UNIVERSITA' DEGLI STUDI DI NAPOLI FEDERICO II

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

XXXVI CICLO

Il sottoscritto dott. Fulvio Parisi (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 XXXVI ciclo.

1. Curriculum sintetico del proponente (max 500 parole)
Dr. Fulvio Parisi is an Assistant Professor in Structural Engineering at University of Naples Federico II, Italy, and an Associate Researcher at the Institute for Complex Systems 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 several invited lectures in different universities and research centres across Europe and USA. He is also a Scientific Board Member and teacher of "Failures and Collapses" in the post-graduate MSc Programme in Forensic Engineering. Since 2018, he is expert reviewer of the Italian Ministry for Education, University and Research. Dr. Parisi is an Associate Editor of the ASCE Journal of Performance of Constructed Facilities, Frontiers in Earth Science (Geohazards and Georisks) and Advances in Civil Engineering, as well as Editorial Board Member of two other peer-reviewed international journals. He is reviewer for more than 40 journals and many international conferences. Besides, he was scientific committee member or mini-symposium organizer for more than 15 international conferences. He was involved in 11 research projects and currently works on 6 projects, carrying out both theoretical and experimental research in the following fields: seismic design, assessment and retrofit of masonry structures; smart structural health monitoring (SHM) and digital technologies for condition-based structural assessment; structural robustness; multi-hazard risk and resilience assessment of civil infrastructure. He authored over 130 papers published in peer-reviewed international journals and conference proceedings, as well as a book, three book chapters, many scientific reports, and three computer tools for seismic analysis of masonry buildings and experimental data selection of masonry properties. He was editor of a book and two journals special

issues. His research outcomes were awarded or recognized by several institutions and journals, including the Macedonian Association for Earthquake Engineering, Journal of Performance of Constructed Facilities (ASCE), Engineering Failure Analysis (Elsevier), and Engineering Structures (Elsevier). Some of his research studies were implemented or cited in three guidelines published by the American Concrete Institute and CNR. In this respect, he is a Task Group Convener for the Fédération Internationale du Béton (fib), a Working Group Member for the European Association for Earthquake Engineering (EAEE), CNR and Comité Européen de Normalisation (CEN), Vice-Coordinator of working group UNI/CT021/GL06 – Robustness for Ente Nazionale di Normazione (UNI), and a member of the Board of Directors and Regional Coordinator of the Complex Systems Society – Italy Chapter.
To implement research and technological innovation in real-world engineering problems involving multi-hazard performance of infrastructure and associated losses, in 2019 Dr. Parisi founded the spin-off company FORENSICS (FORensic ENgineering ServICeS).

2. Dottorandi dei quali il proponente è stato tutor nell'ultimo triennio	
n. 3	Annachiara Piro (33rd cycle, no grant), Martina Scalvenzi (34th cycle, ministerial grant), Giacomo Miluccio (35th cycle, grant funded by research project)

3. Titolo della ricerca proposta
Integrating artificial intelligence with performance-based engineering for building structures subjected to extreme hazards

4. Area tematica
Ingegneria Geotecnica □ Ingegneria Strutturale ■ Rischio Sismico □

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

In the last two decades, the philosophy and methods of performance-based engineering (PBE) have received a growing attention by researchers, designers, facility managers and many stakeholders, stimulating progressive implementation in national and international building codes. PBE was originally delineated in earthquake engineering, where it is currently used as rational and transparent methodology for risk-informed design, assessment and retrofit of civil engineering facilities. Recent studies have shown the feasibility, effectiveness and importance of PBE also in risk management of civil infrastructure subjected to extreme hazards, which are often called low-probability/high-consequence (LPHC) events in the literature. LPHC phenomena include a wide range of natural or human-related events (e.g. blast, impact, and errors in design, construction or retrofit) that are not usually considered in structural design and assessment. Several factors including climate change, terrorist/war scenarios and global connectivity have significantly increased the frequency and intensity of extreme events and their consequences. Therefore, current codes and guidelines are gradually accounting for LPHC events, in some cases providing rules for structural robustness of buildings. In this respect, one major challenge in structural engineering is to evaluate and mitigate the progressive collapse risk, i.e. the risk associated with the propagation of local damage due to an extreme event up to partial or total collapse of the structure. Latest studies have highlighted that quantitative risk analysis of structures under LPHC events is computationally demanding because, in line of principle, the dynamic nature of structural response requires a huge number of nonlinear time history analyses of 3D capacity models with mechanical and geometric nonlinearity sources. Nonetheless, artificial intelligence (AI) techniques are deemed an attractive solution to strongly reduce the computational cost associated with progressive collapse risk management.

This research programme is aimed at implementing AI algorithms in performance-based design and assessment of building structures, in order to develop risk-informed design/retrofit solutions against extreme hazards. Data-driven methods will be trained and tested through physics-based, experimentally-validated performance data, allowing the development of surrogate models (or meta-models) with very high computational efficiency. Special emphasis will be given to masonry and reinforced concrete structures subjected to either single or multiple hazards. The scope is to get performance predictions particularly in those cases in which a small amount of data is available. The methodology will be formulated so that multi-hazard design/retrofit solutions will be obtained as a means for risk mitigation.

The research activity will consist of the following main steps:

- Review and selection of optimal AI algorithms for their use in PBE.
- Selection of building prototypes representative of either sub-standard or code-conforming constructions.
- Advanced numerical simulation under single and cascade extreme events, such as blast, seismically-induced landslides and design/construction errors.
- Development of meta-models through both simulation and experimental data related to full-scale building specimens under extreme loading testing, considering the possible implementation of real performance data provided by digital technologies such as smart SHM systems.
- Investigation of alternative design/retrofit solutions able to meet risk and/or resilience targets in relation to extreme hazards, accounting for their differentiation among consequence classes.

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

Parisi F., Scalvenzi M. (in press). Progressive collapse assessment of gravity-load designed European RC buildings under multi-column loss scenarios. *Engineering Structures*, DOI: 10.1016/j.engstruct.2019.110001.

Parisi F., Scalvenzi M., Brunesi E. (2019). Performance limit states for progressive collapse analysis of reinforced concrete framed buildings. *Structural Concrete*, 20(1):68-84, DOI: 10.1002/suco.201800039.

Adam J., Parisi F., Sagaseta J., Lu X. (2018). Research and practice on progressive collapse and robustness of building structures in the 21st century. *Engineering Structures*, 173:122-149, DOI: 10.1016/j.engstruct.2018.06.082.

Brunesi E., Parisi F. (2017). Progressive collapse fragility models of European reinforced concrete framed buildings based on pushdown analysis. *Engineering Structures*, 152:579-596, DOI: 10.1016/j.engstruct.2017.09.043.

Parisi F., Sabella G. (2017). Flow-type landslide fragility of reinforced concrete framed buildings. *Engineering Structures*, 131:28-43, DOI: 10.1016/j.engstruct.2016.10.013.

Parisi F., Balestrieri C., Asprone D. (2016). Blast resistance of tuff stone masonry walls. *Engineering Structures*, 113:233-244, DOI: 10.1016/j.engstruct.2016.01.056.

Russo P., Parisi F. (2016). Risk-targeted safety distance of reinforced concrete buildings from natural-gas transmission pipelines. *Reliability Engineering and System Safety*, 148:57-66, DOI: 10.1016/j.ress.2015.11.016.

Brunesi E., Nascimbene R., Parisi F., Augenti N. (2015). Progressive collapse fragility of reinforced concrete framed structures through incremental dynamic analysis. *Engineering Structures*, 104:65-79, DOI: 10.1016/j.engstruct.2015.09.024.

Parisi F. (2015). Blast fragility and performance-based pressure–impulse diagrams of European reinforced concrete columns. *Engineering Structures*, 103:285-297, DOI: 10.1016/j.engstruct.2015.09.019.

Parisi F., Augenti N. (2012). Influence of seismic design criteria on blast resistance of RC framed buildings: a case study. *Engineering Structures*, 44:78-93, DOI: 10.1016/j.engstruct.2012.05.046.

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

The research activity is connected to a number of numerical-experimental investigations, which are underway within the following research projects: ReLUIS-DPC 2019–2021 (WP4: Risk Maps and Seismic Damage Scenarios); 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". Most of the PhD student's activity would be carried out in the framework of PON INSIST research project.

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

The research activity will mainly consist of numerical research, which is supported by the abovementioned research projects.

9. 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 is expected to spend 6 months at Universitat Politècnica de València (Valencia, Spain) in cooperation with Prof. Jose M. Adam (joadmar@upv.es), as per a letter of intent.

Prof. Adam is a faculty member of the Department of Construction Engineering in the

Civil Engineering School, a member of the Concrete Science and Technology Institute (ICITECH) and co-founder of the spin-off company CALSENS. Most of his research focuses on resilient building structures, structural failures, as well as structural assessment and retrofitting. He is author of more than 60 journal papers, editor of four scientific books and author of four book chapters. He participated in several research projects funded through competitive calls for a total of more than 5 million Euros.
The research activity will primarily involve the advanced simulation of extreme loading tests on full-scale building specimens. Performance data and damage observed during experimental tests will be evaluated and processed. Both deterministic and probabilistic analyses will be carried out to quantify robustness and repairability under single-column loss scenarios associated with impact, blast or other abnormal actions capable of generating progressive collapse. Nonlinear capacity models will be calibrated through a huge amount of experimental data on reinforced concrete (RC) buildings representative of some existing constructions located in the Euro-Mediterranean region. AI algorithms will be trained and tested to significantly reduce the computational cost of physics-based structural analysis methods such as nonlinear time history analysis of 3D fibre-based capacity models of RC framed structures with masonry infill walls and floor systems. AI-based surrogate models will be used to investigate the progressive collapse risk of selected building classes, including iconic, critical and strategic structures.

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

The research activity will be carried out in cooperation with several companies interested in design, assessment and retrofit of structures subjected to extreme hazards. Some studies on the implementation of artificial intelligence in resilience-based design of buildings will be done in collaboration with CALSENS (Spain). Multi-hazard assessment of buildings under earthquake-induced landslides will be linked to a current cooperation with ARUP (UK).

Napoli, 13/02/2020 FIRMA

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Il presente modulo va compilato in ogni sua parte ed inviato all'indirizzo di posta elettronica phd.dist@unina.it entro e non oltre **venerdì 14/02/2020**.