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

XXXIX CICLO

Il sottoscritto prof. **Elena Mele**

(PO **X** PA □ RU □ RTD □) afferente al Dipartimento di Strutture per l'Ingegneria e l'Architettura

S.S.D. (*indicare codice e nome per esteso)* 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)

2010 full professor, 2006-2010 associate professor, 1999-2006 assistant professor, University of Napoli Federico II, 1995-1997 post-doc research assistant, 1994 PhD in structural engineering.

Research activity:
Topics:

- generative design of megastructures, diagrid and gridshells;
- retrofit of existing buildings with exoskeleton;
- innovative structures for tall buildings;
- robustness and design for collapse prevention;
- seismic isolation at the base and intermediate level;
- tuned mass dampers;
- seismic assessment of masonry structures;
- seismic design of steel structural systems and connections;
- aluminium structures and foams.

Author of more than 260 publications in international and national journals and conference proceedings.

Since 2018 member of board of directors of Council of Steel Technicians (CTA), since 2018 member of Academic and Teaching Committee of Council of Tall Buildings and Urban Habitat, since 2017 fellow of Accademia delle Scienze d'Abbruzzo e delle Regioni Adriatiche, since 2015 member of Council of Tall Buildings and Urban Habitat.
2004 JSPS fellowship for Invited Visiting Professor at Disaster Prevention Research Institute, Kyoto University, Japan Society for Promotion of Science; 2001, 1999, 1998, 1996 visiting researcher at Instituto Superior Tecnico of Lisbon within FCT projects; 1999 visiting researcher at National Technical University of Athens, Laboratory for Earthquake Engineering, (ECOEST 2 - Access to Large Scale Facilities); 1999 visiting researcher at ELSA Laboratory of Joint Research Center, ISPRA.

Member of the Editorial Board on the journals: Buildings, MDPI; Costruzioni Metalliche; Sustainability, MDPI. 2020 Reviewer for book proposals The Institution of Engineering and Technology (IET); 2017-2018 Engineering Structures award for outstanding contribution in reviewing; 2016-2017 Peer Reviewer of CTBUH document: Perfomance Based Seismic Design Guidelines of Tall Buildings; Reviewer for several international journals.

2022-2026: member of the steering committee of FreeGrid, a benchmark on design and optimization of gridshells to be launched at the IASS 2023 Annual Symposium in Melbourne (July 2023).
2022-2024 project DPC-ReLUIS, WP15. RU UNINA-DIST coordinator: Design code contributions on seismic isolation and energy dissipation – the Intermediate Isolation System (IIS).

Teaching activity:
Courses for undergraduate and graduate students at University of Napoli Federico II:
since 2004: Design of steel structures; since 2005: Structures for high-rise and long-span buildings; 2012-2015: Structural design of reinforced concrete buildings; 2001-2005: Tecnica delle Costruzioni II (advanced structural analysis and design).
2006-2015: International II level Master Design of Steel Structures in Smart Cities, University of Naples Federico II: course Structures for high-rise and long-span buildings, Lectures and student project tutoring in Atelier 2, member of executive committee and of the teaching board.
Since 2009: member of thesis-lab board, Engineering Architecture Course. University of Napoli Federico II. Tutor and reviewer of several thesis (around 10/year)
Since 2014 responsible of student internship in UK (AtelierOne) and USA (SOM San Francisco, Columbia University NY), 2021 responsible of student internship at Ufficio Regionale Genio Civile di Napoli.
Since 2001 tutor or co-tutor of 15 PhD students: 3 in Structural engineering, Geotechnics and Seismic Risk; 11 in Construction Engineering, 1 in Drawing and Representation in Architecture.
2016-2017 tutor of 1 post-doc from Cassino University research project funded by Regione Lazio POR FSR.

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

n. ___2__	*Mario Argenziano, Francesco Esposito*

3. Titolo della ricerca proposta

Sustainable design and retrofit of buildings in urban habitat based on innovative dynamic concepts for improved seismic response

4. Area tematica

Ingegneria Geotecnica □

Ingegneria Strutturale **X**

Rischio Sismico **X**

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

Ateneo **X**

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) **X**
DM 118 (Investimento 4.1 Patrimonio culturale) □

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

Motivation and state of art

According to the United Nations [1] the world population living in urban areas, currently equal to 55%, will increase up to 78% by 2050. Further, the European Parliament has set the year 2050 for the accomplishment of the target "Zero land consumption" [2]. Therefore, a sustainable model of urban growth should be based on the density increase, according to two strategic lines: (1) use/reuse of existing building stock, with no additional land consumption and saving the carbon burden that already exists in the built environment; (2) maximum exploitation of the buildable land plot, by erecting tall buildings. In order to make feasible such planning strategic lines in regions of medium/high seismic hazard, as Italy and Mediterranean Europe, a common approach is proposed, based on a well-known principle of structural dynamics, namely the mass damping, though here applied in innovative and diversified ways in the different contexts.

With reference to the built environment, two sub-models, both based on the concept of addition, are proposed: Vertical addition for masonry buildings [3, 4, 5], and lateral addition (exoskeletons) for r.c. buildings [6]; the design parameters are the dynamic properties of the structural addition (in steelwork) and of the connection between the existing and new structural parts. In the case of vertical extension (rooftop addition) the connection is realized by means of a seismic isolation system, located on the roof of the existing building and at the base of the new structure, thus giving rise to an intermediate isolation system (IIS) for the structural complex; the isolation system should be designed for converting the vertical addition into a huge mass damper (MD), with remarkable reduction of the seismic demand on the structural complex, even with respect to the standalone existing building (fig.1a). The

exoskeletons are made by diagrid, hexagrid, o non-conventional structural patterns, which wrap the existing building, can also support ventilated or double skin façades, as well as satisfy solar shading/lighting requirements; starting from the case of "total" (very rigid) connection between the existing building and the exoskeleton, which couples in parallel the two structures, the solution of "partial" (flexible and dissipative) connection is analyzed in depth, and design criteria for activating a mass damper mechanism are investigated (fig.1b).
Therefore, in both cases, the main design parameters are the dynamic properties of the addition (in steelwork), and, specially, of the connection between the existing and new structures, for activating the MD mechanism and reducing the building dynamic response. This addition-based approach, while inherently sustainable since reuse and adapt the building stock, also allows for integrating energy retrofit interventions.
Concerning new tall buildings, the principle is somewhat similar to what suggested for the existing buildings, based on MD, though obtained with the opposite reasoning: indeed for existing building the idea is coupling an additional structure to the existing one, with the former tuned to minimize the dynamic response of the latter; for the tall buildings of new construction, instead, the idea is decoupling a part of the mass of the building itself (a substructure), thus allowing for a relative motion between the two structural parts (the main or primary structure and the substructure or secondary structure). For this aim, the so-called mega-sub-configuration [7] is considered, a reinterpretation of the megaframe concept, composed of vertical legs in the building corners linked by horizontal transfer girder at about every 10 floors. In the mega-sub-configuration, the megaframe is the exterior full-height structure that provides the global strength and stiffness, while the substructures, i.e. the interior structures between two transfer levels (MRF or CBF of about 10 floors), are laterally separated from the megaframe and dynamically isolated at their bases (at transfer level) by means of a combination of isolation and damping devices. This structural organization can be by suitably tuned for working as a mass damper, thus controlling the seismic response of the megaframe while ensuring adequate service and safety conditions for the habitable substructures.

Aims and brief plan of the research project activities:
Final aim of the project is the derivation of design provisions for large scale application of the above strategies to buildings in urban context. For this aim, the following activities should be carried out:

- Unitary study of the dynamic problem, formulation of the governing equation in the space state for simplified lumped-mass models.
- Identification of the design variables (mass ratio, frequency ratio, damping ratio of the absorber) and of the response parameters to be controlled (displacements, accelerations, base shear).
- Search for optimization strategies: analytical (closed form, simplified models), numerical (parametric analyses and/or optimization algorithms).
- Selection of exemplar case studies, analysis and evaluation of applicability of theoretical results.
- Translation of the parameters optimal values into engineering solutions.
- 3D FEM modeling of the solutions, numerical analyses (modal, FRF, RSA, NTHA), assessment of the seismic performance.
- Experimental validation through tests on reduced scale simplified models.
- Generalization of the results and derivation of design provisions for large scale application to buildings in urban context.

References
[1] United Nations. World Urbanization Prospects. The 2018 Revision. Department of Economic and Social Affairs, Population Division, New York, 2019.
[2] Gazzetta ufficiale Unione europea. 28.12.2013. Dec.N.1386/2013/UE del Parlamento Europeo e del Consiglio 20/11/2013 programma generale di azione dell'Unione in materia di ambiente fino al 2020.

[3] Faiella D., Verrone F., Calderoni B., Mele E. Vertical addition as a seismic retrofit strategy: the inter-story isolation system for existing masonry buildings. 3rd Int.Conf. on Protection of Historical Constructions, July 2017, Lisbon.
[4] Faiella D., Calderoni B., Mele E. 2018. Intermediate Isolation System for the seismic retrofit of existing masonry buildings. Costruzioni Metalliche – No.5 Set/Ott. 2018: 28-40.
[5] Faiella D., Calderoni B., Mele E. Seismic retrofit of existing masonry buildings through Inter-story Isolation System. In press. Journal of Earthquake Engineering, 2020. https://doi.org/10.1080/13632469.2020.1752854
[6] Faiella D., Faella V., Alaio E., Mele E. Adeguamento sismico di edifici esistenti in c.a. tramite esoscheletro diagrid. Costruzioni Metalliche – No.5 Set/Ott. 2019: 9-23.
[7] Feng M., Mita A. 1995. Vibration control of tall buildings using mega subconfiguration, J Eng Mech 121(10):1082-1088.

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

D. Faiella, M. Argenziano, F. Esposito, G. Brandonisio, M. Fraldi, E. Mele. 2023. Effectiveness of isolated vertical extension of masonry buildings as nonconventional TMD. Soil Dynamics and Earthquake Engineering, 165, 107675.

F. Esposito, M. Argenziano, D. Faiella, E. Mele. 2023. Intermediate isolation system with nonlinear lower structure and isolation system. Applied Science 13(7), 4590.

D. Faiella, M. Argenziano, F. Esposito, E. Mele. 2023. Coupling of Structural Additions for the Mitigation of Seismic Response in Existing Buildings. Lecture Notes in Civil Engineering, 309 LNCE, pp. 632–642.

M. Argenziano, E. Mele, A. Palmeri. 2023. Optimal design of viscoelastic tuned mass dampers for structures exposed to coloured excitations. In: Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems - Proceedings of the 8th International Conference on Structural Engineering, Mechanics and Computation, 2022, 2023, pp. 63–69.

E. Mele, D. Faiella. 2022. Innovative mass-damping approaches for sustainable seismic design of tall buildings. Chapt. 11 in: Sustainable High-Rise Buildings: Design, Technology, and Innovation, Eds: K. Al-Kodmany, P. Du, M.M. Ali. The Institution of Engineering and Technology. ISBN:9781839532801 e-ISBN:9781839532818. September 2022.

M. Argenziano, D. Faiella, A. R. Carotenuto, M. Fraldi, E. Mele. 2022. Generalization of the Den Hartog Model and Rule-of-Thumb Formulas for Optimal Tuned Mass Dampers. Journal of Sound and Vibration, 538, 117213.

D. Faiella, M. Argenziano, E. Mele. 2022. Improving the Seismic Response of Tall Buildings: From Diagrid to Megastructures and Mega-Subcontrol Systems. Open Construction and Building Technology Journal, 16, e187483682201030.

M. Argenziano, D. Faiella, F. Bruni, C. De Angelis, M. Fraldi, E. Mele. 2021. Upwards - Vertical extensions of masonry built heritage for sustainable and antifragile urban densification. Journal of Building Engineering, 44, 102885.

D. Faiella, E. Mele. 2020. Insights into inter-story isolation design through the analysis of two case studies. Engineering Structures, 215, 110660.

Faiella D., Calderoni B., Mele E. Seismic retrofit of existing masonry buildings through Inter-story Isolation System. Journal of Earthquake Engineering, 2020. https://doi.org/10.1080/13632469.2020.1752854

D. Faiella., E. Mele. 2019. Vibration characteristics and higher mode coupling in intermediate isolation systems (IIS). A parametric analysis. Bulletin of Earthquake Engineering, 17(7), pp. 4347–4387.

E. Mele, D. Faiella. 2018. Inter-story Isolation System (IIS) for tall buildings – design considerations from the analysis of two case studies. CTBUH Journal – International Journal on Tall Buildings and Urban Habitat, Issue II.

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

2022-2024 project DPC-ReLUIS, WP15. RU UNINA-DIST coordinator: Design code contributions on seismic isolation and energy dissipation – the Intermediate Isolation System (IIS).

PRIN Bando 2022 PNRR: Re_Grid – Reuse-based optimization approach for environmentally efficient steel Grid structures. Prot. P2022LFW98 – **submitted, under review**

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

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)

Kyoto University, Disaster Prevention Research Institute, Division of Earthquake Hazards, Section of Earthquake Resistant Structures. Prof. Yoshiki IKEDA

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

SOM, San Francisco, USA

FIP

Napoli, 30/06/2023

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.**