Course guides
250810 - 250810 - Advanced Soil Mechanics

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: Catalan, Spanish, English

LECTURER
Coordinating lecturer: ANTONIO LLORET MORANCHO
Others: ANTONIO LLORET MORANCHO, CARLOS MARIA LOPEZ GARELLO, ANNA RAMON TARRAGONA

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.
13326. 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).

Generical:
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 conscientious 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 course consists of 1 hour per week of classroom activity (large size group) and 0,5 hours weekly with half the students (medium size group).

The 1 hour 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 0,5 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 analyze fracture cases from the point of view of an expert.

- Behavior of saturated soils. Critical state models. Interpretation of drained and undrained response.
- Introduction to the mechanical behaviour of unsaturated soils.
- Flow-deformation coupling.

Conceptualize soils and rocks as porous media governed by concepts of Solid and Fluid Mechanics. Characterize the geological environment and its interaction with civil works. Interpret laboratory trials and field observations to identify the mechanisms responsible for the field response. Plan experimental programs in the laboratory. Analyze, from the viewpoint of an expert, failure cases in Geotechnical Engineering. Report the evidence, identify the mechanisms responsible for the break and check using retro-analysis models. Provide eventual risk reduction solutions. (Specific competence of Geotechnical Engineering specialization). Use in a discriminated way commercial programs of numerical calculation to project and accompany, if necessary, the monitoring of geotechnical structures. (Specific competence of Geotechnical Engineering specialization). * It applies concepts of limit analysis to the calculation of load in soils. * Interpret the behavior of soils within the framework of critical state mechanics. * Interpret the behavior of compacted soils in the framework of unsaturated soil mechanics. *

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours medium group</td>
<td>9,8</td>
<td>7.83</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>63.95</td>
</tr>
<tr>
<td>Hours small group</td>
<td>9,8</td>
<td>7.83</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.80</td>
</tr>
<tr>
<td>Hours large group</td>
<td>19,5</td>
<td>15.59</td>
</tr>
</tbody>
</table>
Total learning time: 125.1 h

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<tr>
<th>CONTENTS</th>
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<tr>
<td>Modeling clay behavior</td>
</tr>
<tr>
<td>Description:</td>
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</table>
Saturated clay behaviour                      |
Cam Clay model (1)                            |
Cam Clay model (2)                            |
**Full-or-part-time:** 21h 36m                 |
Theory classes: 9h                             |
Self study: 12h 36m                           |
| Eodometric test                              |
| Description:                                 |
Oedometric test                               |
**Full-or-part-time:** 7h 11m                  |
Laboratory classes: 3h                         |
Self study: 4h 11m                            |
| Sand liquefaction                            |
| Description:                                 |
Sand liquefaction                             |
**Full-or-part-time:** 7h 11m                  |
Theory classes: 3h                             |
Self study: 4h 11m                            |
| Direct shear test                            |
| Description:                                 |
Direct shear test                             |
**Full-or-part-time:** 7h 11m                  |
Laboratory classes: 3h                         |
Self study: 4h 11m                            |
| First test                                   |
| Description:                                 |
First test                                    |
**Full-or-part-time:** 7h 11m                  |
Practical classes: 3h                         |
Self study: 4h 11m                            |
### Triaxial test

**Description:**
Triaxial test

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

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### Theorems of plastic collapse

**Description:**
Upper bound and the lower bound theorems

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

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### Finite element method

**Description:**
PLAXIS in elastic cases  
PLAXIS in elasto-plastic cases

**Full-or-part-time:** 14h 23m  
Theory classes: 3h  
Practical classes: 3h  
Self study : 8h 23m

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### Second Test

**Description:**
Second Test

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

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### Oral presentation of works

**Description:**
Oral presentation of laboratory work

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

Weights of different activities:

- 0.45 [average of two partial tests]
- 0.2 [average reports of group practices]
- 0.1 [oral presentation of group practices]
- 0.15 [average rating of the delivered problems]
- 0.1 [average rating of questionnaires]

EXAMINATION RULES.

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:

Complementary: