UNIVERSITÀ DI PAVIA

Anno Accademico 2021/2022

GEOTECHNICAL EARTHQUAKE ENGINEERING	
Anno immatricolazione	2020/2021
Anno offerta	2021/2022
Normativa	DM270
SSD	ICAR/07 (GEOTECNICA)
Dipartimento	DIPARTIMENTO DI INGEGNERIA CIVILE E ARCHITETTURA
Corso di studio	INGEGNERIA CIVILE
Curriculum	PERCORSO COMUNE
Anno di corso	2°
Periodo didattico	Secondo Semestre (07/03/2022 - 17/06/2022)
Crediti	6
Ore	51 ore di attività frontale
Lingua insegnamento	English
Tipo esame	SCRITTO
Docente	LAI CARLO GIOVANNI (titolare) - 6 CFU
Prerequisiti	Basic knowledge of geotechnical engineering, mechanics of deformable body and engineering seismology.
Obiettivi formativi	Scope of the course is to introduce students to the basic theories and methods of earthquake geotechnical engineering and soil dynamics. Topics include propagation of mechanical waves in geomaterials, ground response analyses, soil liquefaction, seismic instability of slopes, surface fault rupture, dynamic soil-structure interaction, seismic analysis of foundations and earth-retaining systems. The course consists of lectures and interactive tutorial sessions. Each subject is illustrated with examples and well-documented case histories from major earthquakes worldwide drawn from the experience of the instructor.
Programma e contenuti	In the first part of the course, basic concepts of propagation of mechanical waves are discussed in elastic, viscoelastic and poroelastic

continua. They include mathematical classification of wave motion, Fermat’s principle, Zoeppritz equations and physical causality. Surface Love and Rayleigh waves and their dispersive properties are also introduced including a discussion of the Lamb problem and of the differences between 2D vs. 3D radiation.
Next, fundamental concepts of seismometry are presented jointly with basic techniques of digital signal processing of earthquake recordings. Basic notions of engineering seismology are also reviewed; these include probabilistic and deterministic seismic hazard, design earthquake, intensity measures of ground motion, acceleration and displacement response spectra, selection of seismic- and spectrum-compatible accelerograms. These concepts will be applied to study ground response analyses of soil deposits in 1D linear and linear-equivalent modeling after introducing the concept of transfer function in elastic and viscoelastic layered systems. Examples of phenomena of ground amplification in well-known earthquakes are presented and thoroughly discussed. More advanced topics like non-linear effective stress analyses, numerical modeling of 2D ground response, basin effects and topographic amplification are introduced. Finally, ground amplification as treated in well-established building codes (e.g. Italian NTC 2018 and Eurocode EC8 Part 1) is illustrated jointly with the seismic micro- zonation of an extended territory such as an urban centre.
The second part of the course focuses on subjects of soil dynamics. They include the study of drained and undrained response of soils under earthquake loading, concepts of critical state theory, shear strength and stiffness degradation of soils under cyclic loading. These topics are preliminary to the subject of geotechnical site characterization via in-situ and laboratory investigations and to the study of phenomena of ground failure like earthquake-induced soil liquefaction, lateral spreading ground and seismic instability of natural slopes.
The course ends with an introduction to dynamic soil-structure interaction (SSI). After stating the problem, the notions of kinematic and inertial interaction are illustrated in association with that of dynamic impedance of a shallow foundation. This is used to solve SSI problems via the substructure approach. Finally, the pseudo-static and displacement-based methods are used for the seismic analysis and design of earth-retaining structures and foundation systems.

Metodi didattici

Lectures (hours/year in lecture theatre): 56
Tutoring classes (hours/year in lecture theatre): 8

Testi di riferimento

Kramer, S. (1996). Geotechnical Earthquake Engineering. Prentice-Hall, pp. 653. Reference textbook.

Kokusho, T. (2017). Innovative Earthquake Soil Dynamics. CRC Press, pp. 478. Reference textbook.

Ishihara, K. (1996). Soil Behaviour in Earthquake Geotechnics. Oxford Press, pp. 350. Reference monograph on soil dynamics and laboratory tests.

Verruijt, A. (2010). An Introduction to Soil Dynamics. Springer-Verlag,

	New York, 431 pp. Reference textbook on theoretical soil dynamics. Lecture notes, scientific articles and reports will be provided throughout the course.
Modalità verifica apprendimento	Assignments will be handed over and graded during the course. The final examination will consist of a 3 hours, written test. The final-exam format is closed-book. An equation-sheet will be provided, if needed. Grading: 40% assignments, 60% final exam.
Altre informazioni	The course material is posted at the KIRO web site accessible at the link https://elearning.unipv.it/
Obiettivi Agenda 2030 per lo sviluppo sostenibile	Gli obiettivi