Politecnico di Torino

**Ph.D. Candidate:** Elena Miceli

**Tutor:** Prof. Paolo Castaldo

**Co-Tutor:** Prof. Giuseppe Carlo Marano

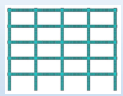

**Ph.D. in Civil and Environmental Engineering**
**XXXVI cycle**
**Ph.D day, 18th October 2023**
**A.Y. 2022/2023**

ScuDo – Scuola di Dottorato – Doctoral School – WHAT YOU ARE, TAKES YOU FAR

# RESEARCH ACTIVITY

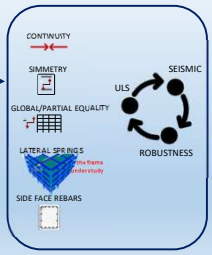
## Safety of structural systems

### Robustness design



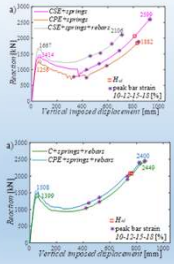
*5-floors 4-spans RC building in L'Aquila designed according to STANDARDS:* NTC2018, EC2, EC8

**Robust design**

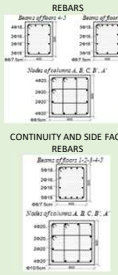



**Displacement controlled pushdown analyses**




**Selection of the more robust and sustainable frame**



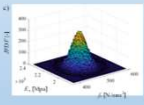

### Robustness & reliability

**Probability of collapse**

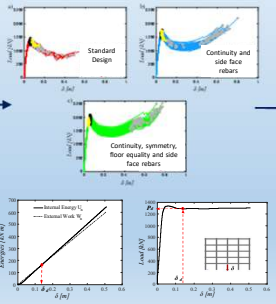
$P[C] = P[C|LD] \cdot P[LD|H] \cdot P[H] = P[C|LD] \cdot P[H]$

**Full-probabilistic sampling with Latin Hypercube with N=100 samples**

- **Loads ($G_1$ $G_2$ $Q_p$ $Q_c$)**
- **Materials ($f_c$ $f_u$ $f_y$ $\varepsilon_{su}$ $E_s$ $\rho$)**



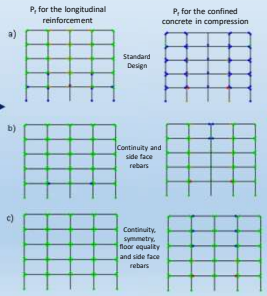
**Static-equivalent analysis: amplification of loads using an energetic equivalent approach (Izzudin et al, 2008)**




**Local failure probability**

$$P_f = P(S > R) = \int_{r=-\infty}^{\infty} \int_{s=-\infty}^{r} f_{S,R}(s,r)\,ds\,dr$$

$$\beta = -\Phi^{-1}(P_f)$$

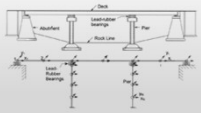



**Robustness evaluation in reliability terms**

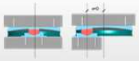
$P_f > 10^{-4}$ $\beta < 2.3$
$10^{-4} \le P_f < 10^{-5}$ $2.3 < \beta < 3.1$
$10^{-5} \le P_f < 10^{-7}$ $3.1 < \beta < 5.2$
$P_f < 10^{-7}$ $\beta > 5.2$

## Seismic performance of infrastructures

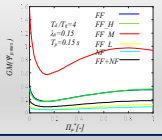
**Seismic isolation using single concave friction pendulum system (FPS) devices**



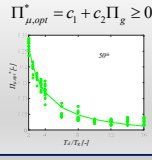

Jangid, Seismic Response of Isolated Bridges, 2004



**Optimal friction coefficient**

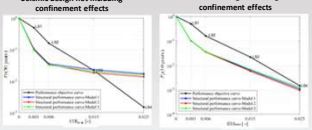



$$\Pi^*_{\mu,opt} = c_1 + c_2 \Pi_g \ge 0$$



## Confinement effects in seismic design

**Probability of exceedance of the LS thresholds in 50 years**




**Visiting Researcher as a PhD student**
Strathclyde University, Glasgow, UK
(01/10/2023 – 31/01/2024)
Supervisor: Prof. Enrico Tubaldi

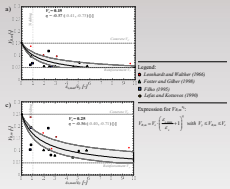
## Global resistance safety factors *fib*

