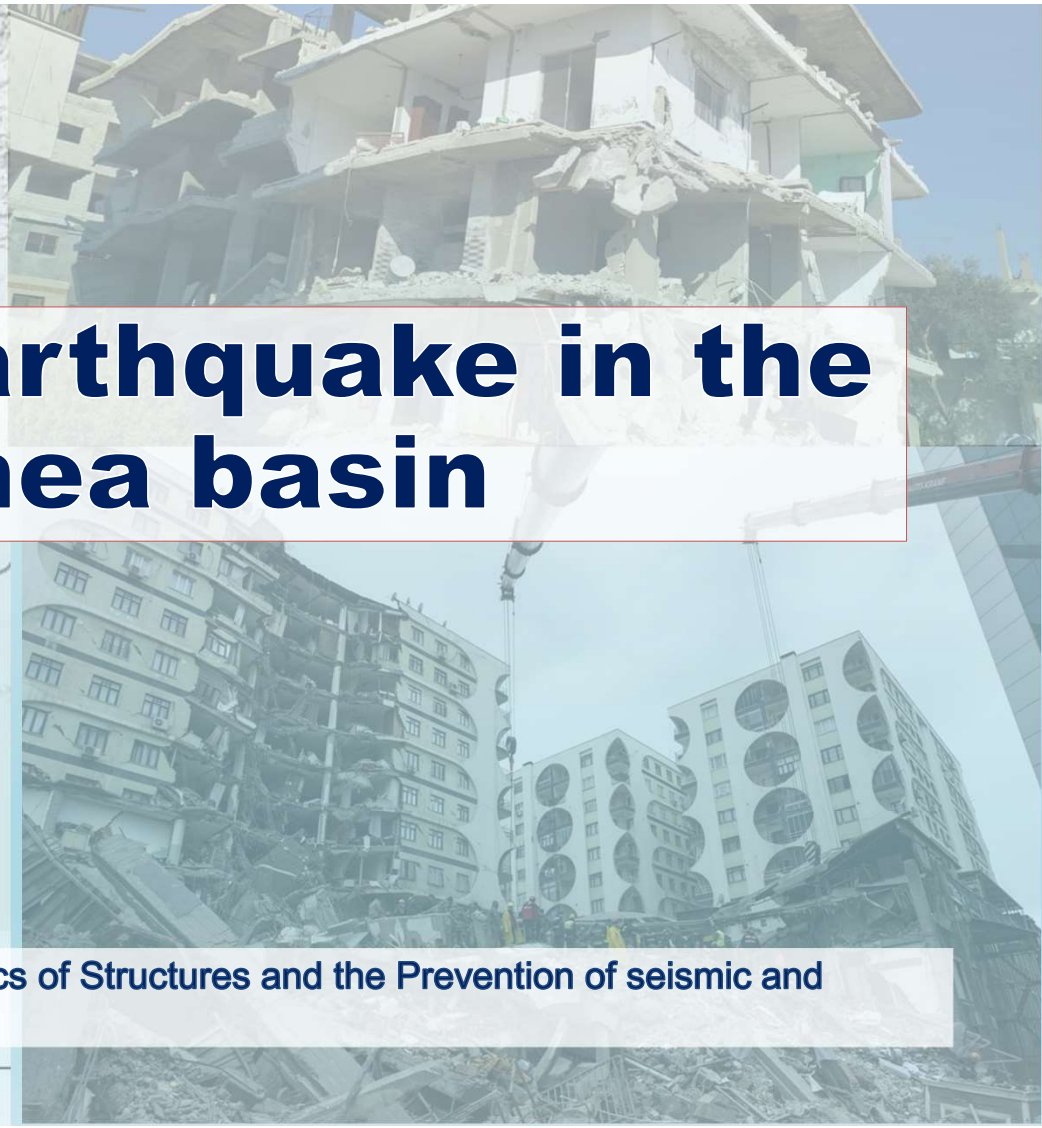
Italian National Agency for New Technologies, Energy and Sustainable Economic Development

# Living with the earthquake in the mediterranea basin

**Eng. Anna Marzo** - Head of Laboratory Technologies for the Dynamics of Structures and the Prevention of seismic and hydrogeological risk (SSPT-MET-DISPREV)

## Risk should be managed, not disaster…

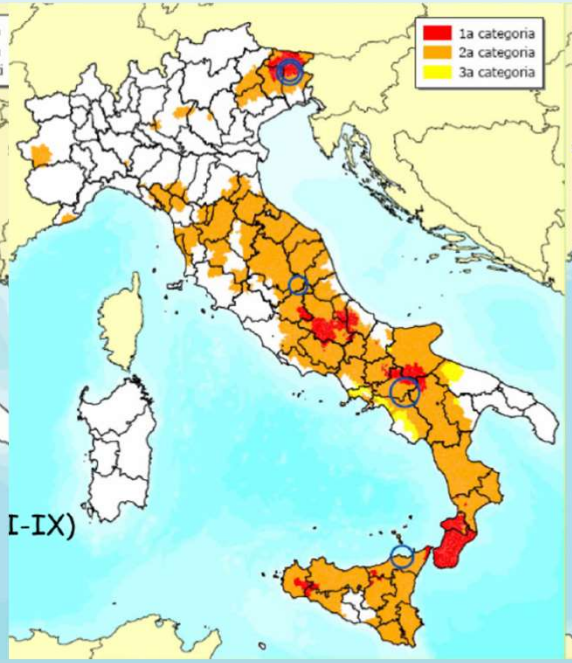
**The main acts for the risk management are:**

1. **The Knowledge (environmental parameters, sites peculiarities, built-up, etc.)**

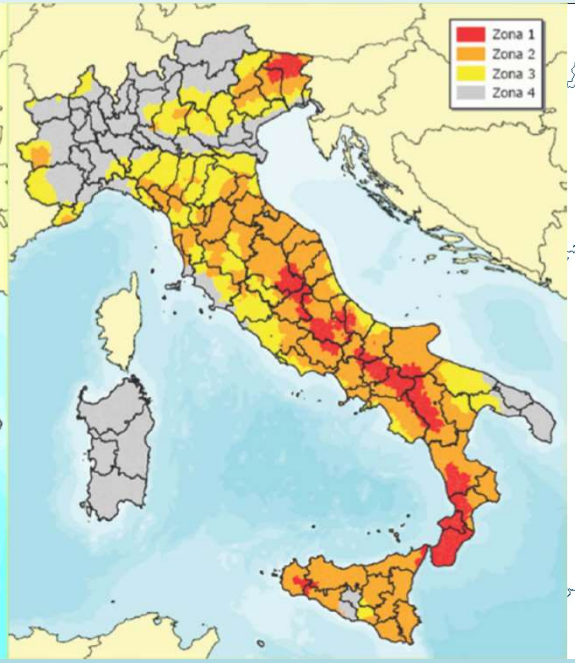
2. **Design of proper mitigation actions (exposure reduction and/or vulnerability reduction)**

# Seismicity Classification evolution in Italy

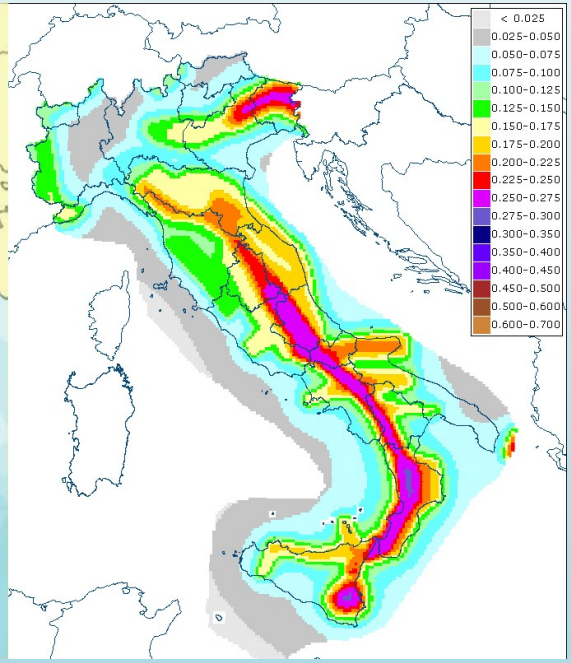

1980: 25% in z 1 and 2




1981: 43% in z 1, 2, 3



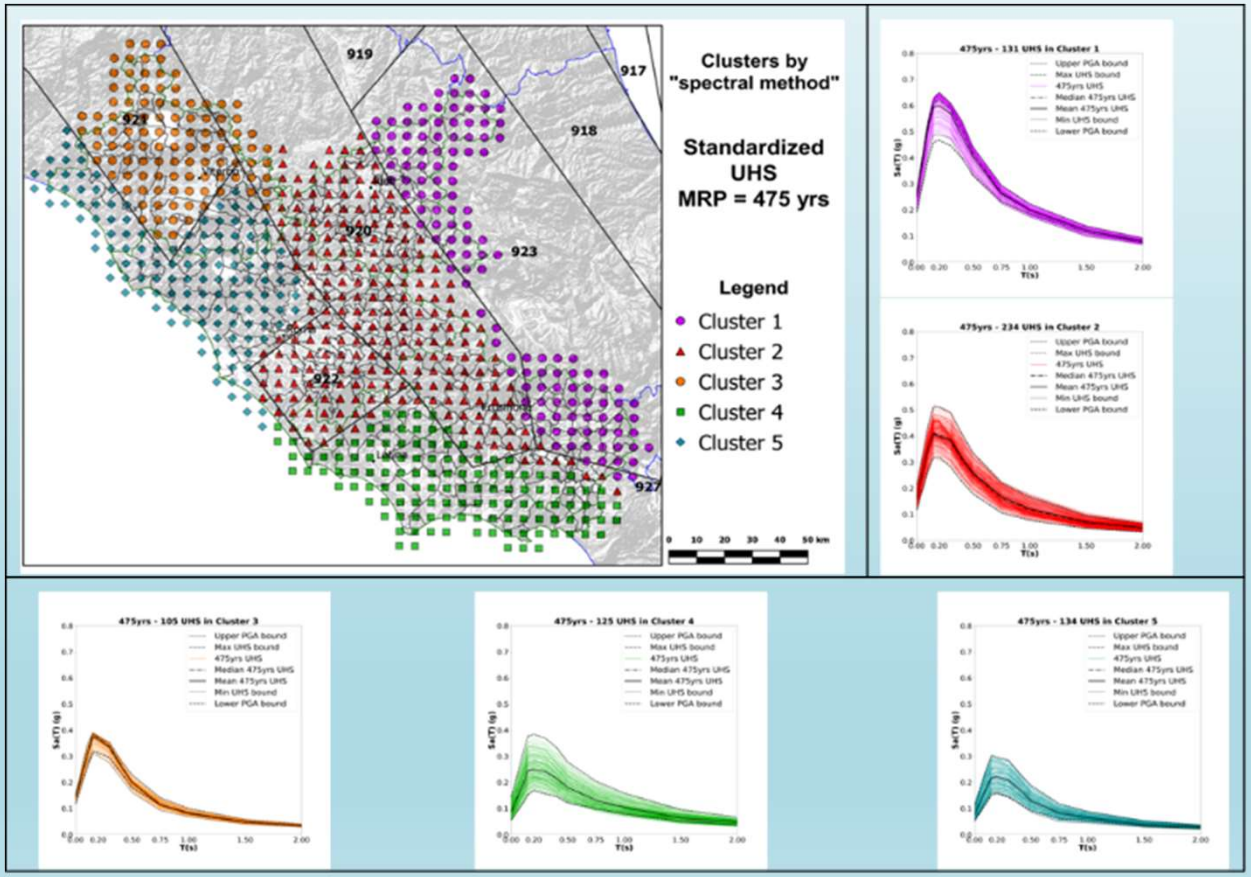

2003: 70% in z 1, 2, 3
Introduction of z 4




From 2008 to nowday

# THE KNOWLEDGE OF TERRITORY: Seismic Risk distribution

After the 2016 earthquake in central Italy, ENEA took part in microzonation studies in the Lazio region




Territory «Cluster» with homogeneous seismic hazard

**Regional accelerograms of reference**

The Lazio region provides accelerograms for technical applications on the regional territory: Level 3 of Seismic Microzonatione (SM3) and studies of Local Seismic response (LSR)

# Retrofitting strategies for vulnerability reduction

- TO INCREASE STRENGHT AND STIFFNESS
- TO INCREASE DISSIPATIVE CAPACITY
- TO IMPROVE NON-STRUCTURAL ELEMENTS PERFORMANCES
- TO SEPARATE THE STRUCTURE MOTION FROM THE BASE ONE: Base Isolation

**INTEGRATED STRUCTURAL-ENERGY EFFICIENT INTERVENTIONS**

**SUSTAINABLE INTERVENTIONS**

# To increase strenght, stiffness and dissipative capacity

## Local or global interventions

### MASONRY STRUCTURES


Masonry strengthening

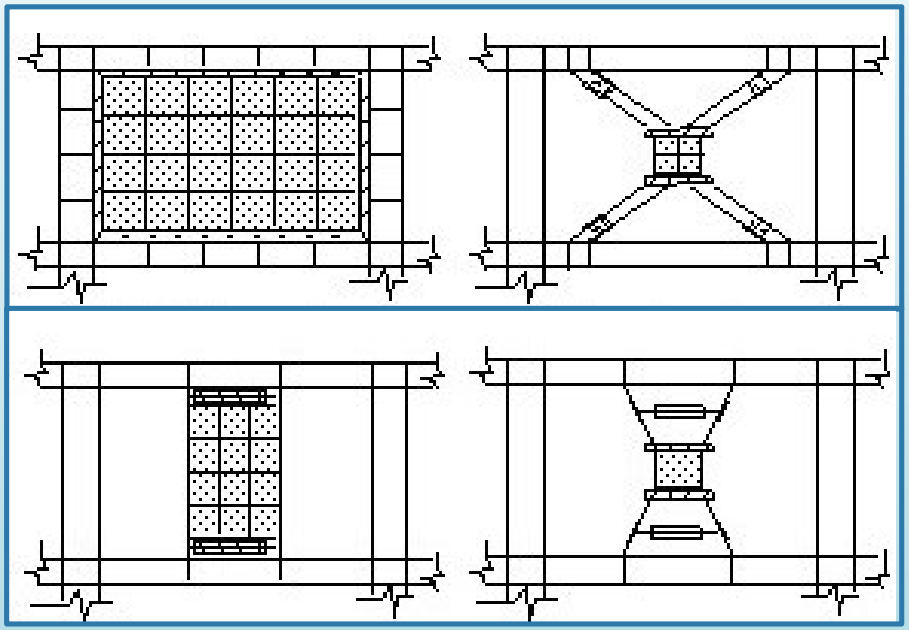
### R.C. STRUCTURES

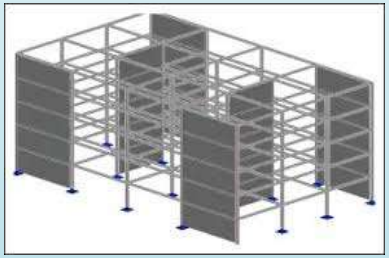
Reinforcement of r.c. elements

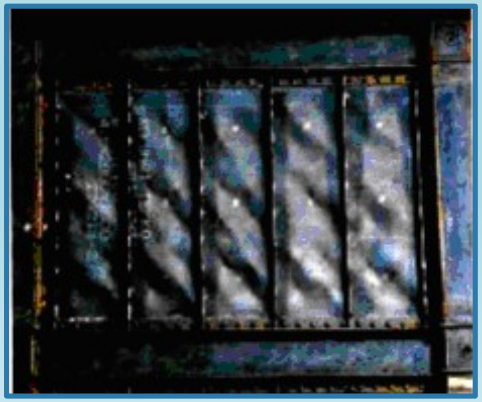
# To increase strenght, stiffness and dissipative capacity

