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 prof. _____Marco Di Ludovico_____

(PO □ PA ⊟ RU □ RTD □) afferente al Dipartimento di _____

_____Strutture per l'Ingegneria e l'Architettura (DiSt)_____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 XXXVI ciclo.

1. Curriculum sintetico del proponente (max 500 parole)

Prof. Marco Di Ludovico is currently Associate Professor at Department of Structures for Engineering and Architecture, University of Napoli Federico II. He hold the PhD in Civil Engineering in the 2007 at the same department. His research activities focus on theoretical and experimental work in the field of: non-linear behavior of structures, behavior of RC members under biaxial actions, strengthening of PC girders, RC and masonry structures with composite materials (Fiber-Reinforced Polymers, FRP, Cementitious Composite, FRC, Fabric Reinforced Cementitious Matrix, FRCM, Composite Reinforced Mortar, CRM, and Fibre Reinforced Mortar, FRM) , pseudo static, pseudo dynamic and dynamic tests on full scale structural members, in – situ testing, health monitoring systems, fragility curves on existing structures, post-earthquake damage and performance loss, reparability of existing structures, expected seismic losses, innovative methodologies and technologies for knowledge, management restoration and protection of Cultural Heritage.
He had the scientific responsibility of the following research projects: ReLUIS 2014-2016 RS13, DPC - ReLUIS 2016-2018- RS 4, DPC - ReLUIS 2019-2021 – Research Line - WP 2, WP 4; WP 7; WP 8 , INCASS. He participated to several research projects: MACE, MAMAS, SIMURAI, SIT-MEW, DABACOM N, PROVACI, INNOVANCE, STRIT, METROPOLIS, METRICS; H2020 LIQUEFACT. Scientific coordinator of the scientific consultancy for the Saint Gobain PPC Italia S.p.A. "Characterization and Qualification of FRCM systems for strengthening masonry structures.
His scientific activity is documented more than 61 ISI papers on national and internationals journals and 150 conference papers, h-index 24/26 and 1344/2158 citations (Scopus/Google scholar),. He authored two chapters and he coordinated the editorial activity of the text book titled "RC Structures - Design bases" by E. Cosenza, G. Manfredi, and M. Pecce, Hoepli Editor.
Supervisor of 4 concluded PhD and 60 MSc theses, Supervisor of 3 concluded Postdoc projects, Member of: fib bulletin TG 5.1, CNR DT 200, CNR-DT 215/2018, Technical committee for developing Commentary to Italian Building Code NTC 2018, EAEE (European Association for Earthquake Engineering), Working Group 1 (EC8) Future Directions for Eurocode 8. Co-founder of the spin-off SEISMART srl, Sustainable Engineering, Innovative Solutions & Materials for Anti-

seismic Reliable Techniques (www.seismart.it). Reviewer of several scientific journals: (ASCE J. Comp. for Constr; ACI Struct. J.; ACI Struct&Mat. J.; Bull. of Earth. Eng.; Comp.& Struct.; Constr. & Build. Mat.; Earth. Eng.&Struct. Dyn.; Eng. Str.; J. of Earth. Eng.; J. of Reinf. Plast.&Comp.; J. of Civ. Struct. Healt Monit.; Int. J. of Conc. Strcut.&Mat.; Mat.&Struct.; Struct. Eng.&Mech.; Polymers; Sustainability; Natural Hazards and Earth System Sciences.

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

	specificare tipologia di borsa: ateneo, pon, por, senza borsa, ecc.
*n. __1_*	Alessandro Lubrano Lobianco (Phd program in Structural and Geotechnical Engineering and Seismic risk, XXXV cicle, ongoing) grant: Ateneo
*n. __2_*	Natale Andrea (Structural and Geotechnical Engineering and Seismic risk, XXXIV cicle, ongoing) grant: POR
*n. __3_*	Autiero Francesca (PhD program in Industrial Product and Process Engineering, XXXIIV cicle) grant: Ateneo
*n. __4_*	Del Zoppo Marta (Phd program in Phenomena and Environmental Risks, University of Napoli Parthenope, XXXI cicle) grant: Ateneo

