UNIVERSITÀ DI PAVIA

Anno Accademico 2018/2019

GEOTECHNICS

Enrollment year	2018/2019
Academic year	2018/2019
Regulations	DM270
Academic discipline	ICAR/07 (GEOTECHNICS)
Department	DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES
Course	APPLIED GEOLOGICAL SCIENCES
Curriculum	PERCORSO COMUNE
Year of study	1°
Period	2nd semester (04/03/2019 - 14/06/2019)
ECTS	6
Lesson hours	45 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	LAI CARLO GIOVANNI (titolare) - 7 ECTS GIOFFRE' DOMENICO - 2 ECTS
Prerequisites	Basics of Hydraulics and Mechanics of Deformable Body.
Learning outcomes	Scope of the course is to provide students with the theoretical foundations on the hydro-mechanical behaviour of soils which is propaedeutic to the solution of the main problems associated to geotechnical engineering like design and assessment of foundation systems and earth-retaining structures. Special emphasis will be given during the course to geotechnical characterization of construction sites through field and laboratory investigations. The course will comprise lecturing hours dedicated to the illustration of the theoretical topics and hours of exercising dedicated to problem-solving and/or deepening some of the themes treated during the lectures. The course subdivision in didactic modules with lecturing hours (L) and exercising hours (E) is illustrated in the following.

It is specified that the content of the course is the same of the course in GEOTECHNICS borrowed for students in Architectural Engineering and Geologists.

Course contents

First didactic module (6L+4E) – Origin, description, fabric and classification of soils.
Origin of soils and macro-structural characters of natural deposits. Phase relations. Clay minerals and chemism of clays. Identification and systems of classification of soils. Grain size distribution curves. Atterberg limits. Casagrande plasticity chart. Initial state soil parameters. Interaction between fluid phase and solid skeleton. Burland intrinsic compressibility curve.

Second didactic module (8L+4E) – Review of continuum mechanics. Analysis of the state of stress and state of strain within the small-strain theory. Principal and octahedral stresses. Use of invariants. Decomposition of stress tensor. Mohr circle. Equilibrium and compatibility equations. The constitutive relation. The assumption of a linear elastic medium. Isotropy and cross-anisotropy media. Application of the theory of elasticity to the computation of the state of stress and strain induced in a homogeneous medium by external loadings. The Boussinesq and Mindlin problems and their relevance in solving engineering problems. Limits of applicability of elastic theory.

Third didactic module (6L+2E) – The porous medium: peculiarities and general characteristics of natural deposits.
Particulate nature of soils. Limits of applicability of the continuous model. Principle of effective stresses and its physical significance. Total and effective geostatic stresses, pore water pressures. Partially saturated and saturated soil deposits. Phenomena of capillarity. Geologic history and stress history. The notion of pre-consolidation pressure. The at-rest coefficient of lateral earth pressure. Normally-consolidated and over-consolidated soils. Pre-consolidation from diagenetic and aging processes.

Fourth didactic module (6L+4E) – Water in soils: fundamentals of water flow in porous media.
Kinematical aspects of fluid motion. Review of the fundamental equations of fluid mechanics. Forms of energy and Bernoulli’s equation. Flow of water in porous media. Darcy’s law. Equilibrium conditions under the presence of seepage forces. Hydrodynamic pressure and critical hydraulic gradient. The problems of seepage and piping. Assessment of safety conditions of an excavation. Drained and undrained conditions. Steady state flow. Derivation of Laplace’s equation. Graphical and analytical solutions of boundary value problems associated to Laplace’s equation.

Fifth didactic module (6L+4E) – Theory of consolidation.
Terzaghi one-dimensional consolidation equation. Structure and formal analogy with heat equation. Analytical and numerical solution of Terzaghi equation. Consolidation/oedometer test. Determination of pre-consolidation pressure. Deformability parameters under oedometric conditions: the constrained modulus. Primary and secondary (aging)

compression. Experimental determination of the coefficient of consolidation. Influence of sampling disturbance on the results of oedometer testing. Limits of applicability of the Terzaghi one-dimensional consolidation theory.

