250146 - ENGGEOLOG - Geological Engineering

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 4,5 Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: JORDI COROMINAS DULCET, MARCEL HURLIMANN ZIEGLER
Others: JORDI COROMINAS DULCET, MARCEL HURLIMANN ZIEGLER, ROGER RUIZ CARULLA

Opening hours
Timetable: Mondays from 3 to 5pm

Degree competences to which the subject contributes

Specific:
3029. Knowledge of soil and rock geotechnics and mechanics and the ability to apply this knowledge in carrying out studies, projects, constructions and exploitations in which earthmoving, foundations and retention structures are necessary.
3046. Students will acquire the skills needed to build geotechnical works.

General:
3104. Students will learn to identify, formulate and solve a range of engineering problems. They will be expected to show initiative in interpreting and solving specific civil engineering problems and to demonstrate creativity and decision-making skills. Finally, students will develop creative and systematic strategies for analysing and solving problems.
3106. Students will learn to assess the complexity of the problems examined in the different subject areas, identify the key elements of the problem statement, and select the appropriate strategy for solving it. Once they have chosen a strategy, they will apply it and, if the desired solution is not reached, determine whether modifications are required. Students will use a range of methods and tools to determine whether their solution is correct or, at the very least, appropriate to the problem in question. More generally, students will be encouraged to consider the importance of creativity in science and technology.
3107. Students will learn to identify, model and analyse problems from open situations, consider alternative strategies for solving them, select the most appropriate solution on the basis of reasoned criteria, and consider a range of methods for validating their results. More generally, students will learn to work confidently with complex systems and to identify the interactions between their components.
3110. Students will learn to plan, design, manage and maintain systems suitable for use in civil engineering. They will develop a systematic approach to the complete life-cycle of a civil engineering infrastructure, system or service, which includes drafting and finalising project plans, identifying the basic materials and technologies required, making decisions, managing the different project activities, performing measurements, calculations and assessments, ensuring compliance with specifications, regulations and compulsory standards, evaluating the social and environmental impact of the processes and techniques used, and conducting economic analyses of human and material resources.
3112. Students will develop an understanding of the different functions of engineering, the processes involved in the life-cycle of a construction project, process or service, and the importance of systematising the design process. They will learn to identify and interpret the stages in preparing a product design specification (PDS), draft and optimise specifications and planning documents, and apply a systematic design process to the implementation and operation
Students will acquire an understanding of geological engineering and geology applied to engineering. They will also learn to solve soil engineering problems.

Upon completion of the course, students will have acquired the ability to:
1. Draw up a site-investigation plan that includes the variables to be measured, equipment needed, the points of measurement, the timing of the measurements, and the way in which the results are to be used.
2. Analyse geotechnical problems in linear work and determine the stability of slopes, embankments, cut slopes and masonry foundations.
3. Analyse geotechnical problems in underground work such as tunnels and retaining structures.

Surficial formations, from both geological and geotechnical viewpoints, including the orders of magnitude of their...

Teaching methodology

The course consists of 1.5 hours per week of classroom activity (large size group) and 0.7 hours weekly with half the students (medium size group).

The 1.5 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 field work and supervised design.

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

Students will acquire an understanding of geological engineering and geology applied to engineering. They will also learn to solve soil engineering problems.

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1. Draw up a site-investigation plan that includes the variables to be measured, equipment needed, the points of measurement, the timing of the measurements, and the way in which the results are to be used.
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mechanical and hydrological properties; Rock mechanics, as relates to the matrix, joints and fractures, as well as hydraulic properties; Site-investigation techniques; Relationship between the properties and concepts of excavatability, stability and, in general, the conditioning factors in geotechnical projects; Geological and engineering-related aspects in linear work such as cut slopes and embankments; Geological aspects in underground work; Geological control during earthworks; Geological aspects in dams; Slope stability; Infiltration problems

<table>
<thead>
<tr>
<th>Study load</th>
<th>Total learning time: 112h 30m</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 22h 19.56%</td>
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<tr>
<td></td>
<td>Practical classes: 12h 10.67%</td>
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<tr>
<td></td>
<td>Laboratory classes: 11h 9.78%</td>
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<td></td>
<td>Guided activities: 4h 30m 4.00%</td>
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<tr>
<td></td>
<td>Self study: 63h 56.00%</td>
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</table>
## Content