3. Titolo della ricerca proposta

Seismic behaviour of school buildings: post-earthquake data analysis and seismic risk mitigation strategies

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 e)

The proposed research program consists in the development of a framework for seismic vulnerability assessment and the definition of effective retrofit solution for existing school buildings. The first objective is to collect detailed information on existing school buildings typical of the Italian building stock. Data on: construction age; type of design; adopted code; geometry; type of structural detailing and non-structural components; materials; state of conservation; and type of insulation and building services. Preliminary numerical simulations will be conducted to identify the main weaknesses and solutions to potentially improve structural and energy performances. A portfolio of school buildings with detailed information and a preliminary assessment of performance is a unique research product that is useful for the entire research community. To pursuit this scope an interaction with regional and ministerial offices in charge of collecting the data on repair and reconstruction of school buildings after recent devastating earthquakes is needed. This will result in a big database of records on school buildings. The experience of the research team and the data collected in the aftermath of recent seismic events or in recent research will be used in the initial part of this research project. In particular, preliminary data obtained from on-going recent studies (Campania region database of school buildings, USRC/USRA-ReLUIS project) on school buildings that are typical of the Italian and Mediterranean construction system will be collected. Once the database is defined, the main objective of this research is to assess the vulnerability of the stock of existing building by using observational data. The results will be compared with the detailed seismic performance assessment carried out with refined numerical models on archetype school buildings with different structural and non-structural components, energy systems, and degradations or level of obsolescence. The results of the simulations will provide an overview of the main deficiencies of existing school buildings in the as-built configuration. This allows to identify possible retrofit solutions to be applicable at large scale and with different performance targets. In particular different option will be assessed: low impact retrofit solutions having the main scope of increasing the seismic safety and, thus, less expensive and fast to apply; high performance retrofit solutions aiming at achieving high seismic safety and protect the non-structural components and, thus more expensive. The solutions available in the design project collected by during the recent reconstruction processed will be used to select the most effective solutions and to have reliable estimation of the costs of interventions and the time for their application. The last objective of the research proposal is to assess the impact on a large scale of the proposed retrofit solutions. To do this, reliable numerical modelling will be developed that considers all the non-linearities that are typical of existing old-style RC buildings and their dynamic energy

performances. These models will be validated/calibrated on the results of the experiments. Probabilistic (multi-level) seismic hazard analyses and energy simulations on a large scale will be conducted with the aim of assessing the impact of the proposed retrofit solutions on entire communities. Guidelines and methodologies for developing regional/national investment plans for school building retrofitting will be developed as the final deliverable of the project.

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

1. Polese M., **Di Ludovico M.**, Gaetani d'Aragona M., Prota, A., Manfredi G., (2020), "Regional vulnerability and risk assessment accounting for local building typologies", International Journal of Disaster Risk Reduction, Elsevier, Volume 43, February 2020, Article number 101400, DOI: https://doi.org/10.1016/j.ijdrr.2019.101400
2. **Di Ludovico M**., Digrisolo A., Moroni C., Graziotti F., Manfredi V., Prota A., Dolce M., Manfredi G. (2019), "Remarks on damage and response of school buildings after the Central Italy earthquake sequence", Bulletin of Earthquake Engineering, Volume 17, pp 5679–5700, DOI: https://doi.org/10.1007/s10518-018-0332-x.
3. Del Vecchio C, **Di Ludovico M**, Balsamo A, Prota A. (2018), "Seismic Retrofit of Real Beam-Column Joints Using Fiber-Reinforced Cement Composites", ASCE Journal of Structural Engineering, 2018, 144(5): 04018026, DOI: 10.1061/(ASCE)ST.1943-541X.0001999.
4. Del Vecchio C, **Di Ludovico M**, Pampanin S, Prota A. (2018), "Repair costs of existing RC buildings damaged by the L'Aquila earthquake and comparison with FEMA P-58 predictions", Earthquake Spectra. February 2018, Vol. 34, No. 1, pp. 237-263. DOI: 10.1193/122916EQS257M.
5. **Di Ludovico, M.,** Digrisolo, A., Graziotti, F., Moroni, C., Belleri, A., Caprili, S., Carocci, C., Dall'Asta, A., De Martino, G., De Santis, S., Ferracuti, B., Ferretti, D., Fiorentino, G., Mannella, A., Marini, A., Mazzotti, C., Sandoli, A., Santoro, A., Silvestri, S., Sorrentino, L., Magenes, G., Masi, A., Prota, A., Dolce, M., Manfredi, G., (2017), "The contribution of ReLUIS to the usability assessment of school buildings following the 2016 central Italy earthquake", Bollettino di Geofisica Teorica ed Applicata, Vol. 58, n.4, December 2017, pp. 353-376, DOI: 10.4430/bgta0192.
6. Mannella A., **Di Ludovico M**., Sabino A., Prota A., Dolce M., Manfredi G. (2017), "Analysis of the Population Assistance and Returning Home in the Reconstruction Process of the 2009 L'Aquila Earthquake", Sustainability 2017, 9(8), 1395; doi:10.3390/su9081395
7. **Di Ludovico M**., Prota A., Moroni C., Manfredi G., Dolce M., (2017), "Reconstruction process of damaged residential buildings outside historical centres after the L'Aquila earthquake - part II: "heavy damage" reconstruction", Bulletin of Earthquake Engineering, Volume 15, Issue 2, 2017, Pages 693-729, DOI 10.1007/s10518-016-9979-3.
8. **Di Ludovico M.,** Prota A., Moroni C., Manfredi G., Dolce M., (2017), " Reconstruction process of damaged residential buildings outside historical centres after the L'Aquila earthquake: part I—"light damage" reconstruction", Bulletin of Earthquake Engineering, Volume 15, Issue 2, 2017, Pages 667-692, DOI 10.1007/s10518-016-9877-8.
9. Dolce M., Moroni C., Manfredi G., **Di Ludovico M.**, Prota A., Masi A., Santarsiero G., (2016), "Sicurezza sismica delle scuole – Esperienze ed attività in Basilicata e Abruzzo", Structural 206 –

luglio/agosto 2016 – ISSN 2282-3794, DOI 10.12917/Stru207.23 – http://www.dx.medra.org/10.12917/Stru207.23

10. Postiglione I., Masi A., Mucciarelli M., Lizza C., Camassi R., Bernabei V., Piacentini V., Chiaiuzzi L., Brugagnoni B., Cardoni A., Calcara A., **Di Ludovico M.**, Giannelli M., Rita R., La Pietra M., Bernardini F., Nostro C., Pignone M., Peruzza L., (2016) "The Italian Communication Campaign "I Do not take risks – earthquake", Bollettino Geofisica Teorica ed Applicata, Vol. 57, n.2, June 2016, pp. 147-160, DOI 10.4430/bgta0173.

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

DPC-ReLUIS 2019-2021, WP 7 "Post-earthquake data analysis"

DPC-ReLUIS 2019-2021, WP 4 "Risk maps and seismic damage scenario (MARS)"

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

DPC-ReLUIS 2019-2021, WP 7 "Post-earthquake data analysis"

DPC-ReLUIS 2019-2021, WP 4 "Risk maps and seismic damage scenario (MARS)"

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)

University College London, UCL, Prof. Carmine Galasso, c.galasso@ucl.ac.uk

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

- Ufficio speciale per la ricostruzione dei comuni del cratere (USRC) Abruzzo
- Ufficio speciale per la ricostruzione città de L'Aquila (USRA)

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- Regione Campania 40 01 14 - Governo del Territorio, Lavori pubblici e protezione civile, Difesa del suolo Verifica Attuazione Programma di Governo - Centrale acquisti – Immobili e demanio (Risorse strumentali) - Osservatorio sulle progettazioni e sullo stato di avanzamento lavori

The collaboration with these regional offices aims at the collection and analysis of data on school buildings. This is in order to create a database of existing school buildings and detailed information on their status of conservation, maintenance, student population, damage experienced due to past earthquakes, reconstruction costs and other typological and design data. These activities are fundamental to have reliable data for the model calibration and for the application of the proposed retrofit solution at large scale. The collaboration with these offices started long-time ago with successful research products and continuous growing of the research activities and research grup.

Napoli,_____13/02/2020_____ 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 **venerdì 14/02/2020**