SUBJECT TEACHING GUIDE

G596 - Geomechanical Characterisation of Soils and Rocks

Degree in Energy Resources Engineering

Academic year 2022-2023

1. IDENTIFYING DATA					
Degree	Degree in Energy Resources Engineering			Type and Year	Compulsory. Year 2
Faculty					
Discipline	Subject Area: Mining Pre-Technology Module: Training in Common with the Mining Branch				
Course unit title and code	G596 - Geomechanical Characterisation of Soils and Rocks				
Number of ECTS credits allocated	6	Term		Semester based (1)	
Web					
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. CIENCIAS DE LA TIERRA Y FISICA DE LA MATERIA CONDENSADA
Name of lecturer	ALBERTO GONZALEZ DIEZ
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Office	Facultad de Ciencias. Planta: + 2. DESPACHO PROFESORES (2006)
Other lecturers	PATRICIO MARTINEZ CEDRUN

3.1 LEARNING OUTCOMES

- Students who follow the course, should be in position to distinguish between soil (surface deposits, soil floors, soft geological materials of special features such as expansive clays, saline soils, etc.) and rocks, as well as its most important geomechanical properties.
- Students who follow this course will learn the basic principles of water movement into the soil. They will be able to analyze and evaluate the behavior, the water pressures in materials that contain well as the flow of water on the ground.
- Students who take the course will learn the basic principles of soil mechanics and rock (effective pressures, stress, strain, strength, dimensional state efforts, three-dimensional) as well as tools for study and analysis (Mohr circles, uniaxial testing and triaxial, shear, etc). They will know programs for the study of the mechanics of rocks and soils.
- Students who follow this course will learn the principles of classification of rock mass. They will also be able to study and analyze the rock masses from the parameters commonly used in their study (discontinuities, fillers, degree of alteration, spacing, etc.), including their graphic representation in diagrams or schematics. They will be in a position to classify rock mass response to RMR indexes, Bieniawski, and to use the tools necessary to develop such classifications as used in the classification programs.

4. OBJECTIVES

Students who take the course will be able to distinguish soils and rocks and other soft materials special geological features such as expansive clays, saline soils, etc.).

Students who take the course will learn the basic principles of water movement into the soil.

Students who take the course will learn the basic principles of soil mechanics and rock.

Students who take the course will learn the principles of classification of rock mass.