<table>
<thead>
<tr>
<th>01. INTRODUCTION</th>
<th><strong>Learning time:</strong> 2h 24m</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 1h</td>
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<tr>
<td></td>
<td>Self study : 1h 24m</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Explain the concept of geological and geomechanics model and introduce tools that will be used to build them</td>
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<thead>
<tr>
<th>02. GEOMECHANICAL PROPERTIES OF THE SURFICIAL FORMATIONS</th>
<th><strong>Learning time:</strong> 4h 48m</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 2h 48m</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Discuss the influence of processes that generate residual, glacial and colluvial deposits on their hydraulic and mechanical properties. Provide criteria for understanding the spatial distribution and geometry of these deposits</td>
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<thead>
<tr>
<th>03. GEOMECHANICAL PROPERTIES OF ROCKS</th>
<th><strong>Learning time:</strong> 4h 48m</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 2h 48m</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>Discuss the deformatinal behavior of rocks (elastic, plastic, elasto-plastic) and the phases up to the failure. Explain the influence of textural parameters such as porosity or foliation on the rock strength. Present mineralogical and textural components that determine the hardness, abrasiveness and durability of rocks, and tests for their determination</td>
</tr>
</tbody>
</table>
04. ROCK MASS PROPERTIES

Description:
Concept rock mass
Types of discontinuities and their properties
Strength of the joints. Criterion Barton and Choubey.
Shear tests
Goal
Rock Quality Designation
Q Index
Rock Mass Rating
Geological Strength Index (GSI)
Hoek and Brown failure criterion of rock masses
Rock mass deformability. Testing methods
Using the compass
Application of the geomechanical classifications

Specific objectives:
Introduce the concept of rock mass. Explain how the geometric characteristics of the discontinuities (roughness, undulation, weathering) govern their shear strength.
Provide elements for the characterization and assessment of the rock mass quality by means of simple procedures
Present the Hoek and Brown criterion for the assessment of the rock mass strength and recent its improvements.
Present different procedures for assessing the deformability of rock mass.
Identifying different types of discontinuities of the rock mass. Learning how to measure discontinuities with compass. Field data collection for the geomechanical classifications

Learning time: 12h
Theory classes: 3h
Laboratory classes: 2h
Self study: 7h
## 05. GROUND CHARACTERIZATION

<table>
<thead>
<tr>
<th>Learning time: 19h 12m</th>
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<tbody>
<tr>
<td>Theory classes: 2h</td>
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<tr>
<td>Practical classes: 4h</td>
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<tr>
<td>Laboratory classes: 2h</td>
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<tr>
<td>Self study : 11h 12m</td>
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### Description:
- Objectives of terrain analysis: phases.
- Photo interpretation and remote sensing.
- Geological and geotechnical mapping.
- Constructing a geological geotechnical model of the terrain.
- Criteria for selecting sampling points, in outcrops, trenches and boreholes.
- Description of geological outcrops and trenches.
- Core logging.
- Introduction to stereographic projection.
- Equiangular and equiareal.
- Plotting lines and planes.
- Measurement of angles between lines and planes.
- Density plots.

### Specific objectives:
- Provide the basis for planning the reconnaissance campaign, according to the geological characteristics of the area and the available techniques.
- Prepare a geological-geotechnical cross section of the terrain based on data from surface mapping, geophysical prospecting and mechanical drilling.
- Provide criteria for sampling. Provide criteria for the identification and description of relevant parameters of the ground for construction works.
- Presenting the principles of stereographic projection and its applications.
- Analysis of field data and identification of the main joint sets in the rock mass by means of the stereographic projection.
### 06. GEOLOGICAL ASPECTS OF THE GROUND EXCAVATION

**Learning time:** 16h 48m  
Theory classes: 3h  
Practical classes: 4h  
Self study: 9h 48m

**Description:**  
- Digging Systems  
- Terrain Parameters  
- Seismic criteria. Criterion of Petiffer and Fookes  
- Mechanisms of instability in natural slopes and cut slopes  
- Analysis of plane and wedge failure  
- Assessment of instability: local and structural instability.  
- Criteria for stabilization, interception and protection  
- Planar and wedge failure: Markland test and Hocking refinement  
- Toppling: Goodman Test  
- Representation of the friction cone.  
- Stability analysis of planar and wedge failure.  
- Calculation of the safety factor

**Specific objectives:**  
- Identify and assess the terrain parameters that determine the feasibility and performance of different procedures and machinery for ground excavation  
- Review the mechanisms of instability of slopes and cuts. Analysis of the stability of the most common mechanisms and provide criteria for rock stabilization and protection.  
- Application of kinematic tests to assess the risk of slope failure for different instability mechanisms  
- Evaluation of the stability of blocks and wedges with stereographial and analytical solutions

### 07. GEOLOGICAL ASPECTS OF GROUND FOUNDATIONS

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

**Description:**  
- Geological constraints of foundations: soil-rock contact.  
- Soil heterogeneity and consequences in ground deformability.  
- Dissolution and collapse: solubility of salts, gypsum and limestones  
- Environmental impact of the foundation works on groundwater flow

**Specific objectives:**  
- Review the geological parameters that influence the selection of superficial or deep foundations and the mechanisms of failure. Identify favorable contexts for expansive phenomena and describe the processes involved. Present examples of environmental impact of foundations.
### 12. WORKSHOP

**Description:**
Workshop to review work in progress

**Specific objectives:**
Review the work done by students on the course project.

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

### 08. GEOLOGICAL ASPECTS OF LINEAR INFRASTRUCTURES

**Description:**
Geological constraints for linear infrastructures: relief and geological structure
Identification of critical points
Earthworks. Formations suitable for embankments.
Linear infrastructures and natural hazards
Environmental impact of linear infrastructures
visit of a road, tunnel or dam under construction

**Specific objectives:**
Analyze the influence of the geological context for large linear infrastructures. Provide elements for the recognition and characterization of the terrain
Get an overview of the importance of land in large infrastructure projects.
Fix the concepts given to the subject.
See practical applications and other engineering related topics

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

### 11. ASSESSMENT AND EXAM

**Learning time:** 7h 11m
- Laboratory classes: 3h
- Self study: 4h 11m
09. GEOLOGICAL ASPECTS OF TUNNELS AND UNDERGROUND WORKS

**Description:**
Geology and tunnels: specificities
Lithological control of the excavation of tunnels: brittle, creeping and soluble rocks
Geological structure: roof stability. Dilatancy
Portal Characterization
Tensions in the tunnels: origin. Lithostatic pressure. Tectonic stresses.
Faults. Detection
Water in tunnels. Karstification. Detection
Geological control of the front.

exercise of selection of the most favourable alternative in tunnels

**Specific objectives:**
Presentation of some examples of different geological problems in tunnels. Review of the performance of the main types of rocks. Analysis of the geological structure and the fracture pattern of the rock mass on the stability of the excavation.
Review the origin and distribution of stress and the effect of water in the underground excavation. Present criteria for the early detection of fault and potential water inflows.
Identification of favorable and problematic aspects of the ground
Analysis of alternatives
Selecting the most favorable path

10. GEOLOGICAL ASPECTS OF DAMS AND RESERVOIRS

**Description:**
Geology and dams: specificity.
Dam foundations. Strength, deformability
Leakage. Infiltration tests.
Identifying directions of leakage. Eraso's method
Reservoirs and stability of slopes
Leakage in dams sites and reservoirs

**Specific objectives:**
Presentation of some examples taken in difficult ground. Understanding the most relevant geological aspects taking into account the dam typology and the lithology involved.
Present the most favorable geological contexts for leakage in reservoirs and the available methods to determine the direction of leakage. Discuss the mechanisms of slope instability associated to changes in water level of reservoirs
Determining the direction of leakage.
Design of cutoffs
Qualification system

The mark of the course is obtained from the ratings of the various tests throughout the semester and from that the course project.

Several assessments will be carried out during the course.

The final mark will be given by the following terms:
FINAL MARK = Theory x 0.4 + Exercises 0.25 + Oral presentation of assignments x 0.05 + Assignment x 0.3

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

Regulations for carrying out activities

Failure to deliver the design work, it will be considered as not presented.

Bibliography

Basic: