

International Conference on Protective Structures



Auburn University

May 14-17, 2023

Auburn, Alabama USA

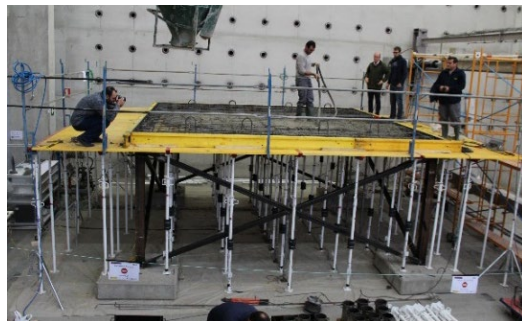
# Improving building robustness through fuse-segmentation

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## Outline

- 1 Research at Building Resilient
- 2 Introduction to fuse-segmentation and the Endure project
- 3 A performance-based approach for fuse-segmentation design
- 4 Designing & testing structural fuses



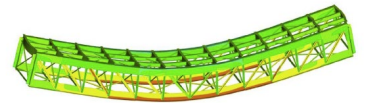
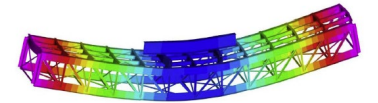


# Research at Building Resilient

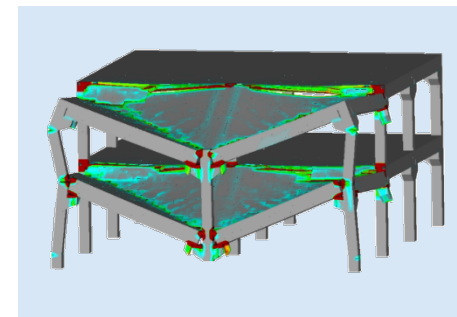
## Research at Building Resilient



### Structural assessment



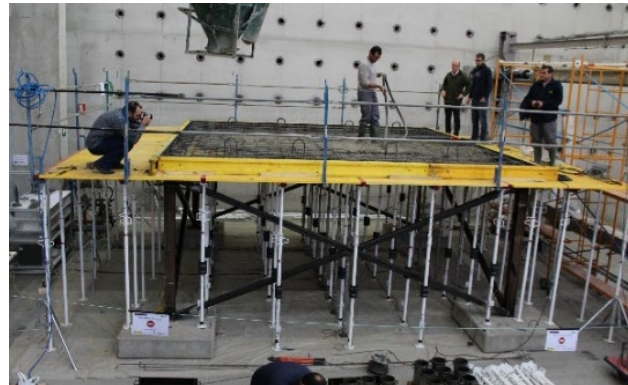
### Structural robustness



## ICITECH structures laboratory



- 35 × 15 m<sup>2</sup> strong floor
- L-shaped reaction wall with a height of 14 m



## Exterior laboratory



## Funding entities



**European Research Council**  
Established by the European Commission



**GENERALITAT  
VALENCIANA**

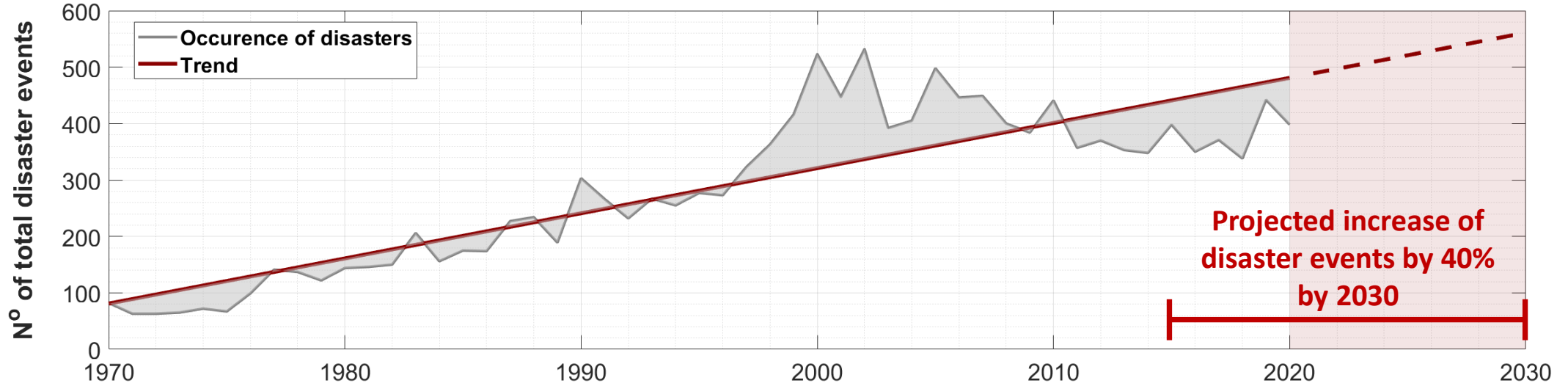
**Fundación  
BBVA**



# Fuse-segmentation & the Endure project

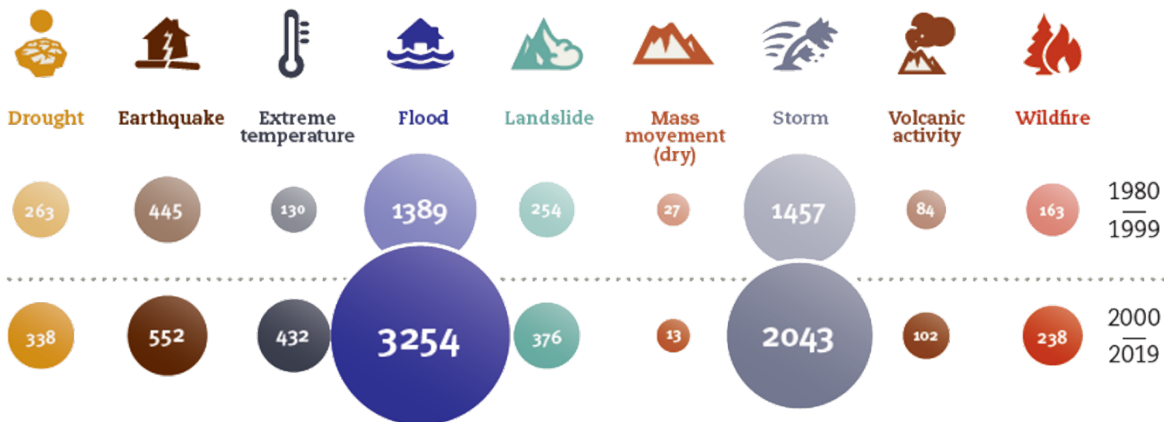


## A world at risk



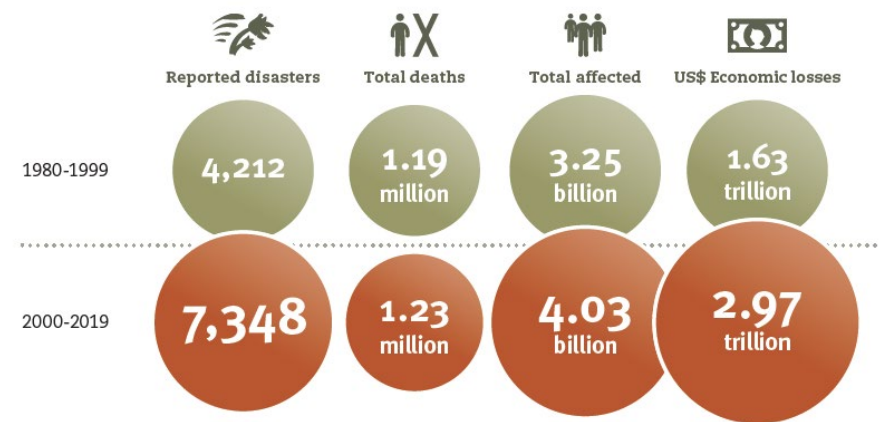
Data from EM-DAT, 2021

### Types of disaster events (Total N° in 20 years)



UNDRR, 2019

### Consequences (Total N° in 20 years)

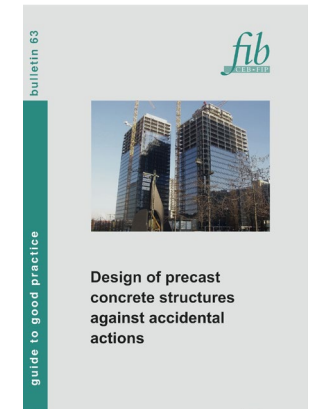
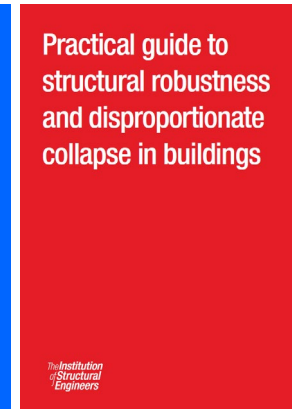
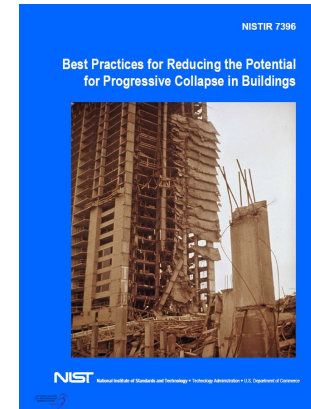
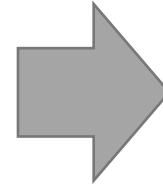
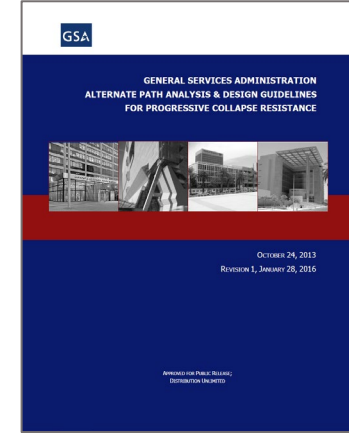
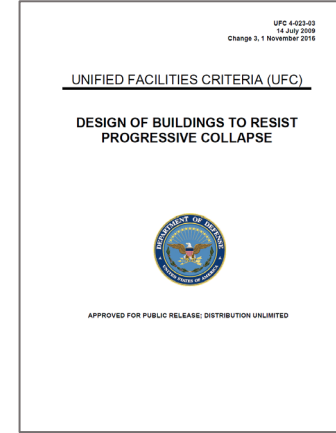
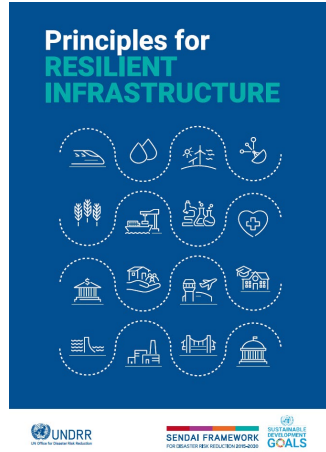


