DIPARTIMENTO DI INGEGNERIA
STRUTTURALE E GEOTECNICA

SAPIENZA
UNIVERSITÀ DI ROMA

GALLERIE PROFONDE– DEEP UNDERGROUND CONSTRUCTIONS AA 2023-24

LM Ingegneria Civile

a. Learning Objectives

The course illustrates the principles of static analysis of deep underground constructions with the aim to: a) give an account of the geotechnical properties which are relevant to the design of underground constructions, with particular attention to rock masses; b) provide the criteria for a decision about the excavation techniques; c) evaluate stability conditions of tunnels; d) design the supporting systems; e) examine the interaction between the ground and the provisional and final supports.
Specific skills. Successful students will be able to cooperate in design teams for planning excavation of tunnels and other underground structures. They could be charged of the investigation activity in the field and of the data collection and organization. The competences could be also employed in the site staff for controlling the excavation or the machine performance in mechanized tunnelling, and collecting monitoring data (*knowledge and understanding*).
At the end of the course students acquire the ability to independently handle the complexity of geotechnical problems (*applying knowledge and understanding*). Since the required engineering project is based on real cases, students have to turn complex reality into possible models (*making judgements*). Then students are called to: define the gaps of information provided in the real case, identify additional requests for improving knowledge, independently address any further studies intended for his/her learning (*making judgements*; *learning skills*).

b. Pre-requisites

Basic knowledge of the disciplines:
Theory of structures, Mechanics of Fluids, Fundamentals of Geotechnics

c. Program

a. Exploration techniques in deep tunnel excavations
b. Rock mass classifications. Assessment of geotechnical characteristics: strength, deformability, in situ stress, groundwater conditions
c. Excavation techniques: drill and blast tunnelling, mechanized excavation
d. Support and reinforcement techniques
e. Stresses and strains around underground excavations. Elastic and elastoplastic models. Influence of the dead weight of the ground. Influence of the pore pressure gradients
f. Stability conditions of the face and of tunnel
g. Design of tunnel supports and ground support interaction analysis
h. Monitoring systems for tunnels

d. Frequency & Classroom-Taught Lessons

Lectures will be presented on the blackboard and, occasionally, via PowerPoint.
Classroom teaching includes lessons (40 hours) and exercises (20 hours). Approximately 9-10 exercises, that will be illustrated and partly carried out in the classroom, will be addressed. The complex exercises

require, in order to be solved, an extra individual working time. A written report is strongly recommended.
Students are expected to attend the class and take notes, as this is one of the best ways to acquire new competences, followed by regular individual review outside the classroom.

e. Mode of evaluation

The structure of the course provides that part of the classroom time will be devoted to solving complex exercises, which require an individual working time. It is suggested to practice the exercises in groups of two or three students, with the aim to: develop communicative skills, argue personal technical choices, accept different technical choices from others, experience personal ability to lead a group.
The completion of each of the complex exercises is attested by a document per group containing the elaborations and a technical report.
The exam consists of the presentation of the technical reports carried out during the current semester. The reports must be sent to the teacher one week before the oral test and produced in print form during the exam session. Alternatively, student carries out a written test without submitting the technical reports.
The oral exam typically includes two questions related to topics covered during the complex exercises and a third theoretical question. During the exam, the student has to declare his/her personal contributions given in the reports, which will be evaluated by the teacher. The evaluation takes also into account: the autonomy of making judgment in dealing with the complexity of geotechnical problems, the acquired learning skills and the ability to deepen critical knowledge that lead to constant learning during professional life.

f. Textbook

Textbook: Meccanica delle Rocce. Dalla Teoria alle Applicazioni nell'Ingegneria. Ribacchi et al. (2018) Efesto Edizioni
Other additional documents.

g. References

Bieniawski, Z. T. Rock mechanics design in mining and tunnelling.
Brady B.H.G., Brown E.T. Rock Mechanics for Underground Mining. George Allen & Unwin
Hoek E., Brown E.T. Underground Excavations in Rock. IMM, London
Hoek E., Kaiser P. K., Bawden W. F. Support of Underground Excavations in Hard Rock. CRC Press