Integrated course offered for the PhD Program in
Structural Engineering, Geotechnics and Seismic Risk

1. Title

GEOLOGICAL AND GEOTECHNICAL APPROACHES IN THE ASSESSMENT OF SEISMIC GROUND MOTION AND VULNERABILITY OF THE PHYSICAL AND BUILT ENVIRONMENT AT A TERRITORIAL SCALE

2. Description

The quantitative prediction of seismic ground motion, including site amplification and earthquake-induced permanent soil deformation due to liquefaction and slope instability, is a key tool for the management of the post-event emergency and land use planning. Additionally, such predictions represent a basis for reliable predictions of damage scenarios in urban areas by convolution of amplified ground motion and instability maps with fragility curves expressing the vulnerability of structures. The level of detail in the quantitative prediction of the seismic hazard and its effects on natural and built environments decreases as the area of interest expands from specific sites to urban areas until the national territory. The course aims to provide key insights into up-to-date approaches developed in Italy and relevant applications to areas recently struck by seismic sequences, with a particular focus on Campania Region. The topic is conceived to be of transversal interest for attendants pertaining to the fields of geotechnical and structural engineering, as well as of geophysics and applied seismology.

The integrated course will address the following topics:

- Module 1. An overview of geological setting of Italy and southern Apennines seismicity. Seismic online databases from the Database of Individual Seismogenic Sources (DISS) to the Seismic Hazard Map (MPS). International literature approaches for seismic soil classification and amplification factors for implementation into Shakemaps. Multi-level approaches to seismic microzonation for site amplification and ground instability. Overview of selected case studies.
- Module 2. Geotechnical characterization for seismic site response: definition and measurement of the mechanical parameters describing soil behaviour under dynamic loading; identification of stratigraphic and morphological factors that influence the seismic response of natural deposits. Handling site-specific data, defining input motions and analysing seismic response for applications at a local scale (specifically, the Western area of Naples) as well as over larger areas (Italian peninsula).
- Module 3. Predisposing, preparatory and driving factors for seismically induced liquefaction. Evaluation of liquefaction susceptibility using multi-level approaches from screening criteria, empirical qualitative methods to dynamic analyses. Liquefaction susceptibility assessment of Napoli urban area and Ischia Island.
- Module 4. Predisposing, preparatory and driving factors for earthquake-induced slope instability. From historical data analysis to susceptibility maps for Campania region based on threshold screening criteria and multi-factorial statistic analysis. Prediction of earthquake-induced slope displacements at territorial and local scales for Sabato River valley and North-Western Ischia island.
- Module 5. Overview of current empirical methodologies for seismic fragility and vulnerability assessment utilizing post-earthquake data and heuristic or hybrid procedures. Recent findings contributing to the updating and refinement of the vulnerability model for the National Risk Assessment (a project led by the Department of Civil Protection). Applications to case studies of l'Aquila city and the western area of Napoli.

3. Preliminary organization

SYLLABUS	Lecturer	N° hours (#)
Reference geological and seismicity mapping	Giovanni Forte	3
Seismic site response	Gaetano Falcone	4
Evaluation of seismic liquefaction susceptibility	Anna d'Onofrio	3
Prediction of earthquake-induced slope instability	Francesco Silvestri	3
Vulnerability of structures by means of fragility curves	Carlo Del Gaudio	3

4. Lecturers

-Dr. Giovanni Forte – Assistant Professor in Engineering Geology, University of Naples Federico II.
-Dr. Gaetano Falcone - Research Fellow in Geotechnical Engineering, University of Naples Federico II.
-Prof. Anna d'Onofrio - Associate Professor in Geotechnical Engineering, University of Naples Federico II.
-Prof. Francesco Silvestri - Full Professor in Geotechnical Engineering, University of Naples Federico II.
-Dr. Carlo Del Gaudio – Research Fellow in Structural Engineering, University of Naples Federico II.

5. Duration and Credits

16 hours (2 CFU).

6. Activation mode and teaching period

The whole course may last one week. Tentative period: 10-14 June, 2023.
Location: Arrigo Croce Conference Room, DICEA, Building C8, Ground Floor.

7. Final exam

Questions related to the topics and discussion on the practical applications proposed during the course.

8. Brief CV of Lecturers

Giovanni Forte is Assistant Professor (RTD-B) of Engineering Geology at Department of Civil, Architectural and Environmental Engineering (DICEA), University of Naples Federico II. He has a Bachelor degree cum laude in Earth Sciences (2008), a Master degree in Geology and Engineering Geology cum laude in 2010. He is PhD in Seismic Risk (XXVI cycle) at University of Naples Federico II defending a thesis on "Integrated approach to the analysis of earthquake triggered landslides and their impact on roadway infrastructures" in 2014. He got the National Scientific Qualification (ASN) for the position of Associate Professor on 4th September 2018.
Since 2011 he supports the teaching activities of the engineering geology group. Since January 2018 he is Professor of the courses of Engineering Geology (Geologia Applicata) 6 CFU, Geological Risks for the design of Civil Engineering works (Rischi geologici nella Progettazione di Opere di Ingegneria Civile) 3/9 CFU for the bachelors and master degrees in civil, building and environmental engineering. Since 2021 he also teaches Digital maps and geological 3D modelling 9 CFU for the master in Transportation Engineering and Mobility.
He supervised more than 35 students for their graduation thesis for both bachelor and master degrees.
The main scientific research topics deal with natural hazards, slope stability, earthquake engineering and hydrogeology. The results of the researches are presented in several national and international congresses and summarized in several indexed-journals. He participated in several Research Projects as: AMABT (FRA), MASLIDE (FRA), ISTOS (Horizon2020), MITIGO (PON), RELUIS (Department of Civil Protection), VIRA (Department of Civil Protection), CLARITY (Horizon2020), GRISIS (POR), METROPOLIS (PON).

Gaetano Falcone is a research fellow at the Department of Civil, Building, and Environmental Engineering at the Federico II University in Naples, Italy. He graduated in Civil Engineering in 2012 from Politecnico di Bari, Italy, and subsequently obtained his PhD in Risk and Environmental, Territorial, and Building Development under the supervision of Professors Angelo Amorosi and Daniela Boldini. During his PhD, Dr. Gaetano Falcone spent time abroad working at Newcastle University under the supervision of Prof. Gaetano Elia.
His research interests encompass: seismic risk mitigation, evaluation of seismic performance of structural emergency systems, and numerical simulation of various boundary value problems, under both static and dynamic conditions, with particular emphasis on areas characterized by a complex geomorphological setting and uneven topography. He was actively involved in teaching Foundation Engineering and Earthquake Geotechnical Engineering at Politecnico di Bari. Additionally, he worked as a research fellow at the Institute of Environmental Geology and Geoengineering of the National Research Council in Rome, Italy. This research was part of a grant with the Italian Department of Civil Protection. The objectives of the research

were to: define hazard levels, identify the minimum structural elements necessary for emergency management in the territorial context, and evaluate their operability. Furthermore, procedures were established for the programming, assessment, and monitoring of seismic risk mitigation interventions. Among the main outcomes of this research are national maps of stratigraphic amplification factors and the NC92Soil code for deterministic and stochastic local seismic response analyses.
Results from his research have produced 18 articles in peer-reviewed international journals and 20 proceedings at national and international conferences on geotechnics. Dr. Gaetano Falcone serves as a reviewer for 29 international journals, including Computers and Geotechnics, Acta Geotechnica, and Soil Dynamics and Earthquake Engineering, among others.

