SUBJECT TEACHING GUIDE

G596 - Geomechanical Characterisation of Soils and Rocks

Degree in Energy Resources Engineering

Academic year 2019-2020

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
E-mail	alberto.gonzalez@unican.es
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	SECTION I. ROCKS GEOMECHANICAL CHARACTERISATION -Chapter 1. Hard terrestrial materials, main properties and classification. Igneous rocks, sedimentaries and metamorphics. The rock cycle. Physicochemical properties of rocks and classification criteria. Components of the rocky massif and its spatial characterization: rocky matrix and discontinuities. The stereographic projection as a tool for terrain analysis (Dips 5.1 program). The weathering of rocks the water in the rocky massif. Sequence of alteration of rocks. Types of porosity : primary and secondary. Influential factors. Rock identification tests carried out in the field and laboratory. -Chapter 2. Stresses and strains on rocks. Determining the density of rocks. Confinement pressure. Pore water pressures. Effective pressure on rocks. Variation of the confining pressure with depth. Orogenic differences, horizontal and vertical components. Strength of rocks. Stress-strain relationships. Types of ruptures in rocks. The behaviours of rocks: elastic, plastic and fragile. Dynamic modules. Failure criteria: Mohr-Coulomb, Hoek and Brown. Rheological behaviour. Software for the analysis of the strain - stress in rocks (RocData 4.0). -Chapter 3. Resistance of the discontinuities. Shear strength at discontinuities. The Patton and Barton criteria and Choubey, and Ladanyi modifications. JRC coefficient; the role of filling and filtration in the resistance of discontinuities. The use of the esclerometer for measuring resistance at discontinuities. Programs for analysis of stress and strength in rocks (RocData 4.0 and RocLab1.0). Laboratory tests. -Chapter 4. Resistance and rupture, stress strain relationships. Types of ruptures. Elastic, plastic and fragile behavior on rocks. Dynamic modules. Breaking Criteria: Mohr-Coulomb, Criterion of Hoek and Brown. Rheological behavior. Programs for the analysis of efforts and Resistances in rocks (RocData 4.0). Laboratory tests. Simple compression test. Triaxial test with and without drainage. Direct cut test. Frankling essay. -Chapter 5. Resistance of discontinuities. Criteria of Patton, Barton and Choubey, Ladanyi. JRC coefficient. The role of filler and water in the resistance of discontinuities. Use of the sclerometer for the measurement of resistance in discontinuities. Programs for the analysis of rock stresses and resistances (RocData 4.0 and RocLab1.0).
2	SECTION II. ROCKS GEOMECHANICAL CHARACTERIZAION II -Chapter 6. Geomechanical classifications. Description and zoning of the outcrop. Characterization of the rock matrix. Description of discontinuities: orientation, spacing, continuity, roughness, strength of walls, opening, filling, filtrations. Number and types of families of discontinuities, block size and degree of fracturing, alteration. RQD. Point load tests. Instruments used in the characterization of the rock mass. Beniawski RMR, Q Barton other classifications. Structural representation of rock mass anisotropy by stereographic projection (Dips 5.1 program). Tests useful for the characterization of rock mass. -Chapter 7. Strength, effort (stress), deformability and shear strength. Forces and strengths, strengths on a plane, strengths in three dimensions. Ellipsoid of efforts. Mohr circle. Mohr-Coulomb criteria, cohesion and internal friction angle, failure envelope. Calculate tangential and principal strengths. Direct shear test. Triaxial test with and without drainage. Simple compression test. Strength and strain of soils.

3	SECTION III. SOIL GEOMECHANICAL CHARACTERISATION -Chapter 8. Soft terrestrial materials, main properties and classification. Origin, description and classification of soils. Surface deposits. Difference between surface deposit, edaphic soil and geotechnical soil. Geotechnics and Geomechanical definition. Clay minerals and their influence on soil. Influence of mineralogy and factory in the geotechnical properties of the sediments. Soil identification tests. -Chapter 9. Relationships between particle size and volume in soils. Porosity, void ratio, relative density, degree of saturation, moisture content, specific gravity, unit weight of water and soils. Structure and grain sizes: size analysis, particle size distribution curve. Consistency and plasticity. Concept of cohesion. Atterberg limits. Obtaining the liquid limits, plastic and shrinkage of soils. Casagrande test. Geotechnical soil classification. Related tests (density, porosity, water absorption, swelling). -Chapter 10. Water into the ground. State of water in the ground. Physical properties of water. Hydrostatic state. Water table. Capillary water. Permeability, seepage (Filtrations) and flow nets. Total charge. Bernoulli's principle. The standing water. Hydrostatic pressures. The water flow in the ground. Hydraulic gradient. Darcy's law. Steady flow in isotropic medium. Calculation of pore pressures. Permeability and flow in stratified soils. -Chapter 11. Tensions on soils. Phases and soil structures. Saturated soils. The postulate of effective stresses. Filtration and piping forces. Geostatic state. Tensional history, lateral stress, tension parameters and graphical representation. Application of loads on saturated soils. Consolidation. Charge with or without drainage. Overconsolidated and normally consolidated soils. consolidation test and applications. Calculation of settlements. Soil compaction. Bulb efforts. Pressure in soils. The floor as supporting element of foundations. Compressibility. Densification. Rankine theory. Mohr circle. Mohr-Coulomb criteria, Strength and strain of soils.
4	SECTION IV. APPLICATIONS OF ROCK AND SOIL MECHANICS TO GROUND SURVEYS (GEOTECHNICS OF ROCKY MASSIF AND SOILS) -Chapter 12. Slope stability and mass movements. Slope processes and their conditionant factors. Main types of ruptures. Stability analysis using limit equilibrium and tenso-deformational methods. The use of stereographic methods in the analysis of instability (5.1 Dips Program). Fundamentals of correction and slope stabilization. Excavability criteria of a slope. Embankments. Geomechanical applications to the design of tunnels classifications. -Chapter 13. Foundations and types. Directs: calculation of the sinking pressure. Load capacity with or without drainage. Admissible pressures and Settlement analysis. Deep foundations. Piles analysis: driving, load, etc., Negative friction. Foundations in complex geotechnical conditions and soft geological materials: swelling clays, dispersive soils, collapsible soils, liquefaction of soil. Densification techniques. Drainages. Tunnels.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Student participation (contribuiting 4% of the final assessment)	Others	No	No	4,00
The test include practical knowledges belonging to each thematic block	Written exam	No	No	40,00
attendance to practical sessions	Others	No	No	3,00
Handed in of reports from practicals carried out	Work	No	No	3,00
Final exam	Written exam	No	Yes	50,00
TOTAL				100,00

Observations

The final exercise might I be composed of multiple choice questions, exercises, problems, questions of relationship and development about contents of the course.

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.