



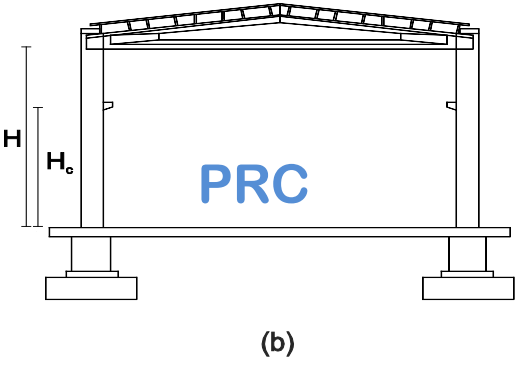
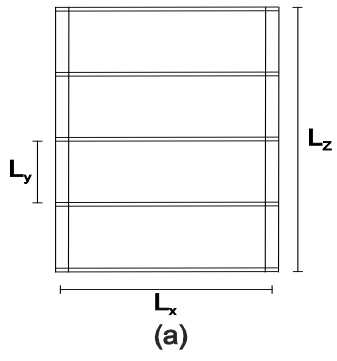
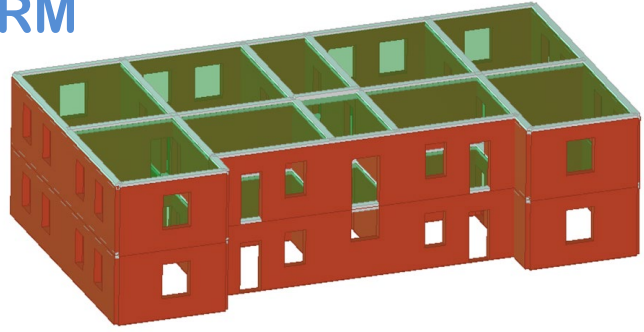
UNIVERSITÀ DEGLI STUDI
DI NAPOLI FEDERICO II

Il progetto RINTC 2019-2021 (WP3)

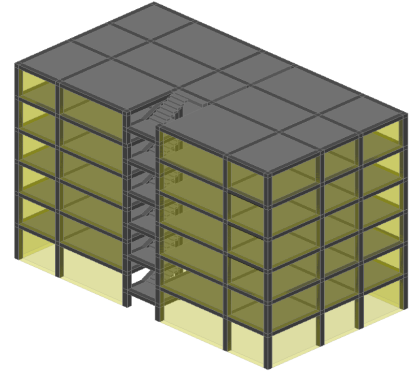
Junio Iervolino

Progetto 2015-2017 valutazione della sicurezza delle strutture progettate con le NTC

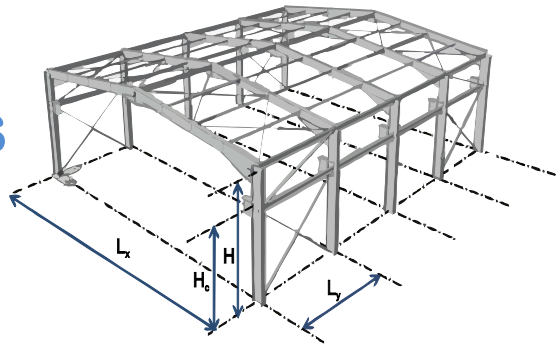
URM



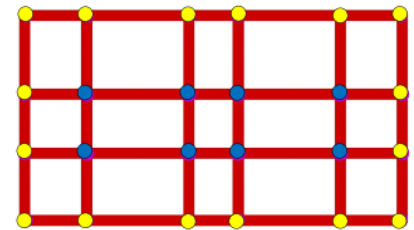
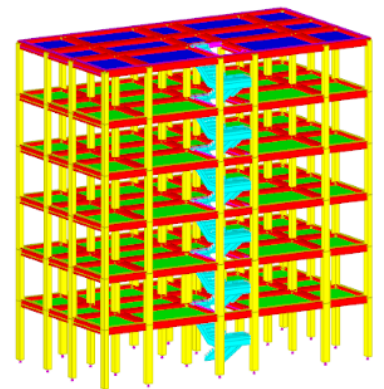
RC



S

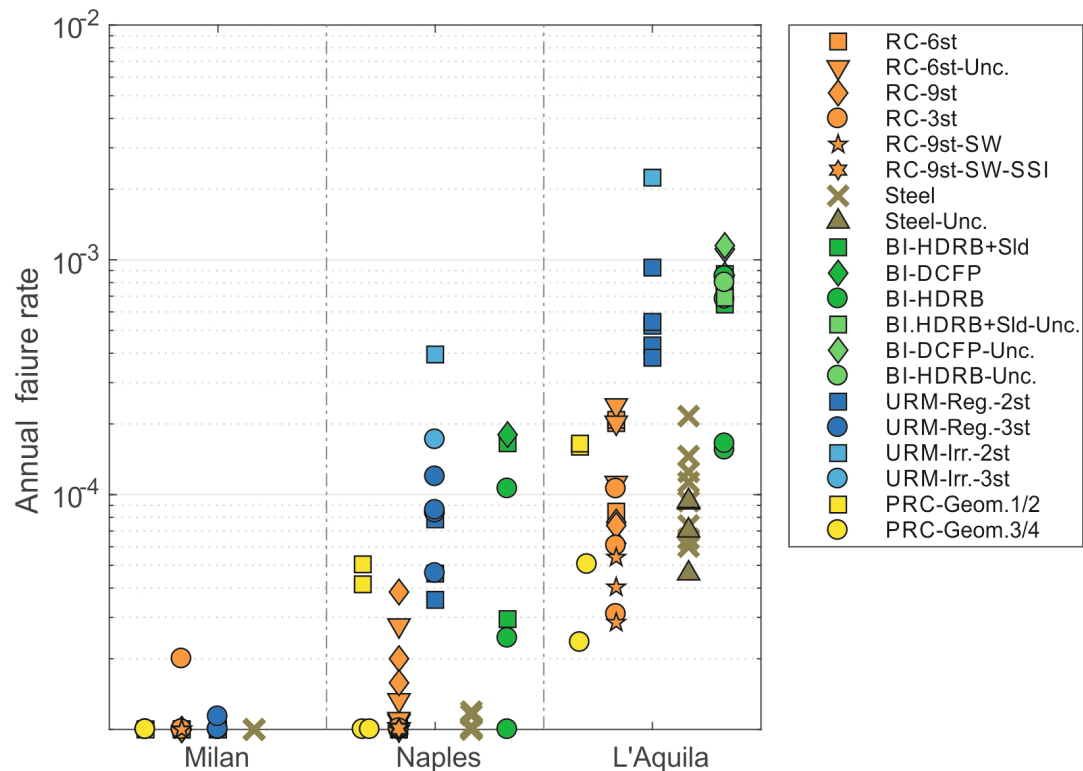


BI



- Slitta
- HDRB

Tassi annuali di fallimento



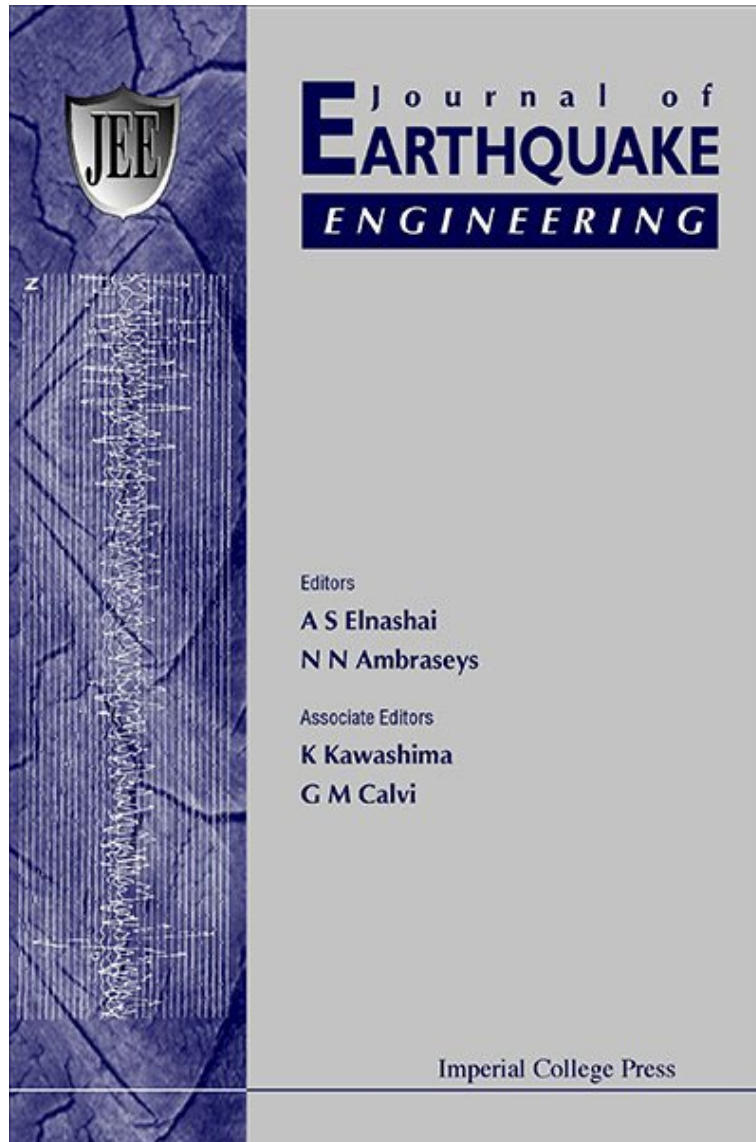
Perché la sicurezza
decrece
all'aumentare della
pericolosità:

1. Minimi e
resistenza a
carichi verticali.

2. Pericolosità
sismica oltre i
periodi di ritorno
considerati nel
progetto.

- Baltzopoulos G., Grella A., Iervolino I. (2021) Seismic reliability implied by behavior-factor-based design. EESD, 50:4076–4096.
- Cito P., Iervolino I. (2020) Peak-over-threshold: quantifying ground motion beyond design. EESD. 49(5): 458-478.
- Iervolino I., Pacifico A. (2021) Fatality rates implied by the Italian seismic code. Earthquake EESD, 50:3083-3089.

JEE – special issue 1



1. Foreword to the Special Issue for the RINTC (The Implicit Seismic Risk of Code-Conforming Structures) Project - Iunio Iervolino & Mauro Dolce
2. Seismic Reliability of Code-Conforming Italian Buildings - Iunio Iervolino, Andrea Spillatura & Paolo Bazzurro
3. Modelling Uncertainties of Italian Code-Conforming Structures for the Purpose of Seismic Response Analysis - Paolo Franchin, Laura Ragni, Maria Rota & Alessandro zona
4. Masonry Italian Code-Conforming Buildings. Part 1: Case Studies and Design Methods - Carlo F. Manzini, Guido Magenes, Andrea Penna, Francesca da Porto, Daniela Camilletti, Serena Cattari & Sergio Lagomarsino
5. Masonry Italian Code-Conforming Buildings. Part 2: Nonlinear Modelling and Time-History Analysis - Serena Cattari, Daniela Camilletti, Sergio Lagomarsino, Stefano Bracchi, Maria Rota & Andrea Penna
6. Modeling and Seismic Response Analysis of Italian Code-Conforming Reinforced Concrete Buildings - Paolo Ricci, Vincenzo Manfredi, Fabrizio Noto, Marco Terrenzi, Crescenzo Petrone, Francesca Celano, Maria Teresa De Risi, Guido Camata, Paolo Franchin, Gennaro Magliulo, Angelo Masi, Fabrizio Mollaioli, Enrico Spacone & Gerardo M. Verderame
7. Modeling and Seismic Response Analysis of RC Precast Italian Code-Conforming Buildings - Gennaro Magliulo, Davide Bellotti, Maddalena Cimmino & Roberto Nascimbene
8. Modeling and Seismic Response Analysis of Italian Code-Conforming Single-Storey Steel Buildings - Fabrizio Scozzese, Giusy Terracciano, Alessandro Zona, Gaetano Della Corte, Andrea Dall'Asta & Raffaele Landolfo
9. Modelling and Seismic Response Analysis of Italian Code-Conforming Base-Isolated Buildings - L. Ragni, D. Cardone, N. Conte, A. Dall'Asta, A. Di Cesare, A. Flora, G. Leccese, F. Micozzi & C. Ponzio

Il progetto rischio-implicito NTC 2019-2021

1. Fragilità delle strutture progettate secondo le NTC.
2. Mappa di rischio ideale (strutture tutte progettate secondo le NTC).
3. Affidabilità sismica dei ponti progettate secondo le NTC.
4. Affidabilità sismica delle strutture progettate pre-NTC (evoluzione della sicurezza sismica).



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UNIVERSITÀ DI ROMA



POLITECNICO
MILANO 1863



UNIVERSITÀ DEGLI STUDI
DI GENOVA



UNIVERSITÀ
DI CAMERINO



Università degli Studi
Basilicata



Università degli Studi di Pavia

Strutture nuove - edifici

Procedure e software per il calcolo della fragilità

R2R-EU
File Info

R2R-EU V1.141 (beta)

Estimation Uncertainty in Performance-Based Earthquake Engineering risk estimates
 (c) Iulio Iervolino, Georgios Baltzopoulos and Roberto Baraschino

Annual rate of failure

$\lambda_f = 3.138E-03$

from lognormal fragility

Close

Parameter distribution

Input Data

Hazard

Current path: C:\Program Files (x86)\R2

Enter input file (.txt format): Analysis_Output_Hazard

REASSESS output Structural period for reading Sa(T) hazard curve (sec) 1

Structural Response

IM EDP Cloud Override fragility

Current path: C:\Program Files (x86)\R2

Enter input file (.txt format): IM_based.txt

Truncated IDA Total number of records: 30

Use Excel

Hazard curve Logarithmic

PF vs IM

Analysis Data

Resampling extractions: 500.00

Parametric simulation extractions: 100.00

Non parametric fragility

Lognormal parametric fragility

Use distributions of Gaussian parameter estimators

Parametric Bootstrap

Parametric Bootstrap (Truncated IDA)

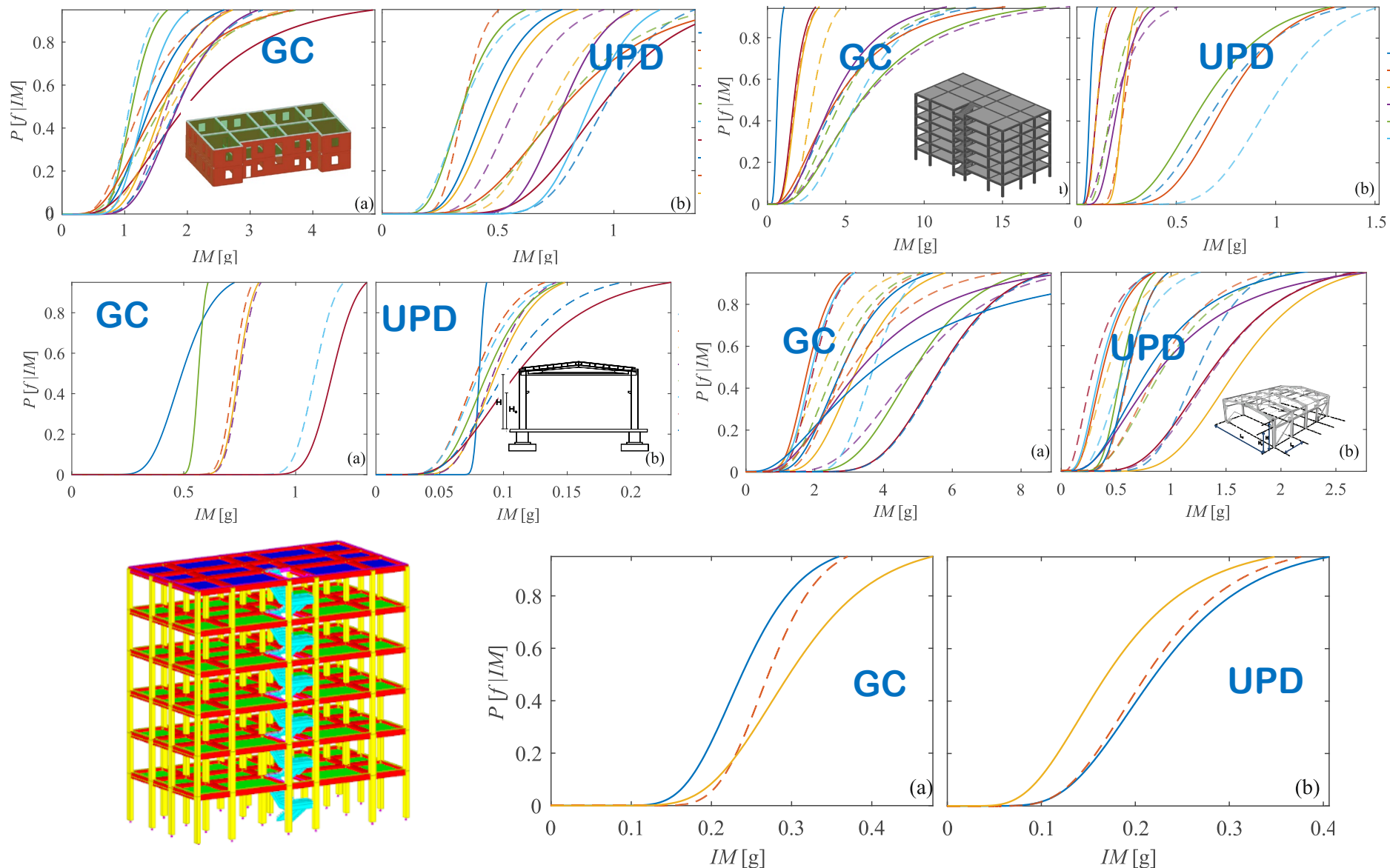
Delta method

Stripe of IM at failure

Bootstrap distribution of the estimator

- Iervolino I. (2022) Estimation uncertainty for some common seismic fragility curve fitting methods. SDEE, 152, 107068.
- Baraschino R., Baltzopoulos G., Iervolino I. (2019) R2R-EU: Software for fragility fitting and evaluation of estimation uncertainty in seismic risk analysis. SDEE. 132: 106093.

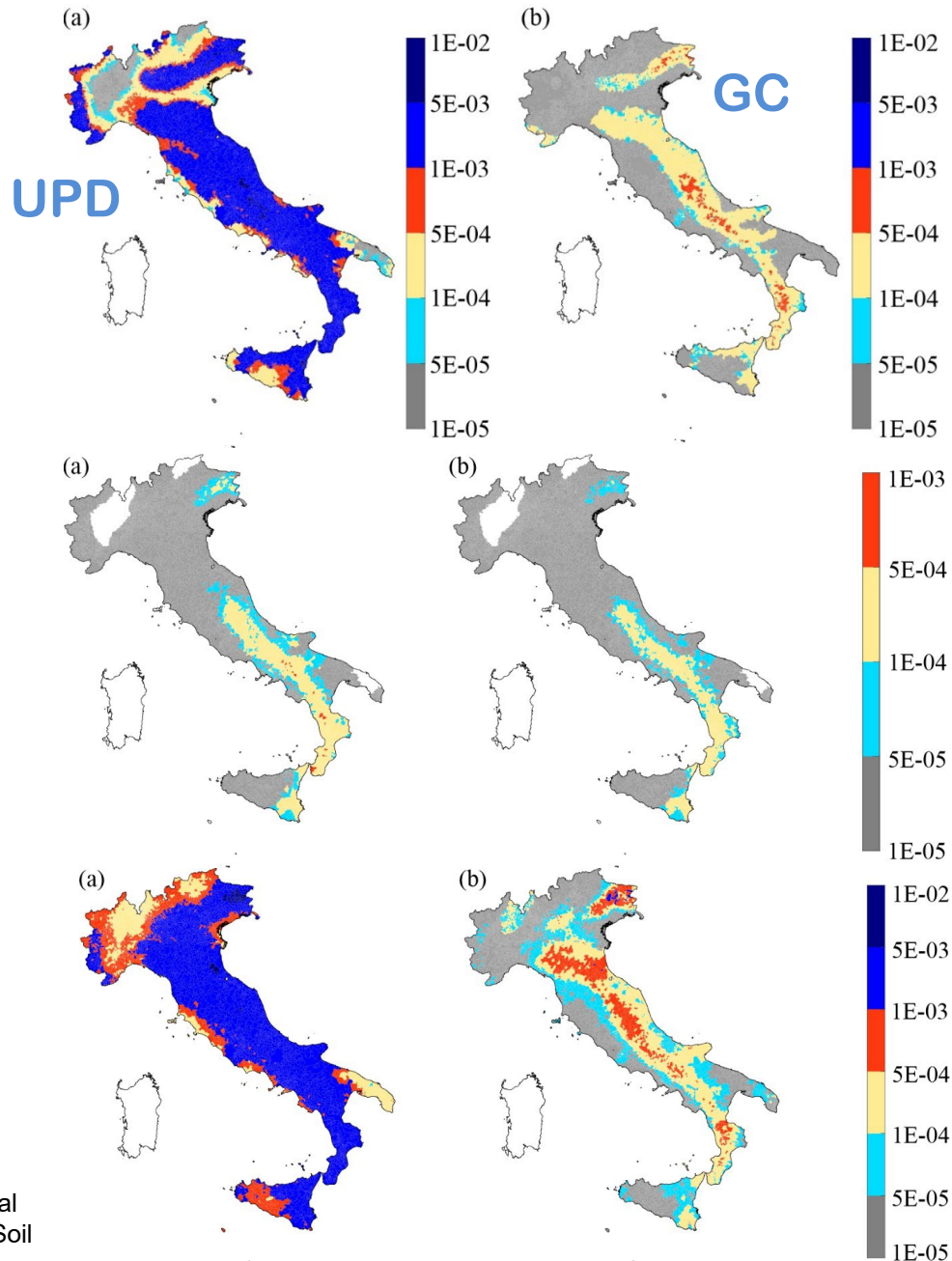
Fragilità URM E RC progettate secondo NTC



Fixed-base structures and MPS04 hazard model

Base-isolated structures and MPS04 hazard model

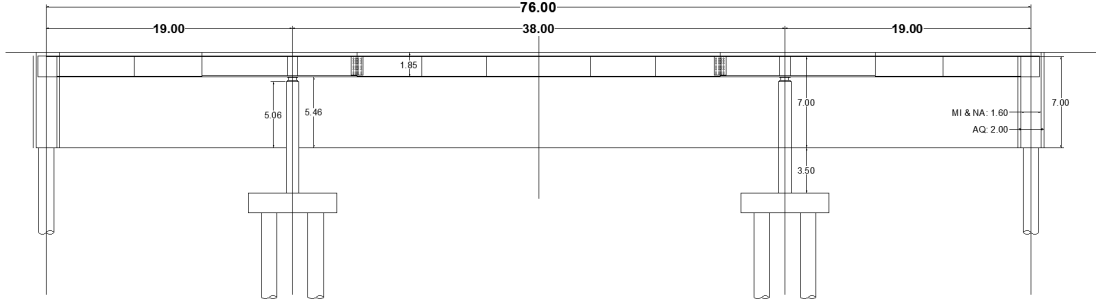
Fixed-base structures and MPS19 hazard model



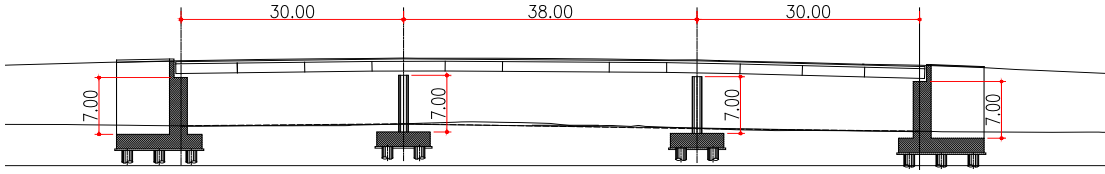
- Pacifico A., Chioccarelli E., Iervolino I. (2022) Residential code-conforming structural seismic risk maps for Italy. Soil Dynamics and Earthquake Engineering, 153, 107104.

Strutture nuove - ponti

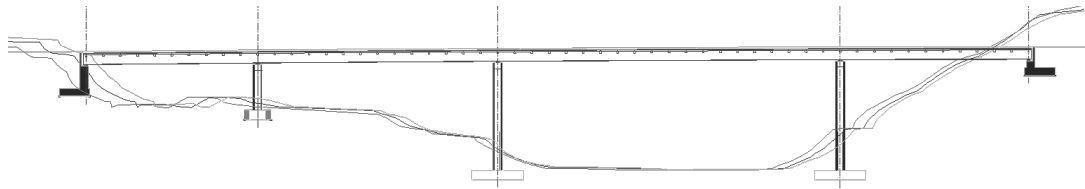
Cavalcavia con spalla integrale



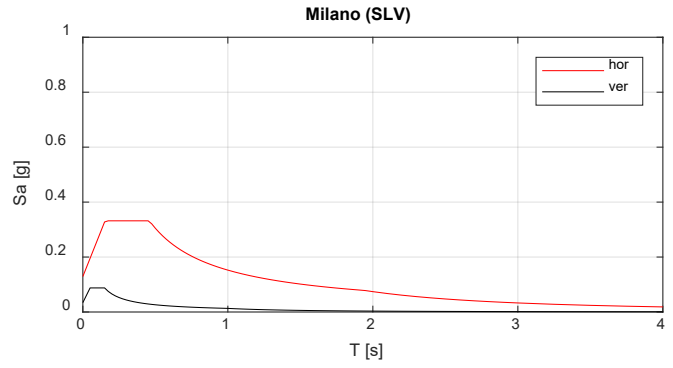
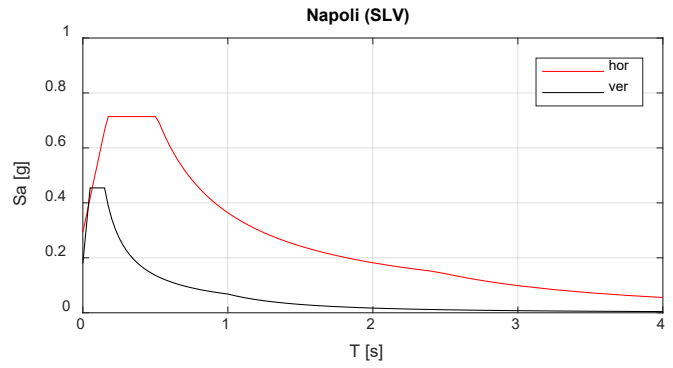
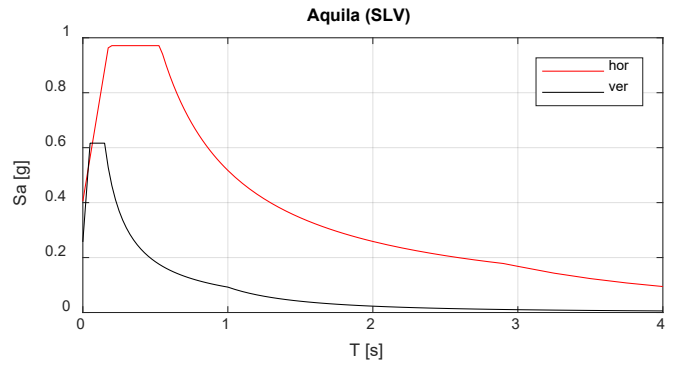
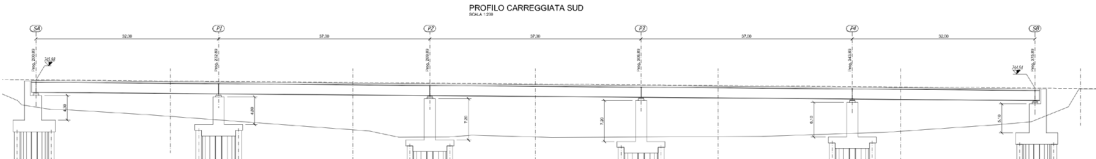
Cavalcavia con spalla tradizionale (anche isolato)



Viadotto alto



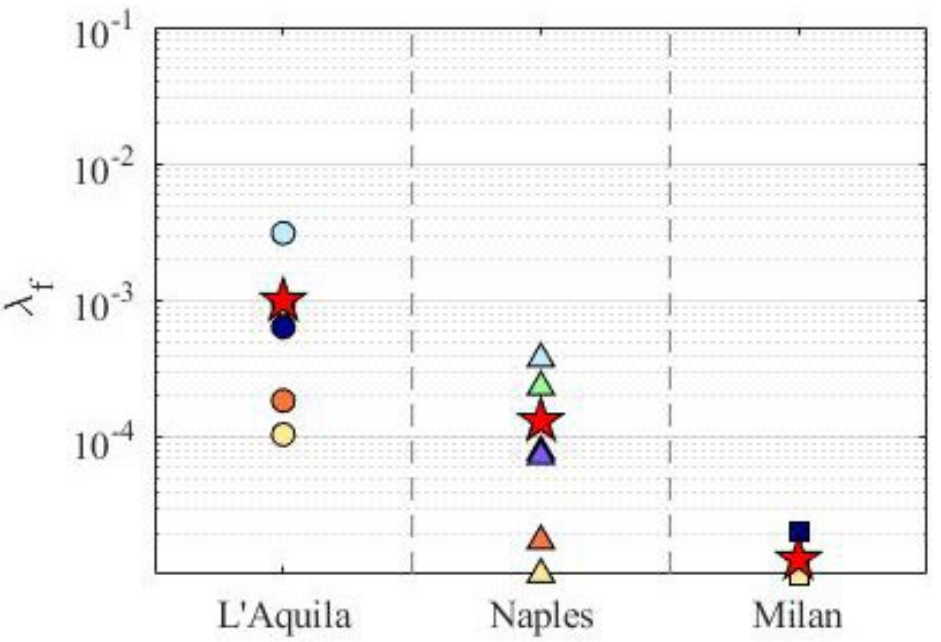
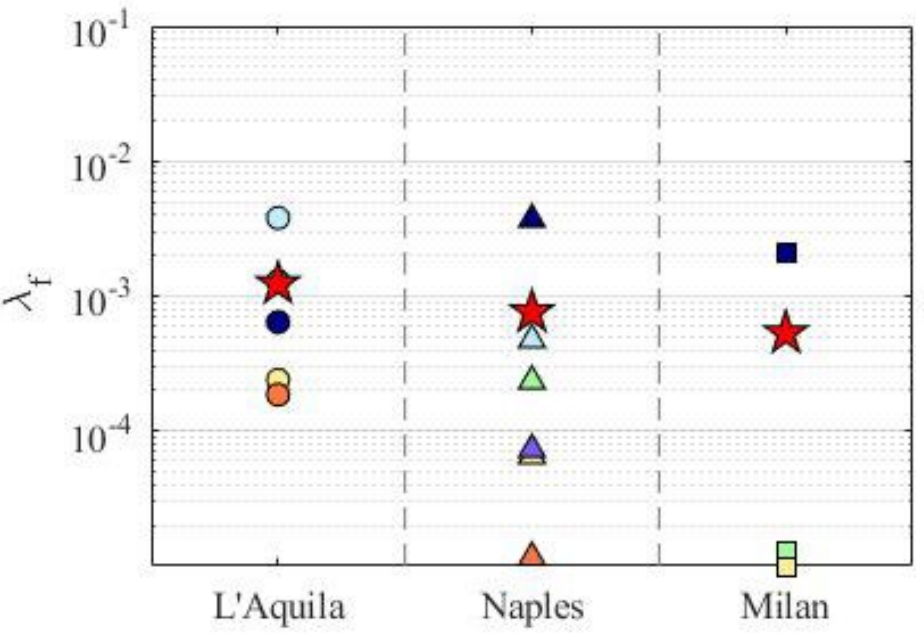
Viadotto basso



Tassi annuali di fallimento

UPD

ED



★ Media per sito

Esistente – benchmarking della modellazione

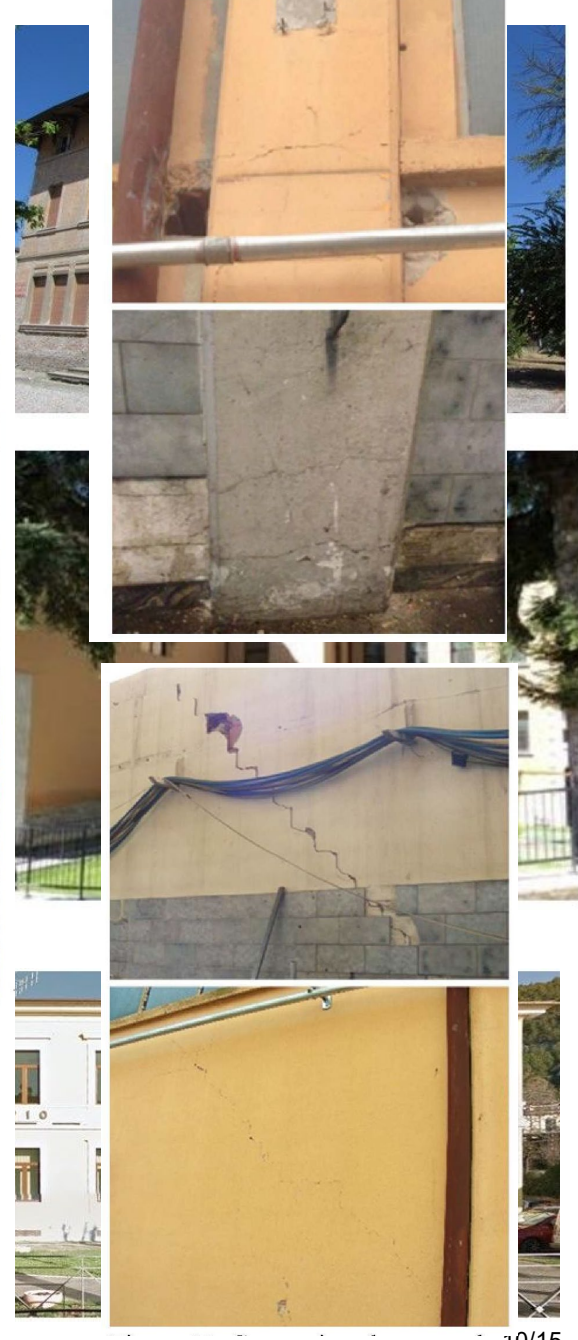
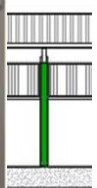


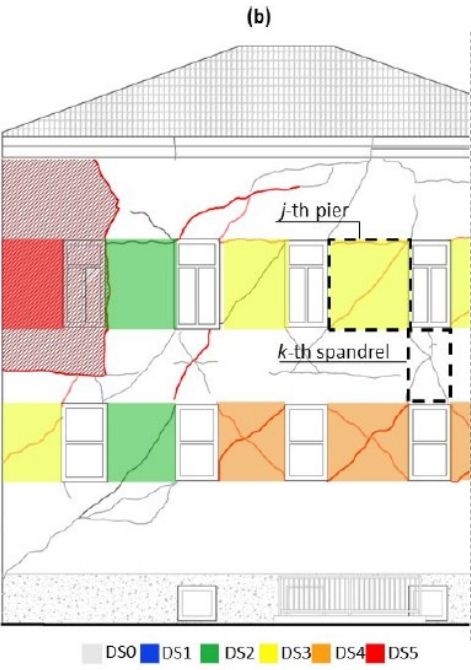
Seis
eve

1) 201
201 Cen
201 Cen
201

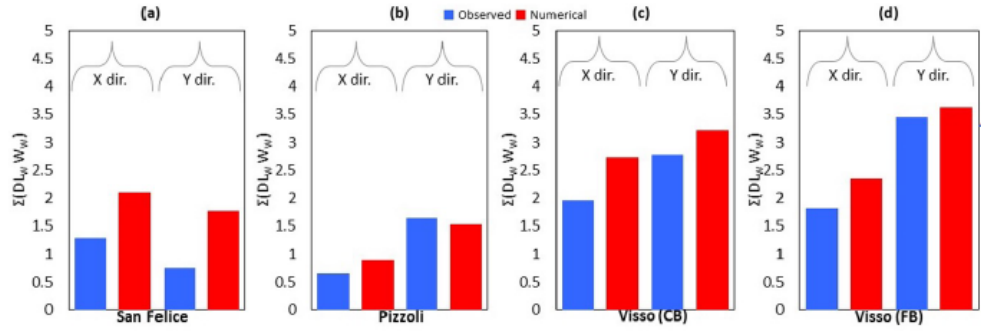
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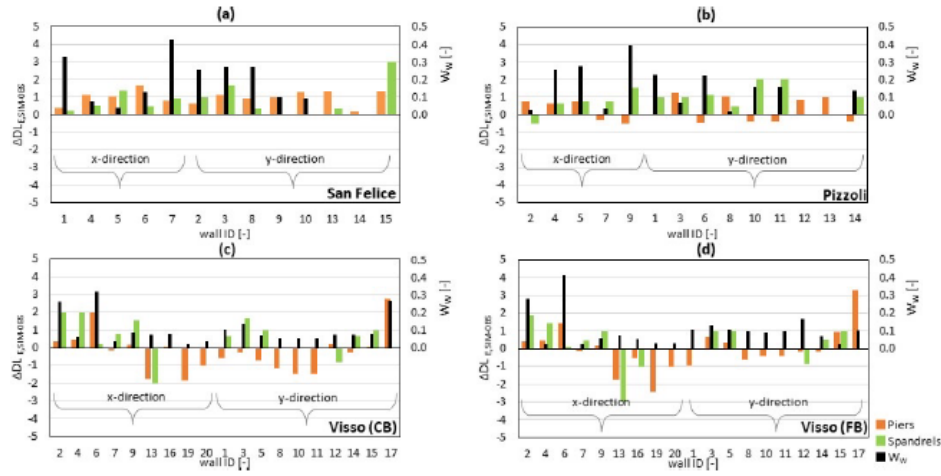
MURATURA



Accordo molto buono/ottimo a livello globale

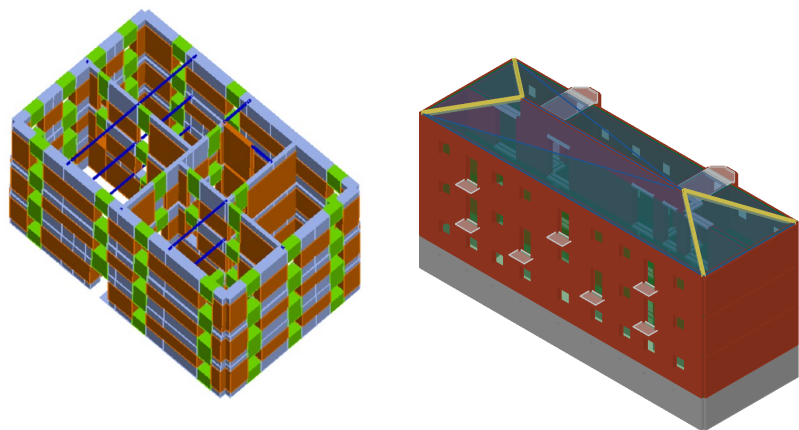
Figure 8. a-d) Observed Vs Simulated overall damage level based on the cumulative weighted damage for the four study cases.

e soddisfacente a livello locale (puntuale di singoli elementi)

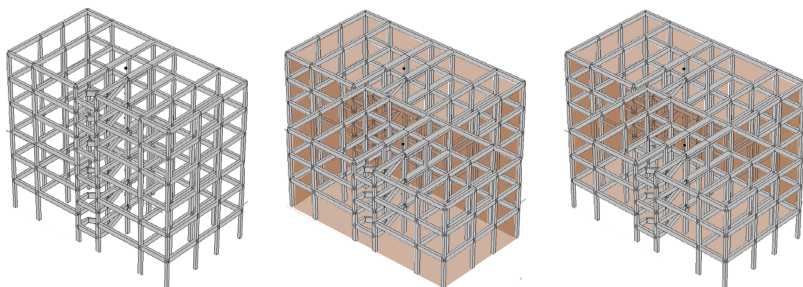


Esistente – valutazione della affidabilità sismica

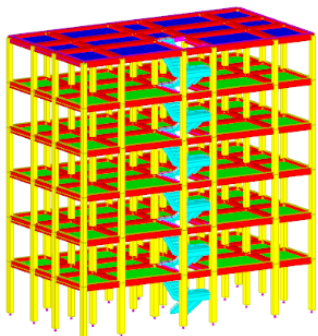
Edifici URM, RC e BI



Design	Age	Sites
Original	Pre-'20	Naples, Catania, L'Aquila, Rome
	'20-'45	Milan, L'Aquila, L'Aquila
	'45-'87	Catania, Milan
	Post-'87	Rome
Seismically upgraded with '90s code	Pre-'20	Naples, Rome
	'20-'45	L'Aquila
Seismically upgraded with the current code	Pre-'20	Naples
	'20-'45	L'Aquila

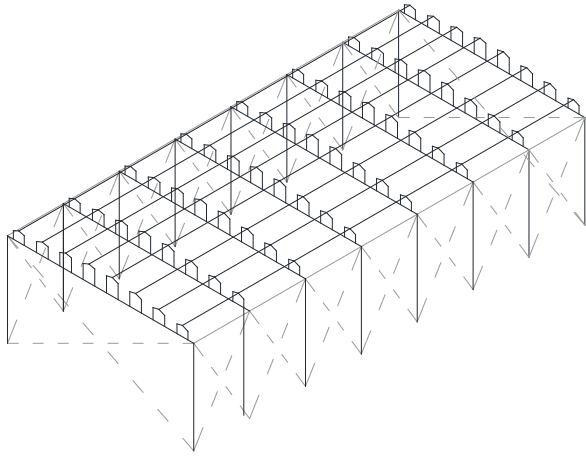


Design	Epoch	Sites	Models	Storeys
Gravity loads (RC-G)	Pre-'70	Milan, Naples, Catania	BF,IF,PF	3,6
	'70s	Milan, Naples, Catania	BF,IF,PF	3,6
	'80-'90	Milan, Naples	BF,IF,PF	3,6
Seismic loads (RC-S)	Pre-'70	L'Aquila	BF,IF,PF	3,6
	'70s	L'Aquila	BF,IF,PF	3,6
	'80-'90	L'Aquila, Catania	BF,IF,PF	3,6

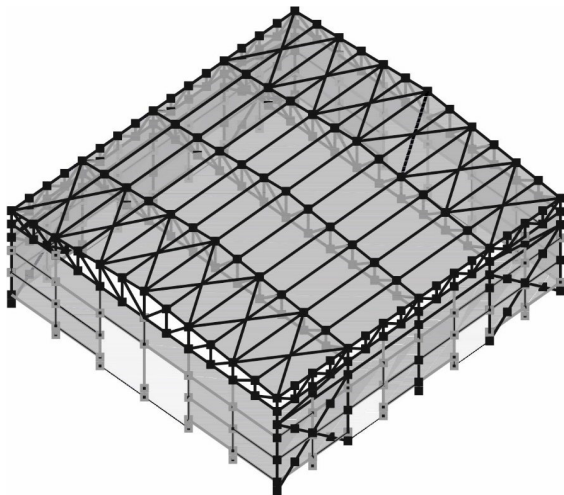


Design	Epoch	Site	Storeys	Isolation system
Gravity loads	Pre-'70	Naples	6	FPS, HDRB+S
	'70s	Naples	6	FPS, HDRB+S
	'80-'90	Naples	6	FPS, HDRB+S
Seismic loads	Pre-'70	L'Aquila	6	FPS, HDRB+S
	'70s	L'Aquila	6	FPS, HDRB+S
	'80-'90	L'Aquila	6	FPS, HDRB+S

PRC buildings

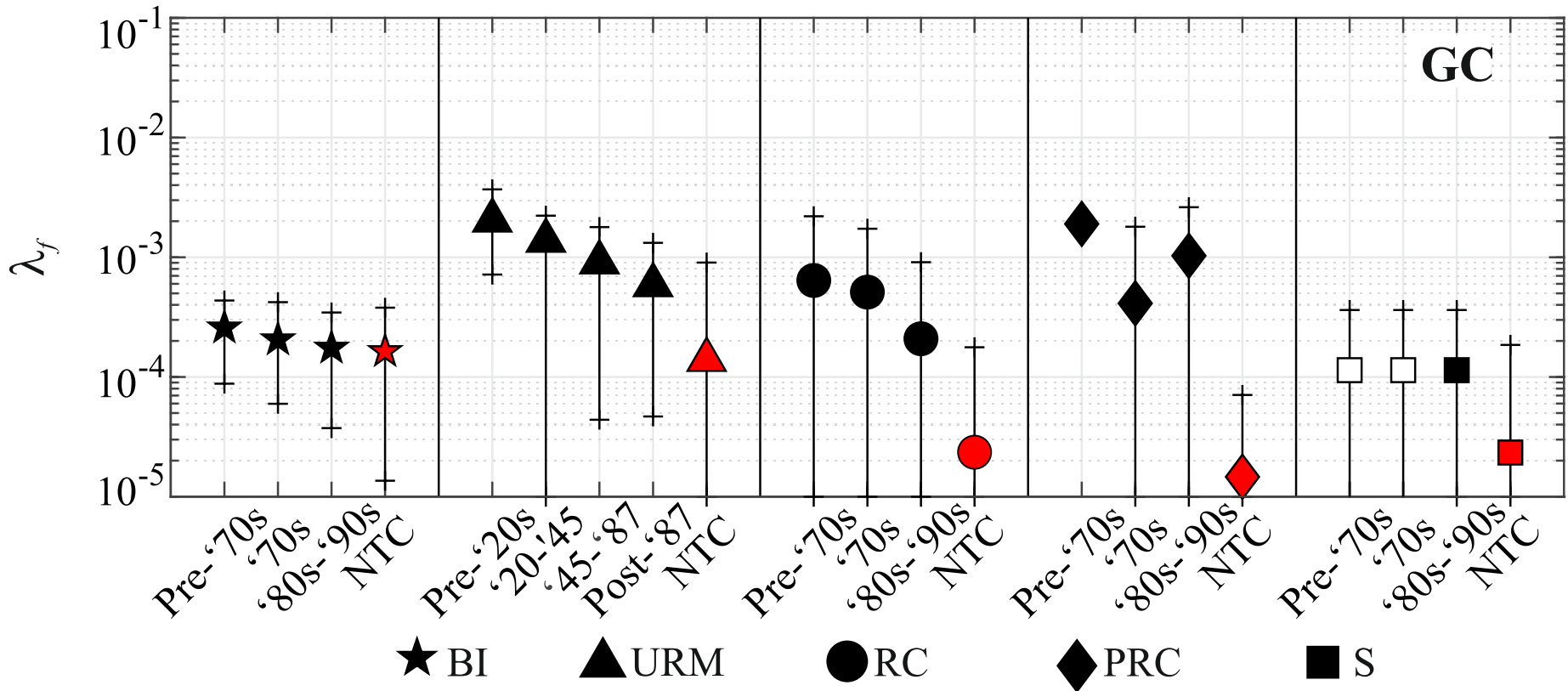


Design	Epoch	Site	Roof	Cladding	Connections
Gravity	'70s	Milan and Naples	Precast elements with additional RC topping	Infilled frames	Friction
		Milan and Naples	Precast elements (wing-shaped)	Infilled frames	Friction
	'80-'90	Milan	Precast elements with additional RC topping	Precast cladding panels	Friction
			Precast elements (wing-shaped)	Precast cladding panels	Dowels
Seismic	Pre-'70	L'Aquila	Precast elements with additional RC topping	Infilled frames	Dowels
	'70s	L'Aquila	Precast elements with additional RC topping	Infilled frames	Dowels
			Precast elements (wing-shaped)	Infilled frames	Friction
	'80-'90	Naples and L'Aquila	Precast elements with additional RC topping	Precast cladding panels	Dowels
			Precast elements (wing-shaped)	Precast cladding panels	Dowels

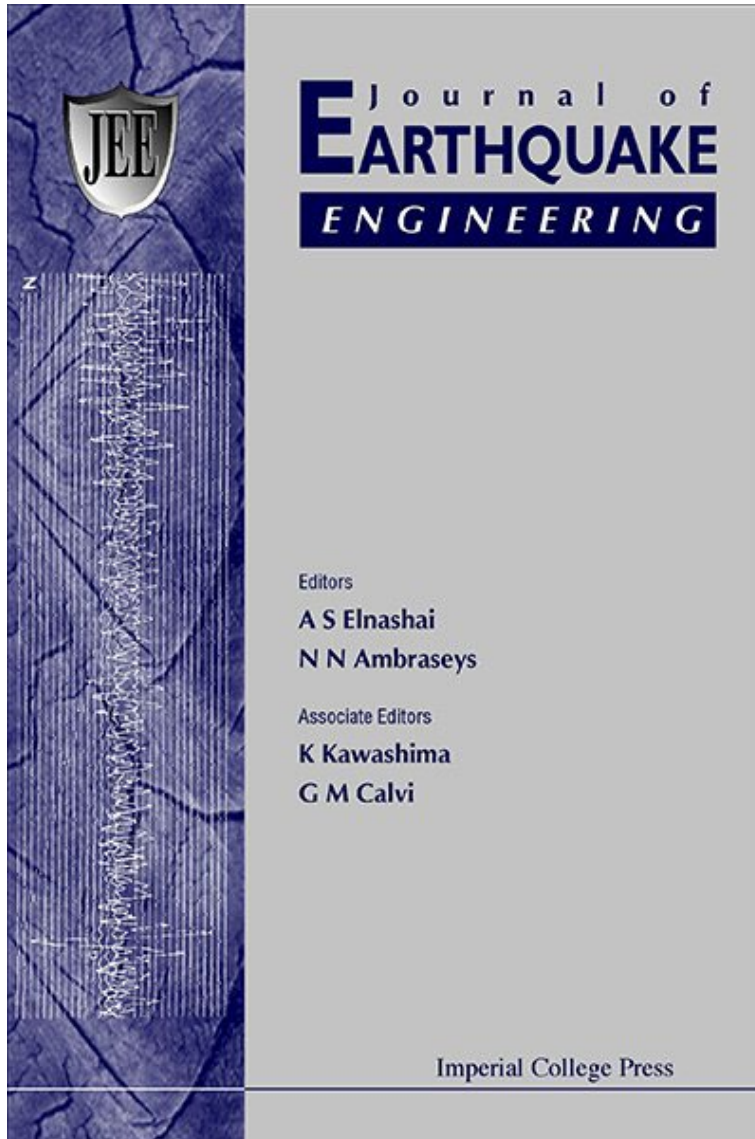


Scheme	Epoch	Sites	Geometry	Bracing	Cladding
PCB	'80-'90	Milano, Napoli, L'Aquila	30m x 8m x 9m	SHS	BF - TS - SP
		L'Aquila		L	BF - TS - SP
SCB	'80-'90	L'Aquila		SHS	BF - TS - SP
		L'Aquila		L	BF - TS - SP
					SP
		Milano, Napoli			

Tassi di fallimento



JEE – special issue 2 (in press)



1. Iervolino, I., Baraschino, R., Spillatura, A., & Pacifico, A. (n.d.). Evolution of seismic reliability of code-conforming Italian buildings. *Journal of Earthquake Engineering*, (in review).
2. Angiolilli, M., Eteme Minkada, M., di Domenico, M., Cattari, S., Belleri, A., & Verderame, G. M. (2021). Benchmark of nonlinear modelling strategies and performance assessment methodologies adopted in the RINTC-e project.
3. Risi, M. T. de, Domenico, M. di, Manfredi, V., Terrenzi, M., Camata, G., Mollaioli, F., Noto, F., Ricci, P., Franchin, P., Masi, A., Spacone, E., & Verderame, G. M. (2022). Modelling and Seismic Response Analysis of Italian pre-code and low-code Reinforced Concrete Buildings. Part I: Bare Frames.
4. Domenico, M. di, Risi, M. T. de, Manfredi, V., Terrenzi, M., Camata, G., Mollaioli, F., Noto, F., Ricci, P., Franchin, P., Masi, A., Spacone, E., & Verderame, G. M. (2022). Modelling and Seismic Response Analysis of Italian Pre-Code and Low-Code Reinforced Concrete Buildings. Part II: Infilled Frames.
5. Belleri, A., Riva, P., Magliulo, G., Bellotti, D., & Nascimbene, R. (2021). Modelling and seismic response analysis of non-residential existing precast buildings in Italy.
6. Cantisani, G., & della Corte, G. (2022). Modelling and Seismic Response Analysis of Non-residential Existing Steel Buildings in Italy.
7. Cardone, D., Viggiani, L. R. S., Perrone, G., Telesca, A., di Cesare, A., Ponzio, F. C., Ragni, L., Micozzi, F., Dall'Asta, A., Furinghetti, M., & Pavese, A. (2022). Modelling and Seismic Response Analysis of Existing Italian Residential RC Buildings Retrofitted by Seismic Isolation.
8. Iovino, M., Noto, F., di Laora, R., de Sanctis, L., & Franchin, P. (2022). Seismic Demand on Mid-Twentieth Century Reinforced Concrete Buildings Founded on Piles: Effect of Soil-Foundation-Structure-Interaction.
9. Penna, A., Rota, M., Bracchi, S., Angiolilli, M., Cattari, S., & Lagomarsino, S. (2021). Modelling and seismic response analysis of existing URM structures. Part 1: modern buildings.
10. Lagomarsino, S., Cattari, S., Angiolilli, M., Bracchi, S., Rota, M., & Penna, A. (2022). Modelling and Seismic Response Analysis of Existing URM Structures. Part 2: Archetypes of Italian Historical Buildings.

In conclusione, che ha prodotto il progetto?

1. Curve di **fragilità** delle strutture progettate secondo le NTC e **mappe di rischio ideale**.
2. **Tassi di fallimento sismico di ponti progettati** secondo le NTC.
3. **Tassi di fallimento edifici esistenti rispetto alla evoluzione delle norme per le costruzioni, con validazione della modellazione.**



UNIVERSITÀ DEGLI STUDI
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Il progetto RINTC 2019-2021 (WP3)

Junio Iervolino