEUDY FELIPE VARGAS ALZATE

Opening hours
Timetable: Thursday from noon to 2 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 professional or research practice.
13301. To lead, coordinate and develop integrated projects in Geo-Engineering.
13302. To identify and design solutions for ge-engineering problems within ethical, social and legislative frameworks.
**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...
250833 - Seismic Hazard Assessment

- 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

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Theory classes: 19h 30m</th>
<th>15.60%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 9h 45m</td>
<td>7.80%</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 9h 45m</td>
<td>7.80%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 6h</td>
<td>4.80%</td>
</tr>
<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
</tr>
</tbody>
</table>
## 250833 - Seismic Hazard Assessment

### Content

<table>
<thead>
<tr>
<th>01 Introduction</th>
<th>Learning time: 14h 23m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Self study : 8h 23m</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>02 Deterministic seismic hazard</th>
<th>Learning time: 14h 23m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Self study : 8h 23m</td>
</tr>
</tbody>
</table>

**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.
### 03 Probabilistic seismic hazard

<table>
<thead>
<tr>
<th>Learning time: 36h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 15h</td>
</tr>
<tr>
<td>Self study: 21h</td>
</tr>
</tbody>
</table>

**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.

### 04 Practices and Laboratory

<table>
<thead>
<tr>
<th>Learning time: 28h 47m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical classes: 5h</td>
</tr>
<tr>
<td>Laboratory classes: 7h</td>
</tr>
<tr>
<td>Self study: 16h 47m</td>
</tr>
</tbody>
</table>

**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.
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.

Activities not performed at the scheduled time will be evaluated with a zero score.

Bibliography

Basic:


Complementary: