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 □ RU □ RTD ■) and prof. Elio Sacco (PO ■ PA □ RU □ RTD □) Department of Structures for Engineering and Architecture

S.S.D. ICAR/09 Structural Engineering ICAR/08 Solid and Structural Mechanics

ASKS

to be included in the list of tutors for cycle XXXVII.

1. Curriculum vitae (max 500 words)

Fulvio Parisi

Dr. Fulvio Parisi is an 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 assessment, retrofitting, robustness, and health monitoring of existing structures.

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 were awarded or recognized by several institutions and journals, with some studies implemented or cited in guidelines published by the American Concrete Institute 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.

Elio Sacco

Elio Sacco (email: elio.sacco@unina.it; Web-page: https://www.docenti.unina.it/elio.sacco; ResearcherID: G-5349-2017; ORCID: https://orcid.org/0000-0002-3948-4781) is full Professor (with tenure) of Solid and Structural Mechanics at Department of Structures for Engineering and Architecture, University of Naples "Federico II".

He teaches the courses entitled "Mechanics of solids and structures" and "Micromechanics of heterogeneous materials".

He had numerous abroad research experiences, e.g. in USA, France, UK, , giving many invited lectures in different universities and research centres. He participated to more than 100 national and international conferences and has been invited for plenary and semi-plenary lectures. He has been member of several scientific congress committees and he is member of editorial advisory board of some international journal.

He was Member of the Evaluation Expert Group (GEV-ANVUR); Member of Evaluation Team of the University of Cassino; Chair of PhD Committee in Civil and Mechanical Engineering; Member of Academic Senate; Head of the Department (2 times).

The main research fields are: Computational Mechanics of Structures, Material constitutive modelling of advanced materials (shape memory alloys); Micromechanics and homogenization techniques for composite materials characterized by nonlinear behavior of the constituents; Multiscale analysis of heterogeneous structures; Mechanics of masonry materials and structures; Analysis of plate and shells.

Bibliometric data (Scopus updated in April 2021): Documents 190; Citations 4338; h-index 37.

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. Title of the proposed research
Computational strategies for seismic assessment of masonry building aggregates

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.)
A significant percentage of the worldwide built heritage consists of masonry constructions, including many historical or even monumental masonry structures such as churches, palaces, towers, and fortresses. Historical urban centres typically include masonry building aggregates that frequently suffer heavy damage and collapse during earthquakes. This issue affects both primary towns and small villages, with significant variability of building characteristics. Poor quality of materials and detailing often results in local collapse mechanisms or even masonry fragmentation, neutralizing any chance to develop a global box-type behaviour as observed in the case of modern masonry buildings. Even when the masonry structure activates a global response, the flexibility of floor systems and/or the presence of thrusting elements (e.g., arches, vaults, roof trusses) produce a combined in-plane (IP)/out-of-plane (OOP) loading of load-bearing masonry walls. This delineates a complex structural behaviour, the analysis of which becomes a challenging yet fascinating task in the case of building aggregates. Indeed, earthquake ground shaking activates several types of interaction between adjacent structural units within the same building aggregate, but scientifically sound rules are still lacking to solve this issue. The aim of this PhD project is to develop a methodology and numerical tools for seismic assessment of masonry building aggregates, which might support developments in current technical codes.

The research activity will follow a multi-scale approach, starting from a single building and moving to the building aggregate. The methodology will consist of the following main tasks:

1) Definition of typological building aggregates, considering different geometric configurations (both in plan and elevation), floor systems (e.g., timber floors, masonry vaults), pre-existing damage types/levels (due to, e.g., material degradation, overloading, previous earthquakes, soil settlements), and construction processes simulating the past development of historical urban centres, according to available data on towns and villages in Italy and/or other countries.
2) Comparative analysis of building aggregates using structural models with different levels of sophistication (from high-fidelity numerical models based on, e.g., finite or discrete elements, to simplified macro-block models) to assess model errors of simplified structural models for seismic safety checking.
3) Development of procedures for seismic assessment of single building units located in different parts of the aggregate (e.g., corner versus central building units).

Special attention will be given to the modelling of flexible floor systems, vaults, and both wall-to-wall and wall-to-floor connections, because they influence the distribution of horizontal actions between load-bearing walls and combined IP-OOP loading of each wall. This will call for a multi-scale modelling where structural components and sub-systems will be first analysed through nonlinear numerical methods and then incorporated into a simplified model of the structure. Other numerical techniques such as the domain decomposition method will be investigated to reduce the computational cost associated with seismic response analysis of a whole building aggregate.

6. Research publications

Addessi D., Sacco E. (2019). A 2D finite element based on an enriched kinematics for nonlinear analysis of masonry walls. *International Journal of Masonry Research and Innovation*, 4(1-2):97-112.

Addessi D., Sacco E. (2016). Enriched plane state formulation for nonlinear homogenization of in-plane masonry wall. *Meccanica*, 51(11):2891-2907.

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

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.

D'Altri A.M., Sarhosis V., Milani G., Rots J., Cattari S., Lagomarsino S., Sacco E., Tralli A., Castellazzi G., de Miranda S. (2020). Modeling strategies for the computational

analysis of unreinforced masonry structures: Review and classification. *Archives of Computational Methods in Engineering*, 27:1153-1185.

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

Ricci E., Fraddosio A., Piccioni M.D., Sacco E. (2019). A new numerical approach for determining optimal thrust curves of masonry arches. *European Journal of Mechanics: A/Solids*, 75:426-442.

Sacco E., Addessi D., Sab K. (2018). New trends in mechanics of masonry. *Meccanica*, 53(7):1565-1569.

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 (UK) or University of Minho (Portugal) in cooperation with Prof. Dina D'Ayala (d.dayala@ucl.ac.uk) or Prof. Paulo B. Lourenço (pbl@civil.uminho.pt). Both tutors have already collaborated with the above-mentioned institutions and professors.

The research activity will focus on methods for seismic safety checks against out-of-plane (OOP) failure modes of load-bearing walls and/or modelling of masonry vaults. Several computational strategies will be investigated. In the case of load-bearing walls subjected to OOP loading, those strategies will include linear and nonlinear kinematic analyses as methods of limit equilibrium analysis for force-based and displacement-based assessment of existing masonry structures. More sophisticated computational methods, such as pushover and incremental dynamic analysis, will be used to define correction factors for simplified methods. Dealing with modelling, macro-block models will be compared to finite and/or discrete element models, which allow realistic simulations of seismic behaviour considering different building configurations in terms of materials, geometry and connections between structural components (e.g., walls, floor/roof systems).

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 in the field of structural assessment as well as structural testing and health monitoring of masonry constructions, such as ARUP and Tecno-In Geosolutions.

Napoli, 28/04/2021 FIRMA