## Global interventions

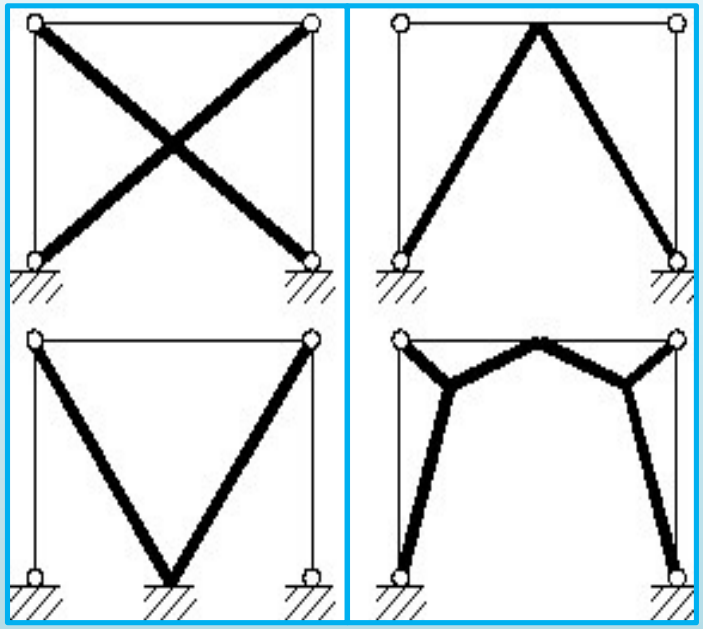
### SHEAR WALLS



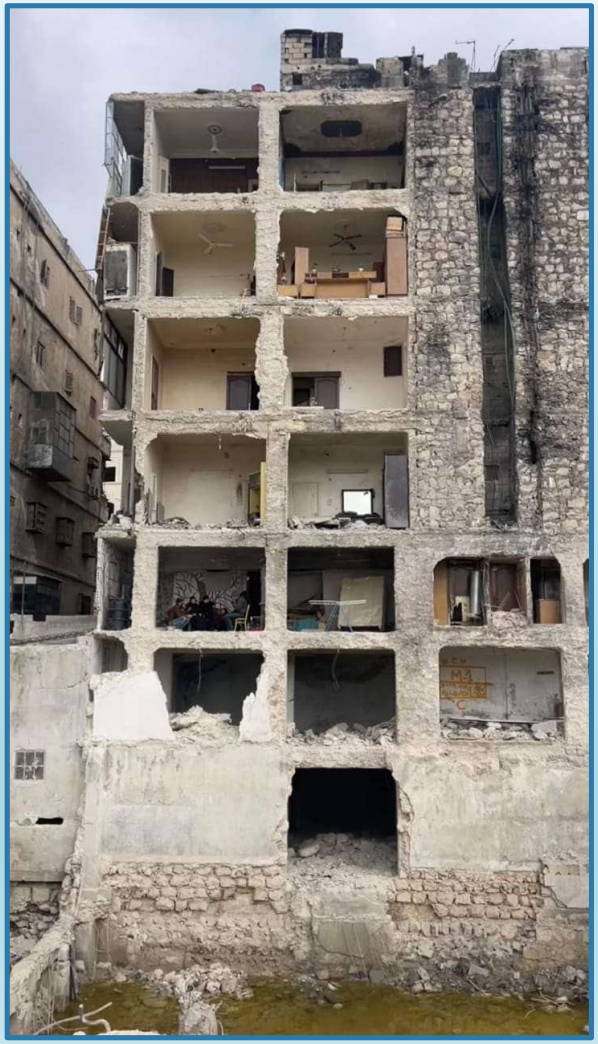




### BRASING SYSTEMS




# To improve non-structural elements performances



# To improve non-structural elements performances

## NTC 2008 and following

### PERFORMANCE REQUIREMENTS

- *For non-structural elements, must be adopted magisterial to avoid possible expulsion under the **$F_a$** action corresponding to the LS and the UC considered.*
- *Improving the linkages of non-structural elements to the adjacent structures*

$$F_a = \frac{S_a W_a}{q_a}$$

$S_a$= PgA

$W_a$ = Element weight

$q_a$= Behavoiur factor

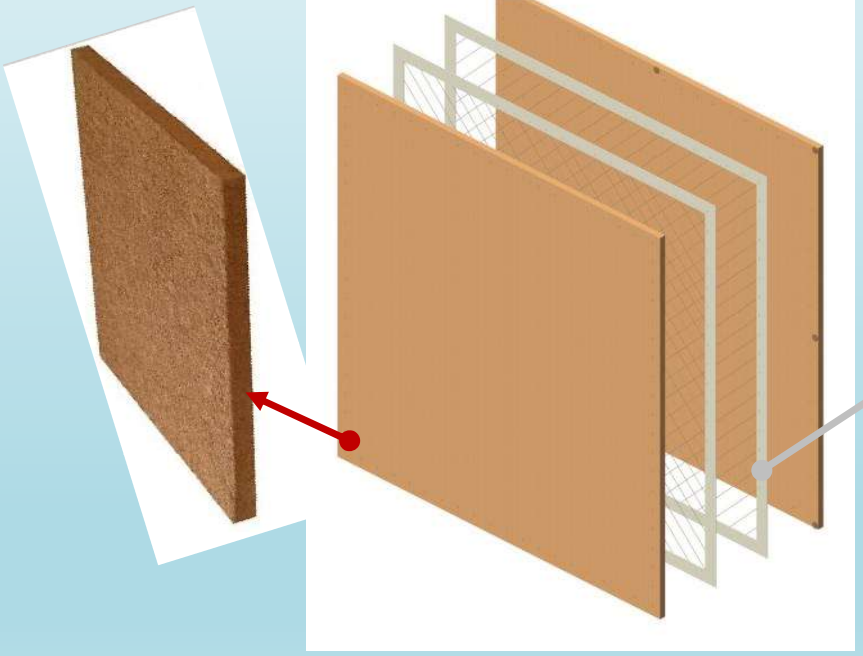
- *Limitation of interstorey drift*

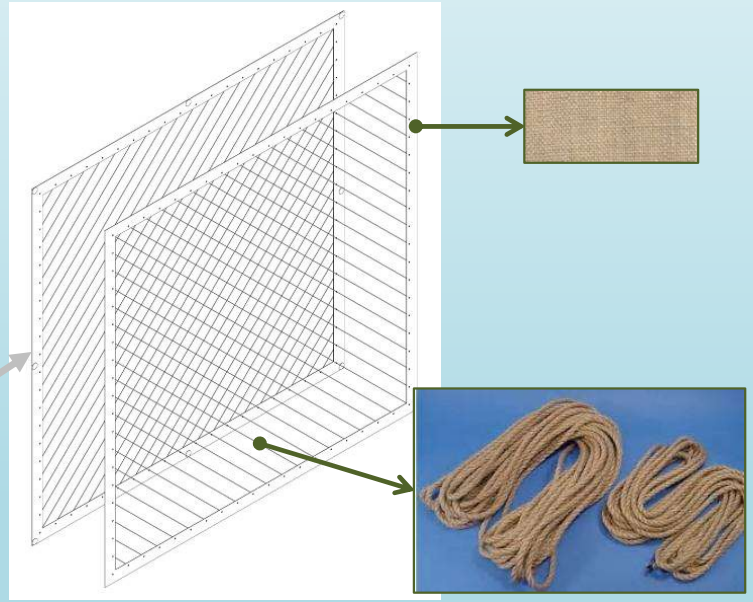
# To improve non-structural elements performances

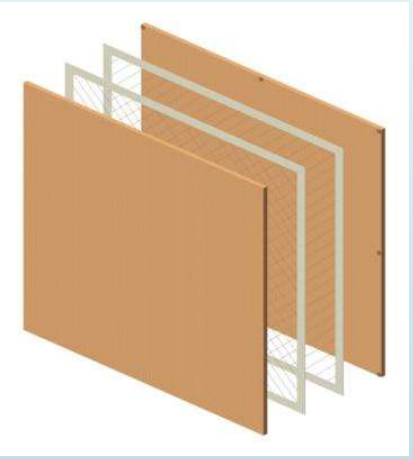
## Infill walls: A dual function soltion which combines seismic safety and energetic efficiency

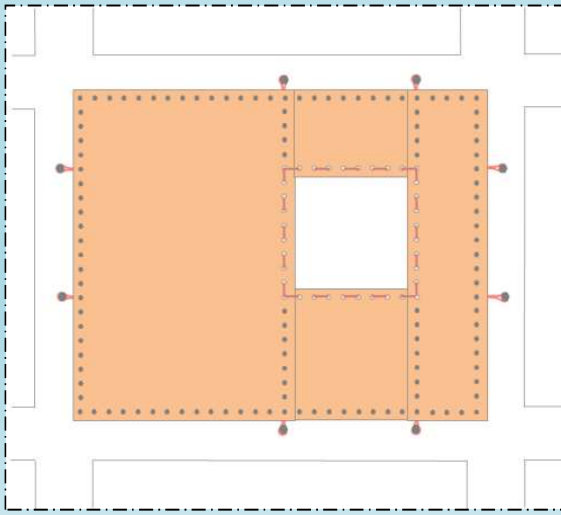
**(ENEA Patent n. 102016000116158 : A. Marzo e C. Tripepi)**

**A modular kit with seismic and heat-insulating functions, delegating them to different elements (ropes and panels) both made of hemp o other natural fiber**



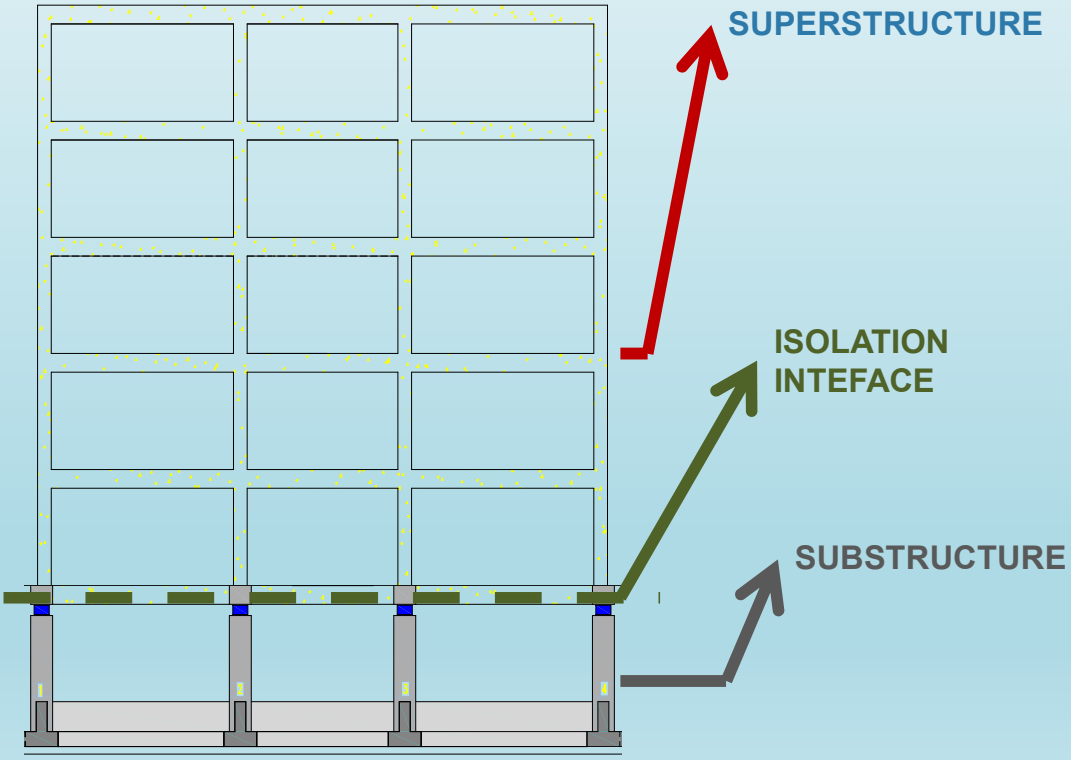


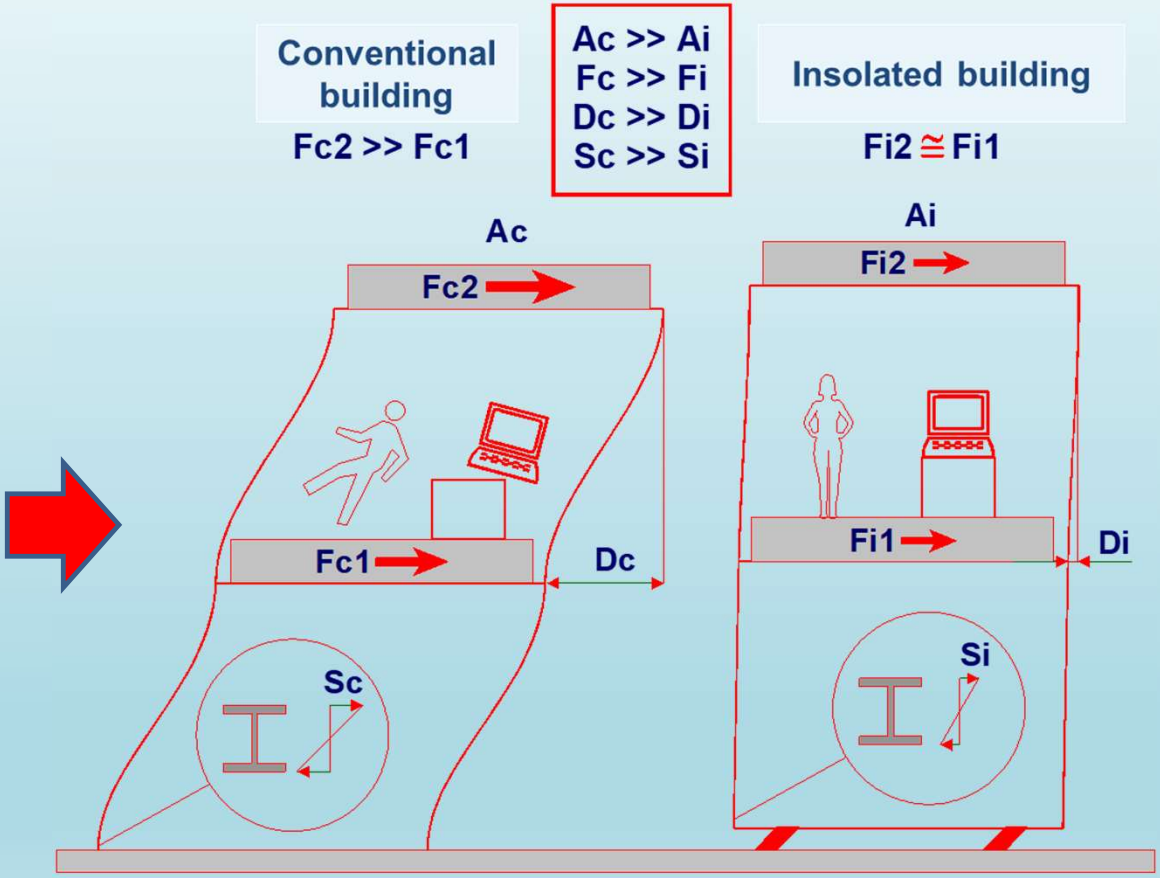




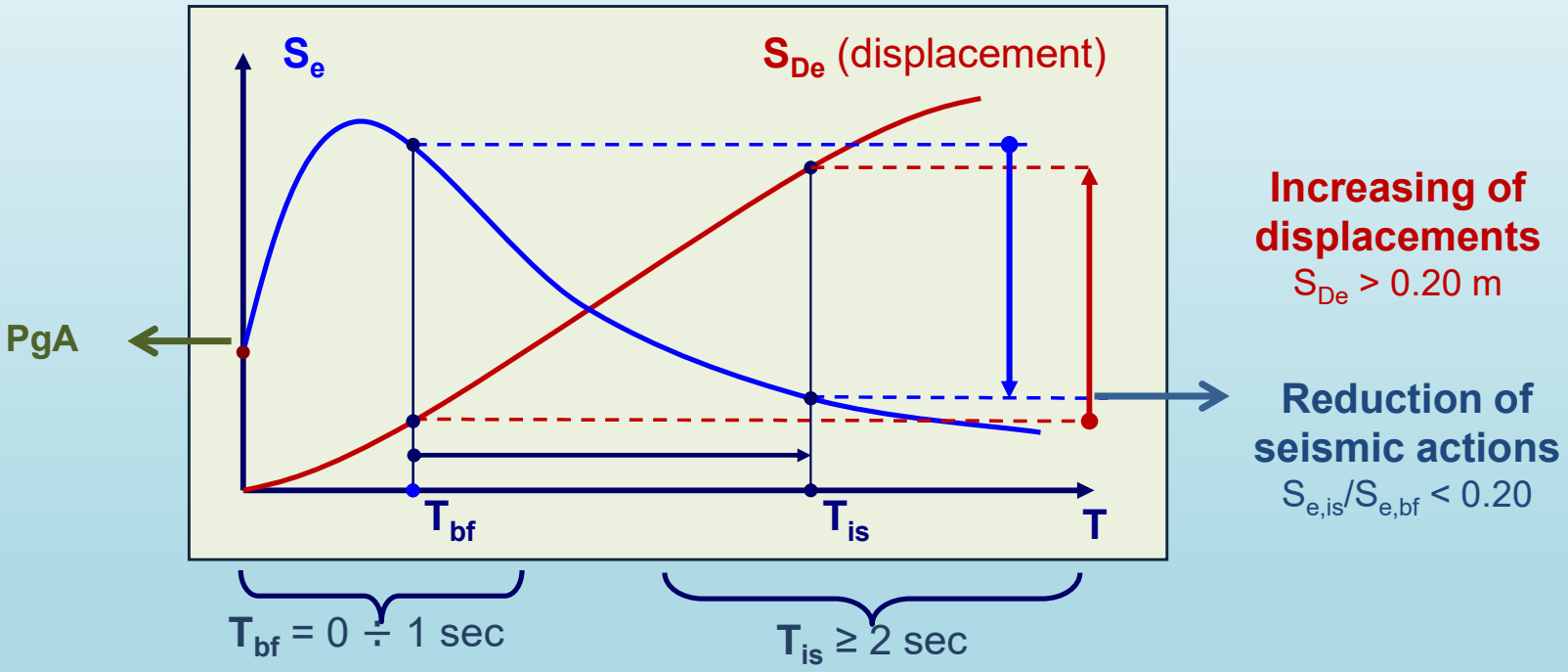
# To separate the structure from the base motion: Base Isolation

## Global intervention



# TO SEPARATE THE STRUCTURE FROM THE BASE: Base Isolation




**Zero Earthquake Damage Buildings**

# TO SEPARATE THE STRUCTURE FROM THE BASE:
# Base Isolation

**Flexibility of the systems**

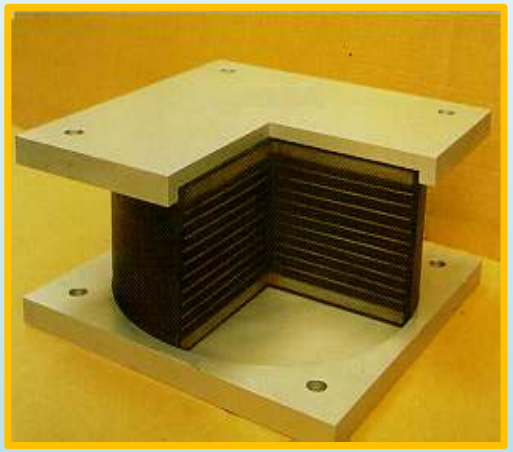
**Gap**

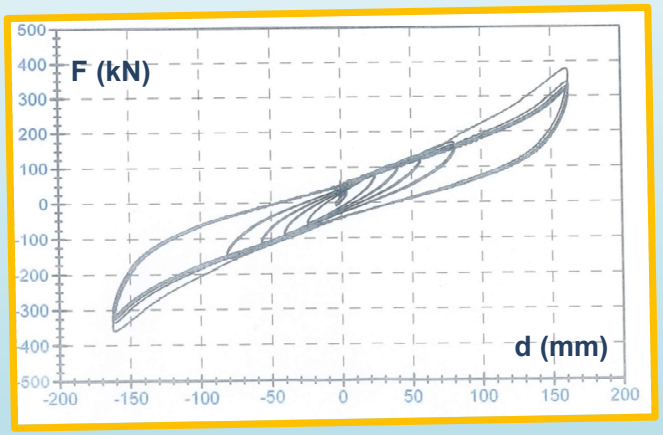
**Accessibility**

# TO SEPARATE THE STRUCTURE FROM THE BASE: Base Isolation

## Main Typologies

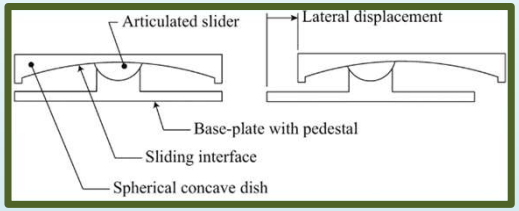
### HDRB

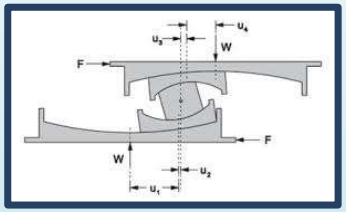


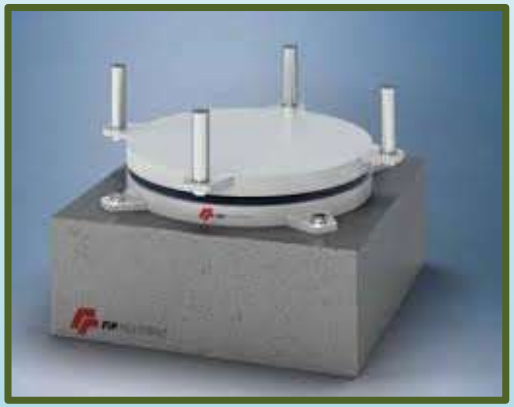


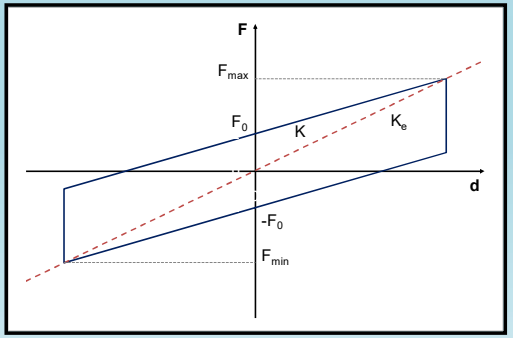

### Sliding devices

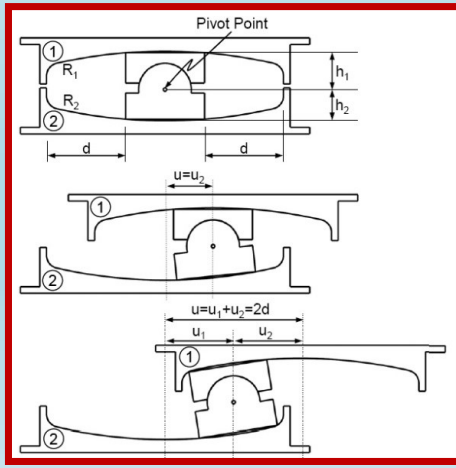
## Curved Surface Slider (CSS) bearing



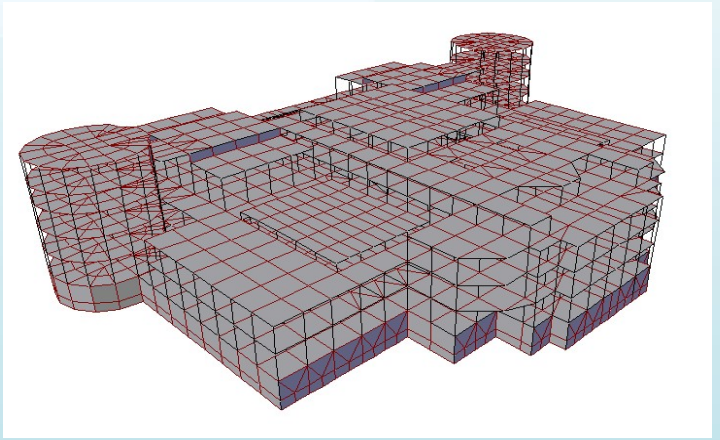





# Base Isolation: Applications

## Multifunctional Center Rione Traiano, Soccavo, Naples




630 HDRB

# Base Isolation: Applications

## Buildings in Pianola (AQ)






# THANK YOU
# FOR ATTENTION

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SSPT-MET-DISPREV