REDUCTION OF THE ECONOMIC-FINANCIAL EXPOSURE OF THE STATE AND PROTECTION OF HUMAN LIVES

MODELS FOR THE PREVENTION AND MITIGATION OF DAMAGES TO PEOPLE AND PROPERTIES THROUGH AN INSURANCE COVERAGE

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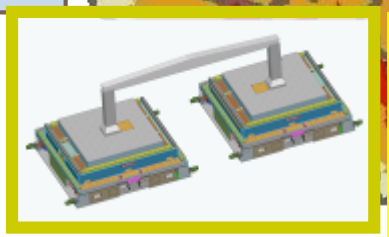
Info-day, Rome 13.03.2014

University of Trento

University of Pavia Eucentre

ENEA-UTS MAT



University of Napoli Federico II

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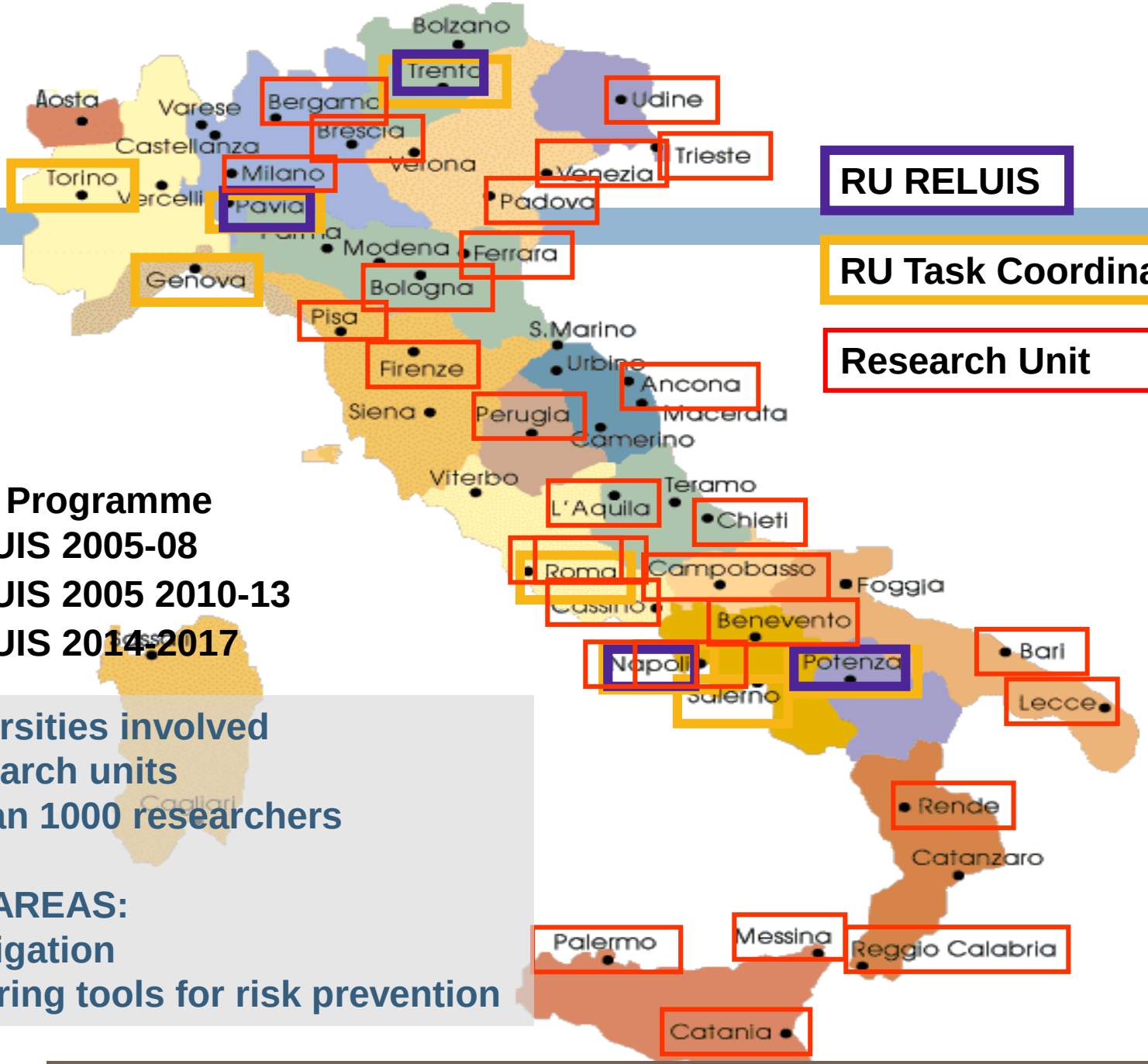
The Laboratories University Network of Seismic Engineering (ReLUIS)



RU RELUIS

RU Task Coordination

Research Unit

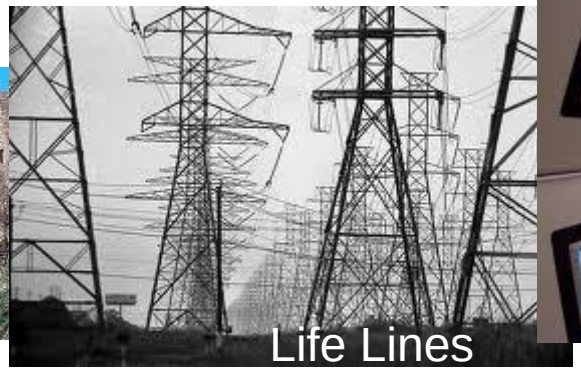
Research Programme
DPC-ReLUIS 2005-08
DPC-ReLUIS 2005 2010-13
DPC-ReLUIS 2014-2017

- 40 universities involved
- 127 research units
- More than 1000 researchers

THRUST AREAS:
- Risk Mitigation
- Engineering tools for risk prevention

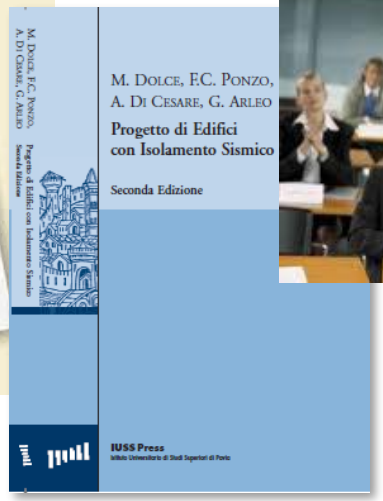
ReLUIS Research ProgrammeTHRUST AREAS:

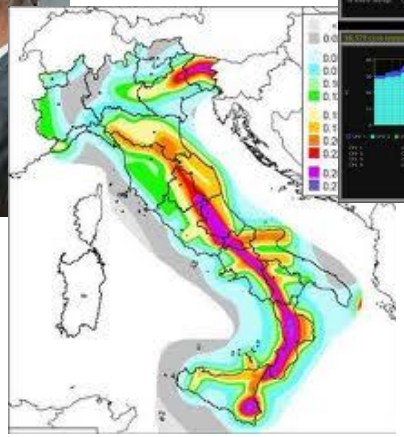
- **Risk Mitigation: Assessment and Design for:**



Researcher, Designers, Politicians

- **Engineering tools for risk prevention**





ORGANIZZAZIONE DEL PROGETTO

Aree Tematiche - AT

AT 1

- 1.1 - Nuovi aspetti nella valutazione delle strutture esistenti e degli interventi di adeguamento e valutazione del rischio sismico del patrimonio costruito a scala regionale
- 1.2 - Sviluppo di approcci agli spostamenti per la valutazione della vulnerabilità

AT 2

- 2.1 - Aspetti nella progettazione sismica delle nuove costruzioni
- 2.2 – Valutazione del rischio sismico di sistemi speciali
- 2.3 – Innovazione tecnologica in ingegneria sismica

AT 3

- 3.1 - Sviluppo di tecnologie per il monitoraggio e gestione del rischio sismico
- 3.2 - Servizi per la gestione delle emergenze e rapid response

Geotecnica - MT

- MT3
- MT2
- MT1

Progetti Speciali - RS

- RS5
- RS4
- RS3
- RS2
- RS1

University of Basilicata Seismic Laboratory

The Seismic QUESTION in Italy

- **30.000 events** have been registered in Italy in the last 1000 years, of which 220 of high intensity (> = VIII MCS);

- **41 Earthquakes** with intensity greater than or equal to 9 MCS in the last two centuries, that caused about 150 thousand casualties and destroyed a large part of the historical, artistic and cultural heritage which can not be quantified;

- **160 Billion** euros the cost of the last 40 years earthquakes

- **1 violent earthquake** on average every 5 years whatever the considered period

Damage and Destructiveness of italian earthquakes

- **The high seismic risk depends on the high vulnerability of the structures, determined by numerous factors, including:**

  - **presence of a large number of old, historical and monumental buildings**
  - **deterioration of suburbs in metropolitan areas,**
  - **illegal construction ("spontaneous") prevalent in areas with greater seismic hazard,**
  - **imperfect knowledge of the seismic hazard of the area**
  - **inadequacy of the standards adopted at the time of construction of the buildings and their application.**

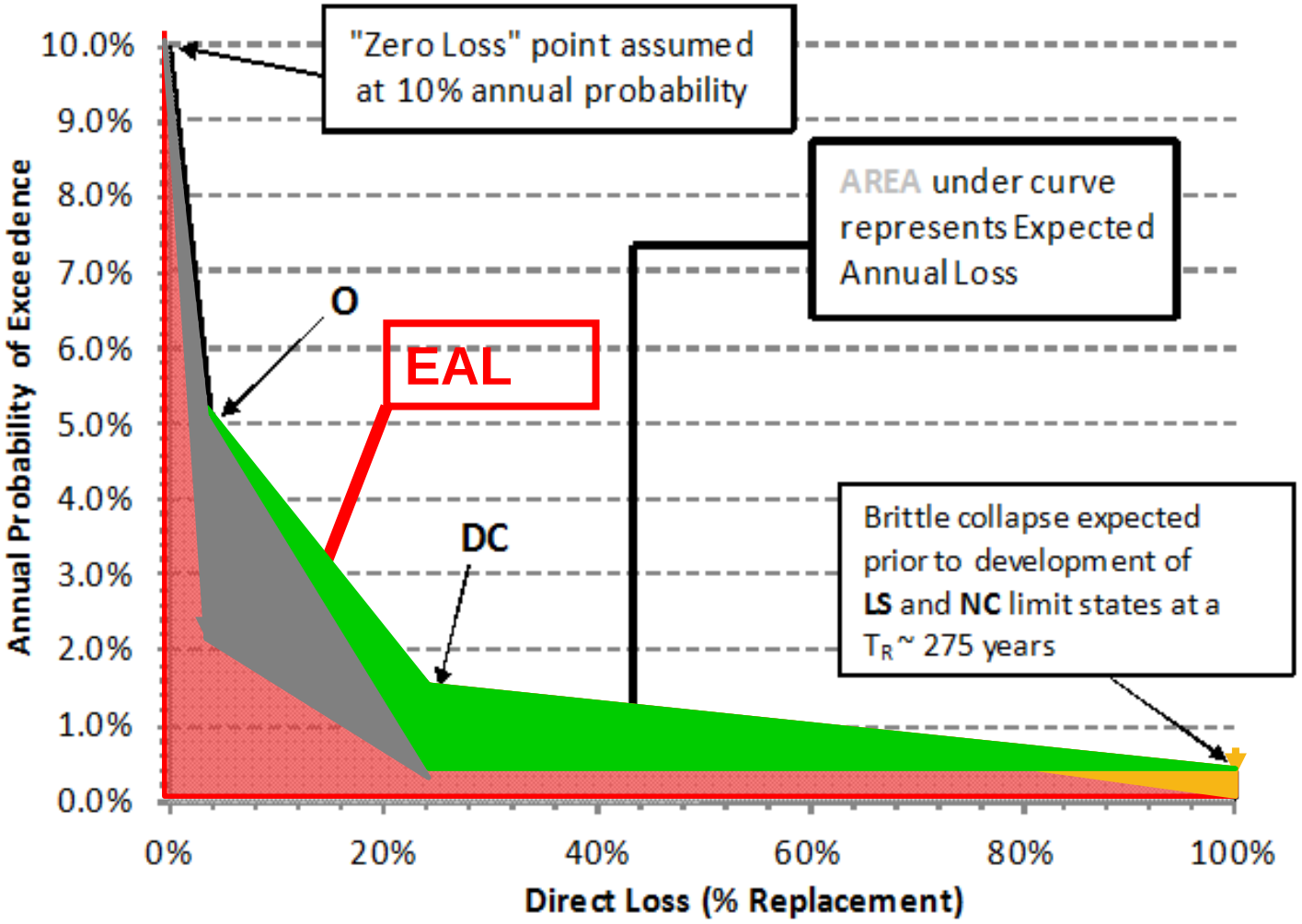
SEISMIC RISK: SCREENING ON XXI CENTURY

- **Based on what happened in the past 2 centuries, should be expected in the next century:**
  - **500 - 2000 deaths and injuries / year**
  - **→50000-200000 deaths and injuries in XXI cent.**
  - **1 - 2 BEuro / year**
  - **→100-200 BEuro on XXI cent.**
- **The cost estimate is relevant only to the homes. The total costs should also include public buildings, monumental buildings and infrastructure. The increase is expected in the order of 50-100%.**

Courtesy of Prof. Mauro Dolce, Italian Department of Civil Protection

EAL – Expected Annual Loss

Loss estimation



Reduction of collapse probability NC

Reduction of damage probability DC

Also reduce the probability related to loose the "fully operational" condition - DC

Courtesy of Prof. G.M. Calvi – EUCENTRE - Pavia

EAL – Expected Annual Loss
Cost-Benefit Analysis

"Expected annual loss" for retrofitted structures

LIMIT STATE		Strengthening Strategy				
		Existing* (do-nothing)	Element (50%)	FPS Isolation**	Shear Walls	Added Damping
Fully Operational	RP(y)	20	20	20	30	30
	$Loss_{Direct}$ | O(%)	4.00%	4.00%	4.00%	2.90%	4.00%
	$Loss_{Indirect}$ | O(%)	1.17%	1.17%	1.17%	1.17%	1.17%
Damage Control	RP(y)	72	72	72	140	200
	$Loss_{Direct}$ | DC(%)	28.27%	28.27%	28.27%	24.73%	28.27%
	$Loss_{Indirect}$ | DC(%)	5.00%	5.00%	5.00%	5.00%	5.00%
Life Safety	RP(y)	273	975	3400	2000	3200
	$Loss_{Direct}$ | LS(%)	100%	66.50%	39.8%	62.53%	66.50%
	$Loss_{Indirect}$ | LS(%)	90.00%	30.00%	5.00%	30.00%	30.00%
Near Collapse	RP(y)	2475	2475	3400	4400	4300
	$Loss_{Direct}$ | NC(%)	100%	81.38%	39.8%	81.17%	81.38%
	$Loss_{Indirect}$ | NC(%)	90.00%	90.00%	5.00%	90.00%	90.00%
Expected Annual Loss	EAL_{Direct} (%)	1.70%	1.37%	1.20%	0.79%	0.84%
	$EAL_{Direct+Indirect}$ (%)	2.66%	1.81%	1.41%	1.06%	1.07%

*Brittle collapse is expected at a 273 year return period for the existing building and near collapse downtime is assumed
**The FPS Isolation case assumes only damage control level of downtime beyond the stick-slip activation of bearings

A PARAMETER FOR SEISMIC CLASSIFICATION OF A BUILDING

The Expected Annual Loss – EAL – is a synthetic parameter that could be used such as a global parameter to evaluate the "seismic quality" of a structure or, using an accurate expression, the "seismic resilience" of a structure (RS).

As example, it could be possible to establish that a building characterized by an EAL < 0.5% of the Rebuilding Cost (RC) falls within the Class of Seismic Resilience A, i.e.:

if EAL < 0.5 % RC then RS = A

similarly, as example:

if EAL < 1.0 % RCthen RS = B
if EAL < 2.0 % RCthen RS = C

WHICH IS THE BEST WAY TO REDUCE ECONOMIC LOSS DUE TO EARTHQUAKES?

Earthquakes

Economic Loss

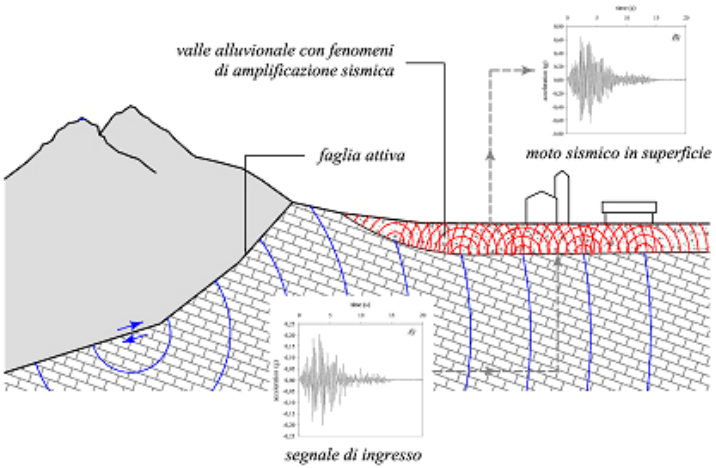
Government can't sustain the cost to repair damages of next earthquakes

Encourage the insurance companies to provide earthquake damage coverage

Reduce recovery costs, building vulnerability and cost of insurance taking into account possible public or private incentives

INFORMATION FROM GEOPHYSICIST

- Maximum expected magnitude
- Acceleration-Velocity-Displacement Response Spectra
- Return Period
- Site fault Information:



far fault and near fault earthquakes

vertical components importance

site amplification problems

soil-structure interaction

STRATEGIES


Emergency or Disaster
Media Focus
Risk Assessment
Mitigation/Prevention
Preparedness
Risk Assesment
Mitigation/Prevention
PRE-DISASTER
Warning/Evacuation
Ongoing Development Activities
RESPONSE
Saving People
POST-DISASTER
Providing Immediate Assistance
Economic & Social Recovery
Assessing Damage
Reconstruction (Resettlement/Relocation)
Ongoing Assistance
Restoration of Infrastructural Services

FAST STRATEGIES FOR STRUCTURAL ASSESSMENT

Calibration of the fragility curves starting from assessment of real benchmarks structures
(Stochastic approach instead of Probabilistic approach)

State of the art vulnerability studies, considering the diversity of building types, materials and ages in the territory

Combination of classical and innovative test procedures (dynamic identification tests, georadar, electromagnetic techniques)

Analysis of the existing structural typologies

Development of the fast strategies for structural assessment as function of the different typologies.

RETROFIT OF EXISTING STRUCTURES

Improvements and simplification of innovative seismic retrofitting techniques for the building vulnerability reduction (developed for specific building typologies)

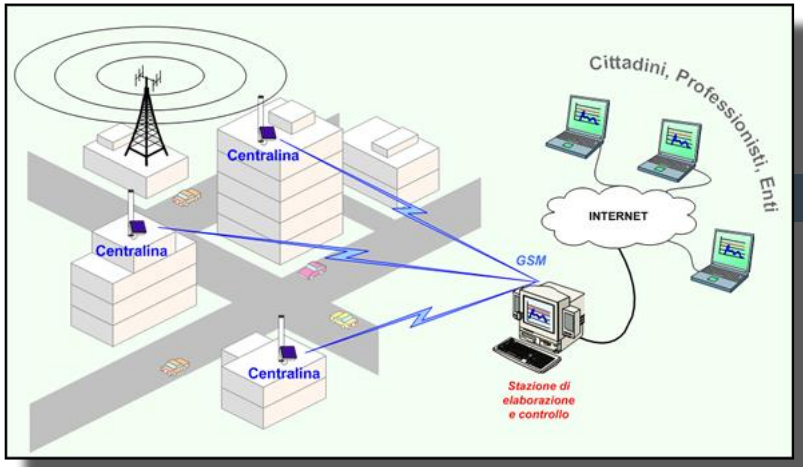
Dissipating braces

Seismic isolation

CAM

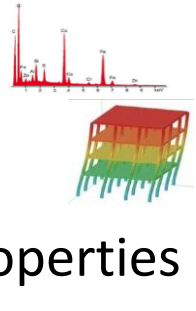
FRP

STRUCTURAL HEALTH MONITORING



Evaluation of the dynamic characteristics of structures:

- Frequencies
- Modal Shapes
- Dissipating Properties



Change over time

- Evaluation of the damage and of its growth
- Damage scenario evaluation (Earthquake Emergency)

Model Updating and Integration with Non-Destructive Testing:

- Construction of more reliable numerical models (boundary conditions, Young modulus, …)

THANK YOU