250811 - Foundations and Earth Retaining Structures

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: Spanish

Teaching staff

Coordinator: JEAN VAUNAT
Others: ANTONIO GENS SOLE, JEAN VAUNAT

Degree competences to which the subject contributes

Specific:
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).

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.

13303. To evaluate the impact of Geo-engineering on environment, sustainable social development and the significance of working within reliable and conscientious professional environment.

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.
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**Teaching methodology**

The course consists of 1.7 hours per week of classroom activity (large size group) and 0.7 hours weekly with half the students (medium size group).

The 1.7 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 0.7 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

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.

**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 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 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 analyze, from the perspective of an expert, cases of failure in Geotechnical Engineering. To report the evidences, identify the mechanisms responsible for the failure and verify using back-analysis models. Eventually provide solutions to risk reduction. (Specific competence of the specialization in Geotechnical Engineering).
To realize studies of land management and urban spaces, including construction of tunnels and other underground infrastructures. (Specific competence of the specialization in Geotechnical Engineering).
To use, in a discriminate manner, commercial software for numerical calculations in order to design and eventually monitor geotechnical structures. (Specific competence of the specialization in Geotechnical Engineering).

* To apply limit analysis concepts to the calculation of limit load in soils.
* To interpret the behavior of soils with regards to critical state mechanics.
* To interpret the behavior of compacted soils with regards to the mechanics of unsaturated soils.
* To suggest a geotechnical field survey campaign.
* To suggest a laboratory research program.
* To critically analyze laboratory and field test results and to obtain soil parameters.
* To calculate shallow and deep foundations.
* To calculate earth contention structures.
* To calculate tunnels in rocks and soils.
* To calculate preloading settlements.
* To use numerical models to calculate soil-structure interaction problems.
* To analyze fracture cases from the point of view of an expert.

- Ground investigation.
- Shallow foundations.
- Deep foundations.
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- Calculation of earth pressure.
- Rigid containment structures.
- Diaphragm walls.

### Study load

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

## Introduction

**Learning time:** 2h 24m  
Theory classes: 1h  
Self study: 1h 24m

**Description:**  
Introduction to the course

## Site investigation

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

**Description:**  
Preliminary documentation  
Density and depth of investigation  
Surface investigation  
Deep investigation  
Trenches and boreholes  
Piezometric observations  
Sampling  
Soil properties and parameters  
Laboratory tests

## In situ tests

**Learning time:** 12h  
Theory classes: 3h  
Practical classes: 2h  
Self study: 7h

**Description:**  
Standard penetration test (SPT)  
Cone penetration test  
Dynamic penetration test  
Vane test  
Pressuremeter test  
Plate load test  
Seismic tests  
Permeability tests  
In situ testing exercises
### Shallow Foundations

**Description:**
- Introduction
- Bearing capacity
- Settlements
- Design criteria
- Factor of safety against failure
- Admissible settlements
- Design of a shallow foundation empirical
- Allowable pressure
- In situ tests

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

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### Deep Foundations

**Description:**
- Preliminaries
- Classification
- Methods of pile construction
- Mechanisms of resistance of piles
- Bearing capacity of an isolated pile
- Tip resistance
- Shaft resistance
- Special cases: gravel, rock
- Bearing capacity of a pile group
- Settlements of a single pile
- Settlements of a pile group
- Piles subjected to lateral loads
- Negative friction
- Foundation exercises

**Learning time:** 14h 23m
- Theory classes: 4h
- Practical classes: 2h
- Self study: 8h 23m

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### Test

**Learning time:** 14h 23m
- Laboratory classes: 6h
- Self study: 8h 23m
## Calculation of earth pressures

**Learning time:** 7h 11m  
Theory classes: 2h  
Practical classes: 1h  
Self study: 4h 11m

**Description:**  
- Coefficient of earth pressure at rest  
- Rankine active and passive states  
- Limit equilibrium  
- Method of Coulomb  
- Additional earth pressures due to surcharges  
- Earth pressure exercises

## Gravity structures

**Learning time:** 14h 23m  
Theory classes: 4h  
Practical classes: 2h  
Self study: 8h 23m

**Description:**  
- General aspects  
- Gravity walls  
- Rockfill walls  
- Cantilever wall  
- Gravity structures exercises

## Reinforced earth

**Learning time:** 7h 11m  
Theory classes: 2h  
Practical classes: 1h  
Self study: 4h 11m

**Description:**  
- Reinforced Earth  
- Green Walls  
- Bolts  
- Anchors  
- Reinforced earth exercises
Qualification system

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

Regulations for carrying out activities

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

Bibliography

Basic:

