250423 - TUNMECROQU - Tunnels and Rock Mechanics

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 CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Teaching unit Optional)
MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Teaching unit Optional)
ECTS credits: 5  Teaching languages: Spanish

Teaching staff
Coordinator: NURIA MERCE PINYOL PUIGMARTI
Others: EDUARDO ALONSO PEREZ DE AGREDA, IGNACIO CAROL VILARASAU, NURIA MERCE PINYOL PUIGMARTI, ANNA RAMON TARRAGONA

Opening hours
Timetable: During lecture breaks, at the end of the class, or during office hours previously agreed with the instructors.

Degree competences to which the subject contributes
Specific:
8200. The ability to apply knowledge of soil and rock mechanics to the study, design, construction and operation of foundations, cuts, fills, tunnels and other constructions over or through land, whatever its nature and state, and whatever the purpose of the work.

Transversal:
8559. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
8560. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.
8561. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Teaching methodology
The course consists of 3 class hours devoted to theory and exercises, and some case studies will also be presented.

Learning objectives of the subject
Specialization subject in which knowledge on specific competences is intensified.

Knowledge and skills at specialization level that permit the development and application of techniques and methodologies at advanced level.
Contents of specialization at master level related to research or innovation in the field of engineering.

Acquiring the necessary knowledge for the interpretation of the behavior of rocks and the ability to design geotechnical constructions, especially underground excavations, both in soil and rocks.

The contents of the course will provide the student with knowledge and skills related to:
- Characterization of the mechanical and hydrological behavior of rock masses.
- Characterization of the behavior of the rock matrix.
- Characterization of the behavior of the discontinuities based on the theories of fracture mechanics.
- Characterization, interpretation and estimation of the stress-strain behavior around an excavation taking into account the elastic and plastic behavior of the terrain using analytical, empirical and numerical solutions.
- Interpretation and prediction of the mechanical behavior of different types of tunnel supports (shotcrete, bolts, steel ribs and concrete rings) and their interaction with the ground.
- Understanding, interpretation and prediction of the movements induced by underground excavations.
- Knowledge of the different procedures of excavation of tunnels.
- Knowledge of specific real cases.

## Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 19h 30m</th>
<th>15.60%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group: 9h 45m</td>
<td>7.80%</td>
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<tr>
<td></td>
<td>Hours small group: 9h 45m</td>
<td>7.80%</td>
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<tr>
<td></td>
<td>Guided activities: 6h</td>
<td>4.80%</td>
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<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
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# Content

| **Introduction** | **Learning time:** 4h 48m  
Theory classes: 2h  
Self study: 2h 48m |
|------------------|----------------------|
| **Description:** | - General introduction  
- Introduction to the Rock Mechanics part  

| **Fracture mechanics** | **Learning time:** 14h 23m  
Theory classes: 6h  
Self study: 8h 23m |
|------------------------|----------------------|
| **Description:** | - Introduction. Mechanisms and modes.  
- Linear fracture mechanics (Griffith theory, stress intensity factor, toughness)  
- Nonlinear fracture mechanics. Scale effect. Onset and propagation of fractures  
- Example/Practice: Scale effect on the behaviour of the earth-dam |

| **Rock matrix, joints and rock mass** | **Learning time:** 14h 23m  
Theory classes: 6h  
Self study: 8h 23m |
|--------------------------------------|----------------------|
| **Description:** | - Rock matrix. Tests. Mohr-Coulomb & Hoek-Brown criteria  
- Discontinuities. General aspects. Patton & Barton Choubey failure criteria |

| **Insitu stresses** | **Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m |
|---------------------|----------------------|
| **Description:** | - Significance. Stress states in an excavation site.  
<table>
<thead>
<tr>
<th><strong>Water and rock mass</strong></th>
<th><strong>Learning time:</strong> 6h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 2h 30m</td>
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<td></td>
<td>Self study : 3h 30m</td>
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</table>

- Characteristic curves of tunnels in the presence of water flow. Implications.

<table>
<thead>
<tr>
<th><strong>Circular tunnel in elastoplastic soil. Characteristic curves</strong></th>
<th><strong>Learning time:</strong> 9h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 4h</td>
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<td>Self study : 5h 36m</td>
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</table>

- Plain deformation. Mohr-Coulomb elastoplastic model. Hoek-Brown elastoplastic model.

<table>
<thead>
<tr>
<th><strong>Interaction tunnel support</strong></th>
<th><strong>Learning time:</strong> 4h 48m</th>
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<tbody>
<tr>
<td>Description:</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 2h 48m</td>
</tr>
</tbody>
</table>

- Bearing curves. Bolts. Circular linings and ribs. 3D phenomena in the face.

<table>
<thead>
<tr>
<th><strong>Construction of tunnels in rock</strong></th>
<th><strong>Learning time:</strong> 4h 48m</th>
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<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 2h 48m</td>
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- Traditional methods. New Austrian Method. Stability of portals. TBMs and TSMs

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<tr>
<th><strong>Tunnel face stability</strong></th>
<th><strong>Learning time:</strong> 3h 35m</th>
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<tr>
<td>Description:</td>
<td>Practical classes: 1h 30m</td>
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<td>Self study : 2h 05m</td>
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- Application of plastic collapse theorems. 2D and 3D solutions for circular tunnels
The final course grade will be calculated on the basis of the geometric average of two exams taken during the course: the first one at about half of the semester (E1), and a second one at the end of it (E2).

Exam E1 will cover the first part of the course (Rock Mechanics) and exam E2 will cover the second part (Underground Excavations):

Final grade= v(GradeE1*GradeE2)

**Qualification system**

The final course grade will be calculated on the basis of the geometric average of two exams taken during the course: the first one at about half of the semester (E1), and a second one at the end of it (E2).

Exam E1 will cover the first part of the course (Rock Mechanics) and exam E2 will cover the second part (Underground Excavations):

Final grade= v(GradeE1*GradeE2)

**Regulations for carrying out activities**

Failure to perform the second test will result in a mark of zero.

It is not possible to advice with notes during the exams.
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Bibliography

Basic:


Complementary:


