



**DIPARTIMENTO DI STRUTTURE PER L'INGEGNERIA E L'ARCHITETTURA
CORSO DI DOTTORATO DI RICERCA IN
INGEGNERIA STRUTTURALE GEOTECNICA E RISCHIO SISMICO**

XXXIX CICLO

La sottoscritta prof.ssa Claudia CASAPULLA

(PO ☐ PA ☒ RU ☐ RTD ☐) afferente al Dipartimento di Strutture per
l'Ingegneria e l'Architettura, S.S.D. ICAR/09 – Tecnica delle Costruzioni

CHIEDE

di essere inserito tra i possibili tutor di studenti di dottorato per il XXXIX ciclo.

1. Curriculum sintetico del proponente (max 500 parole)

Claudia Casapulla (MSc. in 1997 and Ph.D. in 2000) is Associate Professor in Structural Engineering (with awarded national scientific qualification as Full Professor) at the University of Napoli Federico II and, since 2002, Staff Member Responsible (SMR) for Laboratories, Courses and Modules of Structural Engineering at the same university (Bachelor and Master Levels).

She has been Principal Investigator of a Research Project funded by the Campania Region (L.R. n.5/02) and of a Marie Skłodowska-Curie Individual Fellowship funded within the EU Horizon 2020 framework (GA No. 791235). She has also been scientific responsible/member of several national projects, of grants supporting international stages in UK from 1998 to 2005 and currently has active collaborations with the universities of Sheffield (UK), Surrey (UK), Minho (PT) and Budapest (Hungary).

Her research interests are mainly focused on the seismic vulnerability of masonry structures and innovative modelling of their collapse behavior under static and dynamic loadings, with experimental, theoretical and code applications. Particular fields of research are: computational analysis of 3D masonry assemblages of rigid blocks (FEM, DEM, limit analysis), seismic vulnerability of wall connections in the local mechanisms of masonry buildings, design of strengthening interventions with advanced innovative systems, development of fragility curves for masonry churches with reference to both the global and local behavior.

She has authored over 150 original research papers, is a peer reviewer for over 40 indexed international journals and for the Italian scientific evaluation by REPRISSE. She is an associate/academic editor of over 10 international journals and scientific committee member/chair for about 30 international conferences. She has been ranked



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in the World's Top 2% Scientists 2019, 2020 and 2021, as published by Stanford University on Plos Biology.

2. Dottorandi dei quali il proponente è stato tutor nell'ultimo triennio

n. _____	_____
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3. Titolo della ricerca proposta

Local mechanisms in existing masonry structures: sustainable retrofitting, reliability analysis, life-cycle assessment

4. Area tematica

Ingegneria Geotecnica ☐

Ingegneria Strutturale ☒

Rischio Sismico ☐

5. Tipologia di borsa per la quale si propone il progetto

Ateneo ☒

DM 117 (Investimento 3.3) ☐
(in questo caso indicare l'azienda co-finanziatrice)

DM 118 (Investimento 4.1 P.A.) ☐

DM 118 (Investimento 4.1 generici) ☒



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DM 118 (Investimento 4.1 Patrimonio culturale) X

6. Sintesi del progetto di ricerca (max 500 parole. Stato dell'arte, obiettivi e breve programma previsto per le attività e)

In masonry buildings without box-like behavior but with good quality masonry, such as most existing unreinforced masonry (URM) buildings in the historic city centers, local out-of-plane failures can take place, even under low intensities of ground motion and especially for peripheral walls. Recurrent vulnerabilities in these buildings are weak connections between orthogonal walls, absence of connecting ties, insufficiently rigid floor diaphragms, low strength and deterioration of materials; the presence of openings and their position in the walls are further relevant aspects.

In the last decades, significant efforts have been made to improve the understanding of the global and local response of existing URM buildings, employing a combination of advanced numerical analysis models, innovative non-destructive inspection technologies, with both on-site and in laboratory investigations. In addition, special attention has been devoted to their rehabilitation and strengthening interventions by either traditional or innovative strategies. However, the sustainability of strengthening/retrofitting systems still needs to be tackled in many challenging aspects, such as the material compatibility, the reversibility and durability of the intervention, the reduction of cost, time, and greenhouse gas (GHG) emissions, the energy optimization.

The objective of the proposed 3-year PhD Program is to analyze the local out-of-plane mechanisms in masonry buildings and investigate the possibilities of strengthening interventions with both traditional and advanced innovative systems, even integrated with solutions for energy saving or for reducing environmental impacts. The research activities will provide design indications, fundamental for respecting the 'minimum intervention' philosophy for heritage buildings and useful for improving the current relevant Italian standards.

The research activities will cover the following aspects:

- State of the art and recent developments of existing modeling approaches and innovative strengthening techniques for local out-of-plane mechanisms in masonry buildings.
- Evaluation of the ground acceleration corresponding to the activation and the collapse of different kinds of local out-of-plane mechanisms (rocking and flexural failures) by means of classical and advanced approaches existing in the literature (FEM, DEM, Limit Analysis, etc.).



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- Analysis of the most recurrent local mechanisms by using and improving an advanced discrete model based on the macro-block modeling approach with frictional resistances and the non-linear kinematic approach of limit analysis. This activity includes the construction of pushover curves to compare the capacity in terms of both forces and displacements with the seismic demand through the construction of Acceleration-Displacement Response Spectra (ADRS). National and international codes are used and compared.
- Analysis of innovative retrofitting systems to prevent local out-of-plane mechanisms, e.g.:
 - injected anchors with pultruded composite bars (GRFP, CFRP, etc.) and different kinds of grout as pozzolana, lime based or cement-based grout to reinforce wall connections;
 - laminates or FRP fabrics used as confinement systems of columns or mounted at each floor or at the last floor along the perimeter of the building.
- An environmental study of each constructive solution, using a Life Cycle Assessment methodology, and the energy behavior analysis. The results should indicate that "sustainable proposals" may represent a significant environmental improvement, in which a reduction in CO₂ emissions and incorporated energy can be appreciated, apart from an optimal energy certification. Sustainable proposals should also reveal a significant economic reduction on the total budget of the intervention.
- Experimental tests on sub-assemblages of walls with and without the reinforcement with composite injected anchors and FRCM materials, aimed at defining the activation of some recurrent mechanisms and the capacity curves in terms of force-displacement through monotonic and cyclic tests.

7. Eventuali pubblicazioni del tutor sul tema di ricerca (max 10)

1. **C. Casapulla**, A. Maione, F. Ceroni, A. Prota, M. Di Ludovico (2023). Limit analysis and design-oriented approach for out-of-plane loaded masonry walls strengthened by grouted anchors. *Engineering Structures*, 285, art. no. 115991, doi: 10.1016/j.engstruct.2023.115991
2. **C. Casapulla** (2021). Local out-of-plane failure modes in traditional block-masonry buildings. In *Masonry Construction in Active Seismic Regions*; Woodhead Publishing Series in Civil and Structural Engineering; Rupakhety, R., Gautam, D., Eds.; Elsevier:



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- Amsterdam, The Netherlands, 2021; pp. 289–322, doi: 10.1016/B978-0-12-821087-1.00001-6
3. A. Maione, **C. Casapulla**, F. Ceroni, M. Di Ludovico, A. Prota (2021). Efficiency of injected anchors in connecting T-shaped masonry walls: a modelling approach. *Construction and Building Materials*, 301, art. no. 124051, doi: 10.1016/j.conbuildmat.2021.124051.
 4. **C. Casapulla**, L.U. Argiento, A. Maione, Elena Speranza (2021). Upgraded formulations for the onset of local mechanisms in multi-storey masonry buildings using limit analysis. *Structures*, 31, 380-394, doi: 10.1016/j.istruc.2020.11.083
 5. L. Giresini, **C. Casapulla**, P. Croce (2021). Environmental and economic impact of retrofitting techniques to prevent out-of-plane failure modes of unreinforced masonry buildings. *Sustainability* 13(20), art. no. 11383, doi: 10.3390/su132011383
 6. **C. Casapulla**, A. Maione (2020). Experimental and analytical investigation on the corner failure in masonry buildings: interaction between rocking-sliding and horizontal flexure. *International Journal of Architectural Heritage*, 14(2), 208-220, doi: 10.1080/15583058.2018.1529206
 7. **C. Casapulla**, A. Maione, L.U. Argiento (2019). Performance-based seismic analysis of rocking masonry façades using non-linear kinematics with frictional resistances: a case study. *International Journal of Architectural Heritage*, 15(9), 1349-1363, doi: 10.1080/15583058.2019.1674944
 8. **C. Casapulla**, L. Giresini, L.U. Argiento, A. Maione (2019). Nonlinear static and dynamic analysis of rocking masonry corners using rigid macro-block modelling. *International Journal of Structural Stability and Dynamics*, 19(11), art. no. 1950137, 1-32, doi: 10.1142/S0219455419501372
 9. **C. Casapulla**, L.U. Argiento (2018). In-plane frictional resistances in dry block masonry walls and rocking-sliding failure modes revisited and experimentally validated. *Composites Part B: Engineering*, 132: 197-213.
 10. **C. Casapulla**, L.U. Argiento (2016). The comparative role of friction in local out-of-plane mechanisms of masonry buildings. Pushover analysis and experimental investigation. *Engineering Structures*, 126: 158-173.

8. Eventuali progetti di ricerca finanziati in cui l'attività si inserisce

DPC-ReLUIS 2022-2024, WP 4 “Risk maps and seismic damage scenario (MARS-2)”



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9. Eventuali fondi disponibili a supporto dell'attività del dottorando (escluso finanziamento borse)

The same projects above will provide funds for salaries and activities.

10. Informazioni relative ad un periodo di ricerca all'estero (minimo tre mesi) previsto per il dottorando (*indicare Università/ente di ricerca e docente/ricercatore di riferimento con indirizzo mail*) (max 300 parole)

The PhD student will spend a minimum of 3 months at one of the following universities, collaborating with the tutor in several research activities:

- The University of Sheffield (UK). Reference Professor: **Matthew Gilbert**
- Institute for Sustainability and Innovation in Structural Engineering (ISISE), University of Minho (Portugal). Reference Professor: **Paulo B. Lourenço**
- University College London (UK). Reference Professor: **Dina D'Ayala**
- Budapest University of Technology and Economics (Hungary). Reference Professor: **Katalin Bagi**

11. Eventuali collaborazioni con imprese/aziende sul tema di ricerca (max 300 parole)

Napoli, 23/06/2023

FIRMA

Il presente modulo va compilato in ogni sua parte ed inviato all'indirizzo di posta elettronica phd.dist@unina.it entro e non oltre **il 30/06/2023**.