**fib COM3 TG3.1** Reliability and Safety Evaluation: full-probabilistic and semi-probabilistic methods for existing Structures

$$F_d \le R_d \quad \text{where } R_d = \frac{R_{m,k}(f_{m,k}, a_{m,k})}{\gamma_R \cdot \gamma_{Sd}}$$

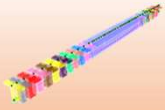
$$\gamma_r = \frac{\exp(\alpha_r \beta - V_{R,m})}{\delta_R} \quad \text{with } V_R \le 0.3$$

COV of the Global Structural Resistance $V_{R,m}$ associated to the material uncertainties




# EXPERIMENTAL RESEARCH

**Research project:** *Valutazione della sicurezza di strutture e infrastrutture in cemento armato – Prove di carico su trave in C.A. e C.A.P.*



**Technical book**: *Valutazione della sicurezza di strutture e infrastrutture in cemento armato: l'esperienza del viadotto Mollere, Casa Editrice la fiaccola srl, 2022*

# OTHER ACTIVITIES

- Participation to **international** (COMPDYN2021, FibYM2021, FibPhD2022, WMCAUS2022, NMP2022, COMPDYN2023) and **national** (ANIDIS2022, CTA2022, ICC2022) **conferences**
- **Member of** *fib* (International Federation for Structural Concrete) and *fib COM3 TG3.1*
- Participation to **research project** (ReLUIS 2019-21 / 2022-24- Safety Assessment of RC structures, ReLuis 2022-24 - Monitoring of RC structures)
- Participation to **research contracts** (Safety assessment of Structures and Infrastructures 2018-21, Accordo quadro dipartimentale tra il DISEG e l'ente P.A. di Paestum e Velia 2020-23, Analisi e valutazione sperimentale sullo stato della precompressione nei viadotti ferroviari esistenti 2023-24)
- Participation to the **organizing commitee** for ANIDIS22-Special session and FibYM 2023
- **Didactic collaboration** for the following courses: Tecnica delle costruzioni, Atelier di progettazione e consolidamento di ponti

# PhD COURSES (hard skills: 187 h – soft skills 120 h)

*Politecnico di Torino*

- *Affidabilità e robustezza sismica di strutture isolate con dispositivi ad attrito (FPS)* (P. Castaldo - 25 h)
- *The Monte Carlo Method* (F. Rossi - 30 h)
- *Dinamica delle vibrazioni random* (G. C. Marano - 20 h)
- *Opere di protezione contro la caduta massi* (D. Peila - 15 h)
- *Behavioural theories* (C. Pronello - 15 h)

*Other Universities*

- *Nonlinear Dynamic Analysis Procedures for PBEE* (F. Jalayer - 22 h) Università degli Studi di Napoli Federico II (grade 30/30)
- *Applied Statistics and Probability Analysis* (F. Jalayer - 22 h ) Università degli Studi di Napoli Federico II (grade 30/30)
- *Scientific Programming and Visualization with Python* (A. Botta - 18 h) Università degli Studi di Napoli Federico II
- *Structural Reliability* (C. Galasso - 20 h) IUSS Scuola Universitaria Superiore Pavia

# JOURNAL PUBLICATIONS


- **E. Miceli**, P. Castaldo (2023): Robustness Improvements for 2D Reinforced Concrete Moment Resisting Frames: Parametric Study by Means of NLFE Analyses, Structural concrete : journal of the FIB (2023), https://doi.org/10.1002/suco.202300443
- P. Castaldo, **E. Miceli** (2023): Optimal single concave sliding device properties for isolated multi-span continuous deck bridges depending on the ground motion characteristics, Soil Dynamics and Earthquake Engineering, 173, 108128
- D. Gino, **E. Miceli**, L. Giordano, G. C. Marano, P. Castaldo (2023): Influence of Masonry Infills on Seismic Performance of an Existing RC Building Retrofitted by Means of FPS Devices, Applied Science, 13, 3509.https://doi.org/10.3390/app13063509
- P. Castaldo, **E. Miceli** (2023): Evaluation of the Failure Probability of a 2D RC Frame Subjected to Column Loss, Journal of Modern Mechanical Engineering and Technology, 10, 1–10. https://doi.org/10.31875/2409-9848.2023.10.01
- P. Castaldo, G. Amendola, L. Giordano, **E. Miceli** (2022): Seismic reliability assessment of isolated multi-span continuous deck bridges, Ingegneria Sismica - International Journal of Earthquake Engineering, Anno XXXIX – Num. 3