Sixth didactic module (8L+6E) – Mechanical behaviour of soils: experimental evidences and mathematical-physical modeling. Representation of states of stress and of stress and strain paths through the Mohr circle. Representation through the t-s plane, the triaxial plane and the q-p plane. Drainage conditions. Stability analyses under drained and undrained conditions. Mohr-Coulomb failure criterion. Mechanical behaviour of fine-grained soils. Shear resistance and deformability of NC and OC clays. Main laboratory equipments: triaxial apparatus, direct shear device. Consolidated undrained and unconsolidated undrained triaxial tests. Undrained shear strength. Selection of shear strength parameters in stability analyses. Mechanical behaviour of coarse-grained soils. Shear strength and deformability. Some peculiarities in the mechanical behaviour of sands. Dissipation of mechanical work. Constant volume friction angle. Peak and constant volume shear strength. Introduction to unified approaches in soil constitutive modeling.

Seventh didactic module (6L) – Field site investigation and geotechnical characterization.
Exploration programme, objectives and extension of the survey. Boreholes and sampling techniques. Undisturbed sampling. In-situ static and dynamic penetration tests. Empirical correlations for the interpretation of CPTU and SPT test results. Vane shear test. Field measurement of pore water pressure. Installation of piezometers. Introduction to geophysical seismic testing. Cross-hole and down-hole tests.

Eighth didactic module (10L+6E) – Foundation systems and earth-retaining structures.
Typologies of foundations. Shallow and deep foundations. Limit bearing capacity of shallow foundations. Geotechnical and structural failure mechanisms. Brinch-Hansen bearing capacity formula. Overview of earth-retaining structures. Computation of active and passive earth pressures according to the classical theories of Coulomb and Rankine. Effects of water pressure and of surcharge live loads. Drainage systems.

Teaching methods

Lectures (hours/year in lecture theatre): 56
Practical class (hours/year in lecture theatre): 30
Practicals / Workshops (hours/year in lecture theatre): 0

Reccomended or required readings

Lecture notes, scientific articles and other didactic material will be distributed during classes. The following monographs are recommended:

Lancellotta, R. (2012). Geotecnica (4th edition). Zanichelli, pp. 530. Recommended basic textbook. (In Italian).

Berardi, R. (2017). Fondamenti di Geotecnica (3nd edition). Città Studi, pp.560. Basic textbook. Practical and of easy understanding. (In Italian).

Atkinson, J. (1997). Geotecnica - Meccanica delle Terre e Fondazioni. Mc Graw Hill, pp.452. Reference textbook. It treats both soil mechanics and design of foundations and earth-retaining structures though at a basic level. (In Italian).

Holtz, R.D. & Kovacs, W.D. (1981). An Introduction to Geotechnical Engineering. Prentice-Hall, pp.733. Excellent book to deepen the study on the hydro-mechanical behaviour of soils. Pragmatic and of easy comprehension.

Lambe, T.W. (1991). Soil Testing for Engineers. BiTech Publishers, pp. 165. Reference monograph for geotechnical laboratory tests.

Lambe, T. W. & Whitman, R. V. (1990). Soil Mechanics. John Wiley & Sons, pp. 576. Classical textbook to deepen the study of soil mechanics.

Nova, R. (2002). Fondamenti di Meccanica delle Terre. Mc Graw Hill, pp.373. Reference monograph to deepen the study on the hydro-mechanical behaviour of soils and of soil constitutive modeling. Advanced theoretical approach. (In Italian).

Wood, D.M. (1990). Soil Behaviour and Critical State Soil Mechanics. Cambridge University Press, pp. 462. Reference monograph to deepen the study on the hydro-mechanical behaviour of soils and of soil constitutive modeling. Advanced theoretical approach.

Mitchell, J.K. & Soga, K. (2005). Fundamentals of Soil Behavior. Wiley and Sons, pp. 592. Reference monograph to deepen the study on the chemism of clays and on the interaction between solid and fluid phases of the porous medium.

Salgado, R. (2006). The Engineering of Foundations. McGraw-Hill, 928 pp. Reference monograph to deepen the study on the engineering of foundations.

Viggiani, C. (1999). Fondazioni. Hevelius, 568 pp. Reference monograph to deepen the study on the engineering of foundations. (In Italian).

Assessment methods

Problems and/or reading assignments will be handed over during the course but they will not be collected. However, at the final exam students will be asked to turn in their work for an evaluation. Students are strongly recommended to attempt all the assigned homeworks in order to have a positive outcome at the final examination.
The final exam consists of a three hours written assessment. The test is split in two parts: the first based on theoretical questions while the second on problem-solving. The final grade will be the arithmetic mean of the two parts each of which should be successfully passed with a score greater or equal to 18/30. The test format is closed-book. An equation sheet will be provided during the test.

Further information

Lecture notes, scientific articles and other material are posted at the KIRO web site:

	https://elearning2.unipv.it/ingegneria/
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile