UNIVERSITY OF NAPLES FEDERICO II

DEPARTMENT OF STRUCTURES FOR ENGINEERING AND ARCHITECTURE
PHD PROGRAM IN
STRUCTURAL, GEOTECHNICAL ENGINEERING AND SEISMIC RISK

CYCLE XXXVII

The undersigned prof. Fulvio Parisi (PO □ PA □ Researcher ■) at the Department of Structures for Engineering and Architecture (S.S.D. ICAR/09 Structural Engineering)

ASKS

To be included in the list of PhD tutors for cycle XXXVII.

1. Curriculum vitae (max 500 words)

Fulvio Parisi is Assistant Professor (with tenure track) in Structural Engineering at University of Naples Federico II, Italy, and Associate Researcher of the National Research Council of Italy (CNR). In 2017, he received the Italian national scientific qualification as Associate Professor in Structural Engineering.
He teaches the courses entitled "Design and Retrofit of Masonry Structures" and "Diagnosis and Therapy of Structural Failures", giving many invited lectures in different universities and research centres across Europe and USA. He is a Scientific Board Member and teacher of "Structural Failures and Collapses" in the post-graduate MSc Programme in Forensic Engineering. Since 2018, he is expert reviewer of the Italian Ministry for University and Research.
He is Associate Editor of 3 international journals and Editorial Board member of 2 international journals. In almost 20 research projects, his research mainly focused on the following topics: multi-hazard vulnerability of reinforced concrete and masonry structures; innovative structural retrofitting with composite materials; soil-structure interaction; structural robustness; structural health monitoring of existing structures; and risk and resilience of civil infrastructure to natural and man-made hazards.
He authored more than 135 papers in peer-reviewed journals and conference proceedings, 1 book, 10 book chapters, 30 reports, and 3 computer tools for seismic analysis of masonry buildings and experimental data selection of masonry properties. He edited 2 books and 2 journal special issues.
His research outcomes received the following awards and recognitions: Young researcher award by Macedonian Association for Earthquake Engineering in the framework of the 14th European Conference on Earthquake Engineering (2010); 2 articles among the most cited papers in Engineering Structures (2019, 2020); 1 article among the most cited papers in ASCE Journal of Performance of Constructed Facilities (2018); 1 article among the most cited papers in Engineering Failure Analysis (2017);

article "Learning from construction failures due to the 2009 L'Aquila, Italy, earthquake" among the best 2010 papers of Journal of Performance of Constructed Facilities (2011).
Some studies authored by Fulvio Parisi were implemented or cited in guidelines published by the American Concrete Institute (ACI) and CNR.
He was a scientific or organizing committee member of more than 15 international conferences, and coordinator or member of working groups in several associations and standard bodies, such as Fédération Internationale du Béton (fib), CNR, Comité Européen de Normalisation (CEN), and Ente Nazionale di Normazione (UNI).
In 2019, he founded the spin-off company FORENSICS srl (FORensic ENgineering ServICeS), where he is Head of Civil and Risk Engineering services.
In 2020, he was included in the list of World's Top 2% Scientists according to the scientific impact of his research activity.

2. PhD students of whom the undersigned has been a tutor in the last three years	
n. 3	Annachiara Piro (33rd cycle, graduated in 2021) Martina Scalvenzi (34th cycle, ministerial grant) Giacomo Miluccio (35th cycle, grant funded by research project)

3. Topic of the proposed research
Seismic fragility assessment of masonry buildings using physics-based models and artificial intelligence techniques

4. Field of study
Geotechnical Engineering □ Structural Engineering □ Seismic Risk ■

5. Summary of the research project (max 500 words. State of the art, short program planned for the activities, etc.)

The Sendai Framework for Disaster Risk Reduction 2015–2030 delineates the need for periodic updating of disaster risk assessment to drive risk mitigation programs at national and international levels. Accordingly, the Department of Civil Protection asked its competence centres (including ReLUIS) to carry out a National Risk Assessment for Italy, developing seismic risk maps. In this respect, the assessment of seismic vulnerability is of paramount importance to estimate the damage susceptibility of assets at risk (e.g., buildings) as a function of earthquake intensity. Vulnerability is usually modelled by means of fragility functions, which describe the conditional probability of exceeding a prescribed damage level given the seismic intensity. Other mathematical representations of seismic vulnerability are the damage probability matrices and vulnerability curves, the latter providing the mean damage ratio under varying earthquake intensity. Vulnerability models can be developed using different approaches, such as analytical methods (based on either simplified analytical models or detailed structural models), empirical methods (where vulnerability modelling is based upon damages observed after past earthquakes), and hybrid methods (which combine different assessment methodologies, calibrating models based on either expert engineering judgement or analytical predictions through observational data). After that fragility is computed and modelled (usually through continuous probability distribution functions), it can be convolved with hazard and consequence models to assess losses associated with future earthquakes.

In this context, the seismic vulnerability assessment of unreinforced masonry (URM) structures is a key issue of risk-oriented performance-based earthquake engineering, which can benefit from artificial intelligence (AI) methods. The use of physics-based structural models to build analytical fragility models is an open issue because of their huge computational demand.

Therefore, the **goal** of this PhD project is to develop analytical fragility functions for existing URM buildings, based on computationally efficient methods that make use of physics-based (structural) models and AI algorithms.

The research activity will thus consist of the following **tasks**:

1) Acquisition and modelling of building exposure, namely, the number of buildings, their percental distributions in different vulnerability classes, and their construction characteristics (e.g., age, size, masonry type, floor type), accounting for their demography and altitude category in selected regions of interest.
2) Definition of building archetypes, which should be representative of the building inventory and automatically generated according to multi-parametric algorithms.
3) Uncertainty modelling, i.e., the identification of both aleatory and epistemic uncertainties as well as their modelling through discrete/continuous probability

distributions and logic trees.

4) Development of computationally efficient methods of structural analysis using spread plasticity macro-element models of URM buildings for training and testing of AI algorithms.
5) Selection of proper intensity measures and definition of performance limit states at component and/or system level.
6) Computation of seismic fragility for each building type under investigation, allowing the estimation of seismic fragility functions for different building classes defined in accordance with the European macro-seismic scale (EMS-98).

6. Research publications

Augenti N., Parisi F. (2019). *Teoria e Tecnica delle Strutture in Muratura*. Hoepli, Milano.

Augenti N., Parisi F. (2010). Constitutive models for tuff masonry under uniaxial compression. *ASCE Journal of Materials in Civil Engineering*, 22(11):1102-1111.

Augenti N., Parisi F., Prota A., Manfredi G. (2011). In-plane lateral response of a full-scale masonry sub-assemblage with and without an inorganic matrix-grid strengthening system. *ASCE Journal of Composites for Construction*, 15(4):578-590.

Brunelli A., de Silva F., Piro A., Parisi F., Sica S., Silvestri F., Cattari S. (2021). Numerical simulation of the seismic response and soil-structure interaction for a monitored masonry school building damaged by the 2016 central Italy earthquake. *Bulletin of Earthquake Engineering*, 19: 1181-1211.

Parisi F., Augenti N. (2013). Seismic capacity of irregular unreinforced masonry walls with openings. *Earthquake Engineering and Structural Dynamics*, 42(1):101-121.

Parisi F., Augenti N., Prota A. (2014). Implications of the spandrel type on the lateral behavior of unreinforced masonry walls. *Earthquake Engineering and Structural Dynamics*, 43(12):1867-1887.

Parisi F., Balestrieri C., Asprone D. (2016). Nonlinear micromechanical model for tuff stone masonry: Experimental validation and performance limit states. *Construction and Building Materials*, 105:165-175.

Parisi F., Balestrieri C., Varum H. (2019). Nonlinear finite element model for traditional adobe masonry. *Construction and Building Materials*, 223:450-462.

Parisi F., Lignola G.P., Augenti N., Prota A., Manfredi G. (2013). Rocking response assessment of in-plane laterally-loaded masonry walls with openings. *Engineering Structures*, 56:1234-1248.

Parisi F., Sabella G., Augenti N. (2016). Constitutive model selection for URM cross sections based on best-fit analytical moment–curvature diagrams. *Engineering Structures*, 111:451-466.

7. Funded research projects in which the proposed research fits
The research activity is connected to a number of numerical investigations, which are underway within the following research projects: • ReLUIS-DPC 2019–2021 (WP4: Risk Maps and Seismic Damage Scenarios and WP10: Contributions to building codes for masonry structures); • PRIN DETECT-AGING "Degradation Effects on sTructural safEty of Cultural heriTAGe constructions through simulation and health monitorING"; • PON INSIST "Smart monitoring system for safety of urban infrastructure". However, other projects could be funded on the topic.

8. Funds available for research grants, equipment, missions, etc.
The research activity will mainly consist of numerical research, which is supported by the above-mentioned research projects. Such projects also provide funding for grants and missions to attend meetings, workshops and conferences.

9. Information related to the research period abroad (min. 3 months) provided for the PhD student (please indicate University/research institution and professor/researcher of reference) (max 300 words)
The PhD student is expected to spend 6 months at University College London (UCL, UK) in cooperation with Prof. Dina D'Ayala (d.dayala@ucl.ac.uk), who is Professor of Structural Engineering within the Department of Civil, Environmental and Geomatic Engineering. She is Head of Civil Engineering and Co-Director of the Earthquake and People Interaction Centre (EPICentre). She is a Director of the International Association for Earthquake Engineering (IAEE) with long experience particularly on the assessment, strengthening, preservation and resilience of existing buildings, structures, transport infrastructure and cultural heritage. In addition to the involvement in many international research projects on resilience against natural hazards, she has 25 years' experience working with international agencies, the World Bank, ODA, UNDP, British Council. She is the Chief Scientist for the World Bank on the Global Programme for Safe Schools (GPSS) and leads the development of the World Bank

GLoSI project.

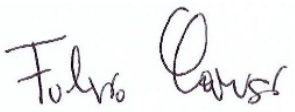
The research activity at UCL will focus on the validation of seismic fragility models developed for unreinforced masonry (URM) buildings, based on empirical data from previous strong earthquakes. The analytical fragility functions will be also compared to those available in the literature for URM buildings that have similar characteristics with respect to those investigated in the PhD project. Special attention will be given to the possible occurrence of local failure modes, which can partially or totally neutralise the activation of the in-plane resistance of load-bearing walls. Therefore, fragility models associated with global box-type behaviour of URM buildings will be combined with fragility models related to out-of-plane failure modes. This will allow appropriate analytical fragility models to be developed for historical URM buildings with typical structural deficiencies, such as low-strength masonry and lacking connections between walls and floor systems. This research activity will also benefit from the interaction between University of Naples Federico II, UCL, several research centres, engineering companies, and risk management agencies.

10. Collaborations with companies on the research topic (if available) (max 300 words)

The research activity might stimulate cooperation with several engineering and construction companies that work on structural response analysis of masonry constructions and multi-hazard risk assessment, such as ARUP.

Napoli, 04/29/2021

SIGNATURE



This form must be filled and sent to the e-mail address phd.dist@unina.it by 04/30/2021.