Course guide
250810 - 250810 - Advanced Soil Mechanics

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). (Optional subject).

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

LECTURER

Coordinating lecturer: PERE PRAT CATALAN

Others: PERE PRAT CATALAN, 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.
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 consciensous profesional environment.
13304. To incorporate new techncologies 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 subject consists of 3 hours of face-to-face classes in the classroom or in the laboratory.

There are 7 theory classes of 3 hours, in which the teacher presents the basic concepts and materials of the subject, presents examples and exercises.

There are 3 laboratory classes of 3 hours, in which the student performs Soil Mechanics experiments, directed by the faculty.

There are 2 practical classes with numerical analysis programs for Soil Mechanics.

There are 2 evaluation tests (exams) of 3 hours during class time during the course.

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.

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 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.

- Behavior of saturated soils. Critical state models. Interpretation of drained and undrained response.
- Introduction to the mechanical behaviour of unsaturated soils.
- Limit analysis . Limit states. Limit equilibrium.
- 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 compac

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

Modeling clay behavior

Description:
Saturated clay behaviour. Oedometer. Consolidation. Shear.
Cam-clay model (1): Introduction and basic concepts.
Cam-clay model (2): Formulation and predictions.
Cam-clay model (3): Strength
Cam-clay model (4): Practical exercises

Full-or-part-time: 36h
Theory classes: 12h
Practical classes: 3h
Self study : 21h

Eodometric test

Description:
Oedometric test

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

Direct shear test

Description:
Direct and ring shear tests

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

Triaxial test

Description:
Triaxial test

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

First test

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

Service analysis

Description:
Service analysis. Settlements.

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

Plastic collapse theorems

Description:
Lower bound theorem

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

Finite element method

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

Full-or-part-time: 14h 23m
Practical classes: 6h
Self study : 8h 23m

Second Test

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

Oral presentation of works

Description:
Oral presentation of laboratory work

Full-or-part-time: 7h 11m
Theory 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:

0.30 [mark from the first partial exam]
0.15 [mark from the second partial exam]
0.20 [average mark from reports of group practices]
0.10 [mark from oral presentation of group practices]
0.15 [average mark of the delivered problems]
0.10 [average mark 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:
- Lambe, T.W.; Whitman, R.V. Mecánica de suelos. 2a ed. México: Limusa : Noriega, 1995. ISBN 9681818946.
- Muir Wood, D. Soil behaviour and critical state soil mechanics. Cambridge, UK: Cambridge University Press, 1990. ISBN 0521337828.

Complementary:
- Atkinson, J. The mechanics of soils and foundations. 2nd ed. Oxford, UK: Taylor & Francis, 2007. ISBN 9780415362566.