6. COURSE ORGANIZATION

	CONTENTS
1	Thematic Block I. SOIL GEOMECHANICAL CHARACTERISATION -Chapter 1. Soft earth materials, main properties and classification. Origin, description and classification of soils (edaphic, geotechnical) and superficial deposits. Granulometric distribution; relationships between granulometries and volume of a soil. Porosity, void ratio, relative density, moisture content, degree of saturation. Consistency and plasticity Concept of cohesion. Atterberg limits Obtaining the liquid and plastic shrinkage limits of a soil. Casagrande test. Geotechnical classification of soils. Related tests (density, porosity, water absorption, swelling, crumbling). -Chapter 2. Water in the ground (soft materials). Water at rest. Capillary water. Water table. Hydrostatic pressures. Interstitial pressures. Bernoulli's theorem. Permeability, seepage. Water flow in the ground. Hydraulic gradient. Darcy's law. Stationary flow in isotropic and anisotropic media. -Chapter 3. Stresses in the ground, effective stress. Soil phases and structures. Saturated soils. The postulate of effective stresses, Rankine theory. Seepage and siphonage forces. Application of loads on saturated soils. Consolidation. Normally consolidated and overconsolidated soils. Stress parameters and graphical representation Stress history, lateral stresses, geostatic state. Oedometer testing; loading with or without drainage. Mohr-Coulomb circle, cohesion and internal friction angle, failure envelope. Calculation of shear and principal stresses in soils. -Chapter 4. Geotechnical characterisation of sediments: types of sediments and their geomechanical properties, Clay minerals and their influence on soils. Problems arising from the behaviour of soft geological materials (soils): expansive clays, dispersive soils, collapsible soils, liquefactible soils.
2	Thematic Block II. GEOMECHANICAL CHARACTERISATION OF ROCKS -Chapter 5. Definition, purpose and scope of rock mechanics. Hard terrestrial materials (rocks). Characteristics of igneous, sedimentary and metamorphic rocks; classification. Main physical, mechanical and chemical properties. Classifications for geotechnical purposes. The weathering of rocks, sequences of rock alteration. Determination of rock density Rock identification tests in the field and laboratory, weathering, crushability. -Chapter 6. Water in the rock mass. Types of porosity: primary and secondary. Influencing factors. Stresses and deformations in rocks. Confining pressures. Interstitial and fluid pressure. Effective pressure in rocks Variation of confining pressure with depth Orogenic differences, horizontal and vertical components. -Chapter 7. Strength, deformability and rupture. Stress-strain relationships. Forces and stresses, stresses in a plane, stresses in three dimensions. Elastic, plastic and brittle behaviour in rocks. Dynamic moduli Stress ellipsoid Rheological behaviour. -Chapter 8. Types of failure, failure criteria. Mohr's circle, cohesion and angle of internal friction, failure envelope. Breakage criteria: Mohr-Coulomb, Hoek and Brown criteria. Software for the analysis of stresses and strengths in rocks (RocData 4.0). Laboratory tests. Compressive strength test. Triaxial test, with and without drainage. Direct shear test. Frankling test. -Chapter 9. Strength of discontinuities. Patton, Barton and Choubey, Ladanyi criteria. JRC coefficient. The role of filler and water in the strength of discontinuities. Use of the sclerometer to measure the strength of discontinuities. Software for the analysis of stress and resistance in rocks (RocData 4.0 and RocLab1.0). -Chapter 10. The rock mass and its components. Spatial characterisation of its components: rock matrix and discontinuities. Stereographic projection as a tool for terrain analysis (Dips 5.1 programmes; Stereonet). Geomechanical rock classifications: example of a geomechanical classification, the RMR of Bieniawski.
3	Thematic Block III. CHARACTERISATION OF ROCKY MASSIFS -Chapter 11. Description and zoning of the outcrop. Characterisation of the rock matrix. Description of discontinuities: orientation, spacing, continuity, continuity, roughness, wall strength, openness, infilling, seepage. Number and types of discontinuity families, block size and degree of fracturing, alteration. RQD. Point load tests. Instruments used in rock mass characterisation. Beniawski RMR, Barton Q, other classifications. Structural representation of rock mass anisotropies by stereographic projection (specific programmes). Tests useful in the characterisation of rock mass. -Chapter 12. Stability of rock slopes. Types of mass movements. Main types of breaks. Slope processes and conditioning factors of slope instability. Main types of breaks. 2D and 3D landslide analysis (Rock Fall). The use of stereographic methods in the analysis of instability (Dips 5.1 software). Stability analysis by limit equilibrium, stress-deformation methods. Slope stabilisation.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Test I, of theoretical-practical knowledge acquired in the first half of the subject	Written exam	No	Yes	15,00
The practical work include all the practice reports carried out by students either in the classroom or in the laboratory. These reports should be included the results obtained and their theoretical support.	Work	No	No	10,00
Test II, of theoretical-practical knowledge acquired in the second half of the subject	Written exam	No	Yes	15,00
The exercise will be a multiple choice test, it will be carried out on the date fixed by the School of mines calendar; and it will be made with theoretical and practical questions. In case of confinement, the exercise will be carried out on the virtual su	Written exam	Yes	Yes	60,00
TOTAL				100,00

Observations

In case of fail either the first or the second test exercises, there will be a second chance, in a date designed by the School. This exercise will be a multiple choice test type, combined with practical exercise questions, and long elaborate questions, as well; and it will be composed of theoretical and practical questions, including problems, relations queries, connecting the theory and practices and main fundaments of the subject.

Observations for part-time students

Part-time students will be evaluated according to the same criteria as other students. Nonetheless they will have a special attention in order to lead them to make evaluanción tests simultaneously to the rest taking into account their availability.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

L González de Vallejo (Co) (2002). Ingeniería Geológica. Pearson, Prentice Hall. Madrid.