Anna d'Onofrio, born in Salerno in 1965, took her M.Sc. degree (magna cum laude) in Civil Engineering at the University of Napoli Federico II in 1992. In 1995 she was Visiting Researcher at the Institute of Industrial Science of the University of Tokyo, where she partially developed her Ph.D. Thesis under the guidance of Prof. F. Tatsuoka. In 1996 she took her Ph.D. in Geotechnical Engineering at the University of Roma La Sapienza, under the supervision of Prof. Filippo Vinale. Since 1996 to 2001 she has been Technical staff member at the Geotechnical Laboratory of the University of Napoli Federico II. Since 2001 to 2005 she has been Research Assistant at the 'Department of Geotechnical Engineering' of the University of Napoli Federico II.
Since 2005 to date she is Associate Professor at the University of Napoli Federico II, currently at the *Department of Civil, Architectural and Environmental Engineering*.
Since 2002 she has been teaching *Soil Mechanics*, *Geotechnical Engineering*, *Soil Dynamics and Earthquake Geotechnical Engineering*, *Foundation engineering*, *Geotechnical risks in urban areas* at the University of Napoli Federico II. Supervisor of 7 PhD theses in Geotechnical Engineering. Teacher at several National and International courses for lifelong learning.
Coordinator of an Erasmus + agreement with the Universitat Politècnica de Catalunya (UPC Barcelona Tech-Spain).
Her theoretical, experimental and numerical research activity mainly deals with the characterisation and the analysis of the mechanical behaviour of natural soils and construction geomaterials undergoing loads varying with time, relevant to working and seismic conditions of building and infrastructures.
In particular, she focused on the following research mainstreams:
- advanced experimental techniques for the measurement of soil mechanical properties;
- analysis and modelling of soil behaviour at small strain levels in saturated and unsaturated conditions;
- experimental characterization of the frequency dependent behaviour of soils in the pre-failure deformations range;
- experimental characterization of the mechanical behaviour of soil treated with cement and lime;
- geotechnical characterisation, site response analysis and seismic microzonation of urban centres in Italy;
- experimental analysis and modelling of the mechanical behaviour of liquefiable soils.
Since 1993 she participated as researcher to more than 30 national and international research projects and she was coordinator of:
- contract with the general contractor Astaldi for the Laboratory characterization of soils for the construction of "Megalotto 3 S.S. 106 Ionica";
- contract with Emilia Romagna Region for the Stability analysis of Scortichino leeve under seismic conditions;
- contract with IGAG *Institute of Environmental Geology and Geoengineering* of the *National Research Council* (for the Microzonation center and its application) on *"Seismic microzonation of urban centres hit by the 2016-17 Central Italy seismic sequence"*.
Member of Technical Committee TC 101 on Laboratory Testing of the *International Society of Soil Mechanics and Geotechnical Engineering* (ISSMGE).
Member of GEER (*Geotechnical Earthquake Engineering Reconnaissance Association*).
Member of the Board Council of the Italian Geotechnical Society.
Head of the geotechnical laboratory at the University of Napoli Federico II.
On the above mentioned research topics, she published more than 130 papers, among them 34 international journal papers, 80 papers and invited reports at international conferences, 12 invited reports, 6 volume chapters).
Appointed as panel reporter at two International conferences.
The indicators of scientific productivity of Anna d'Onofrio, extracted from the Scopus database on December 2023 are: total number of journal papers: 69; total number of citations: 1165; h-index: 22.

Francesco Silvestri, born in Napoli (Italy) in 1960, became M.Sc. in Civil Engineering in 1986, Research Assistant in 1990 and Ph.D. in Geotechnical Engineering in 1991 at University of Napoli Federico II. He served as Associate Professor at University of Calabria since 1998, then as Full Professor since 2003, and since 2007 returned back to University of Napoli Federico II.
Currently teaching *'Soil Dynamics and Earthquake Geotechnical Engineering'* and *'Static and Seismic Foundation Design'* at University of Napoli Federico II and *'Soil dynamics and non-linear site response analysis'* (Master on Geomechanics, Civil Engineering and Risks) at University of Grenoble-Alpes (France).
Supervisor of 14 PhD theses in Geotechnical Engineering or Seismic Risk.
Experimental and analytical research on the seismic behaviour of soils, slopes, buildings and infrastructures; main current interests: seismic response analysis, seismic slope stability, liquefaction, soil-foundation-structure interaction, seismic performance of earth dams and underground excavations.
Scopus indicators of scientific productivity to date: total number of documents: 132 (61 journal articles); total number of citations: 2174; h-index: 26.
Coordinator of national and international Research Projects on soil dynamics and earthquake engineering.
Member of national and international Technical Committees on geotechnical testing and earthquake geotechnical engineering, including ISSMGE TC203 *'Earthquake Geotechnical Engineering'*.
Guest editor of special issues on the Italian Geotechnical Journal (*Rivista Italiana di Geotecnica*) and *Acta Geotechnica*.
Co-organizer and editor of the proceedings of the *International Symposium on Volcanic Rocks and Soils* (Ischia, 2015).
Invited lecturer, session chairman and discussion leader at national and international conferences, including *International Conference on Soil Mechanics and Geotechnical Engineering* (General Reporter in 2013), *Italian Conference in Geotechnical Engineering* (Keynote Lecturer in 2014), *International Symposium on Landslides* (Panel Reporter in 2016), *Performance-based design in Earthquake Geotechnical Engineering* (Theme Lecturer in 2017, Keynote Lecturer in 2022).
Chairman and editor of the proceedings of the 7ICEGE – *7th International Conference on Earthquake Geotechnical Engineering* (Rome, June 17-20, 2019).

Carlo Del Gaudio is a Research Fellow (Type A, Law 240/2010) at the Department of Structures for Engineering and Architecture, University of Naples Federico II, since 2021. He graduated in Civil Engineering at the University of Napoli Federico II in 2011. He attended the PhD fellowship in Seismic Risk (Supervisor: prof. Gerardo M. Verderame) at the University of Napoli Federico II between 2012-2015 and defended his thesis on 2015. He was postdoctoral fellow on the topic "Seismic vulnerability assessment of Reinforced Concrete Buildings via simplified mechanical methods" at the Department of Structures for Engineering and Architecture, University of Naples Federico II from 2015 to 2021.
He got the National Scientific Qualification (ASN) for the position of Associate Professor on 13th February 2023.
The research activities deal with experimental and numerical analysis of reinforced concrete (RC) elements, the modeling and non-linear analysis of RC structures, the influence of infill elements on the response of RC buildings, the evaluation of seismic vulnerability of RC buildings via simplified mechanical analysis, seismic vulnerability and risk assessment for large stock of buildings via empirical approaches, structural intervention and retrofit techniques of RC buildings.
He was Co-Tutor of over than 20 Master Degree Thesis on Structural Engineering and Co-Tutor of a Phd student on the topic of Seismic Fragility Assessment of Existing Buildings at urban scale.
He is member of the Younger Members Committee of the Earthquake Engineering Research Institute (EERI), and actively work in the sub-commission of the World Housing Encyclopedia (WHE), related to housing construction practices in the seismically active areas of the world and sharing experiences with different construction types and encouraging the use of earthquake-resistant technologies worldwide.
He was organizer of 6 Minisimposia at international conferences on Earthquake Engineering and attended over 15 international conferences as Speaker on topics of Earthquake Engineering.
He participated in several Research Projects as: METROPOLIS (PON), PLANNER (POR), RELUIS (Department of Civil Protection), the Extended Partnership RETURN.
He supported the Italian Department of Civil Protection in drafting the "National Risk Assessment 2018", coherently with EU decision 1313/2013 and responding to the specific requirement of the "Sendai Framework for Disaster Risk Reduction 2015–2030" to periodically adjourn the assessment of disaster risk.
He is Co-Author of 43 Documents published in peer-reviewed international journals. He has an h-index 17 resulting from 1010 citations by 604 Documents.