UNDRR, 2019

## Building collapses



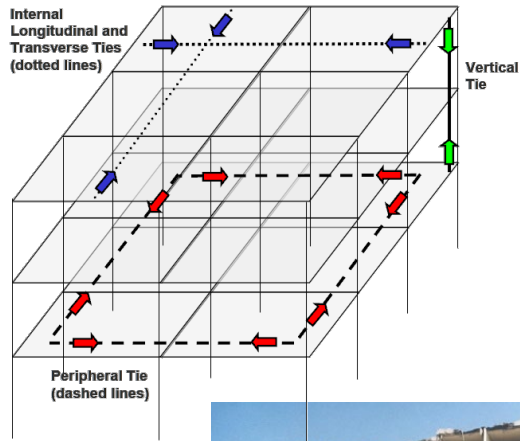
## The need for robust structures



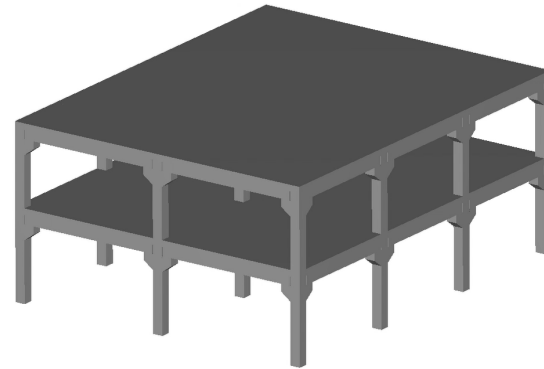
## Current design philosophies

### Continuity, Redundancy & Ductility

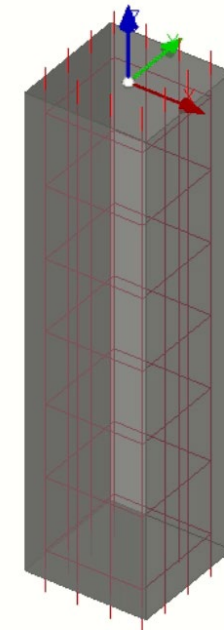
#### Prescriptive Tie Force Requirements



#### Alternative Load Path Method



#### Key Elements (Specific Local Resistance)



## When continuity is effective (flat-slab structures)



## When continuity is effective (precast concrete structures)



## When continuity is effective (precast concrete structures)

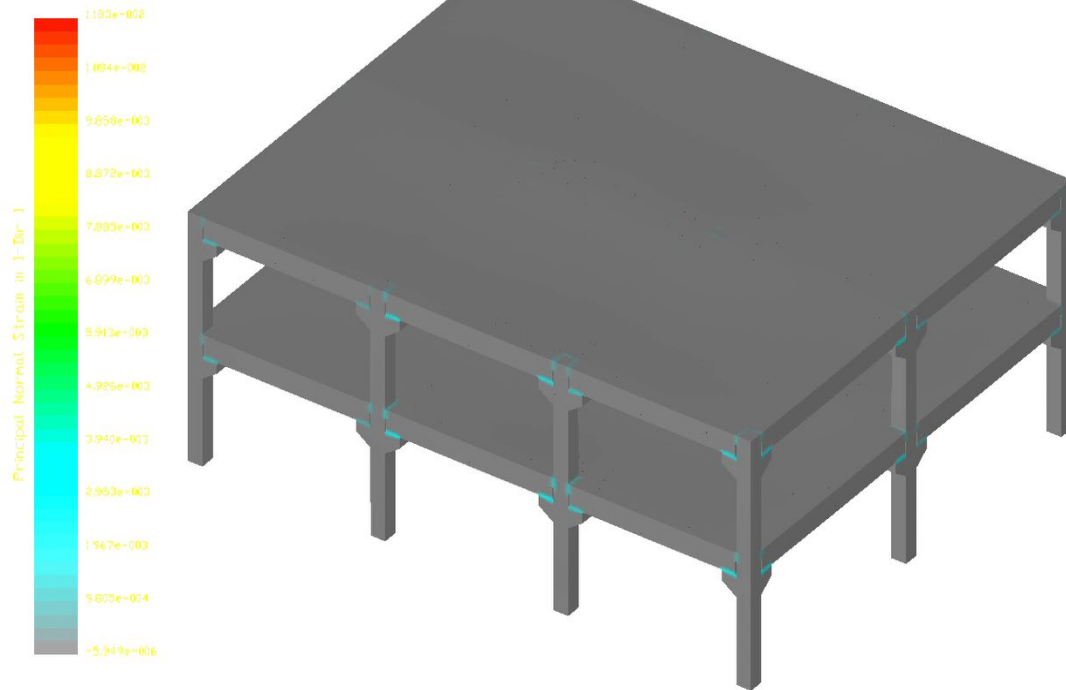


## When continuity is effective (precast concrete structures)

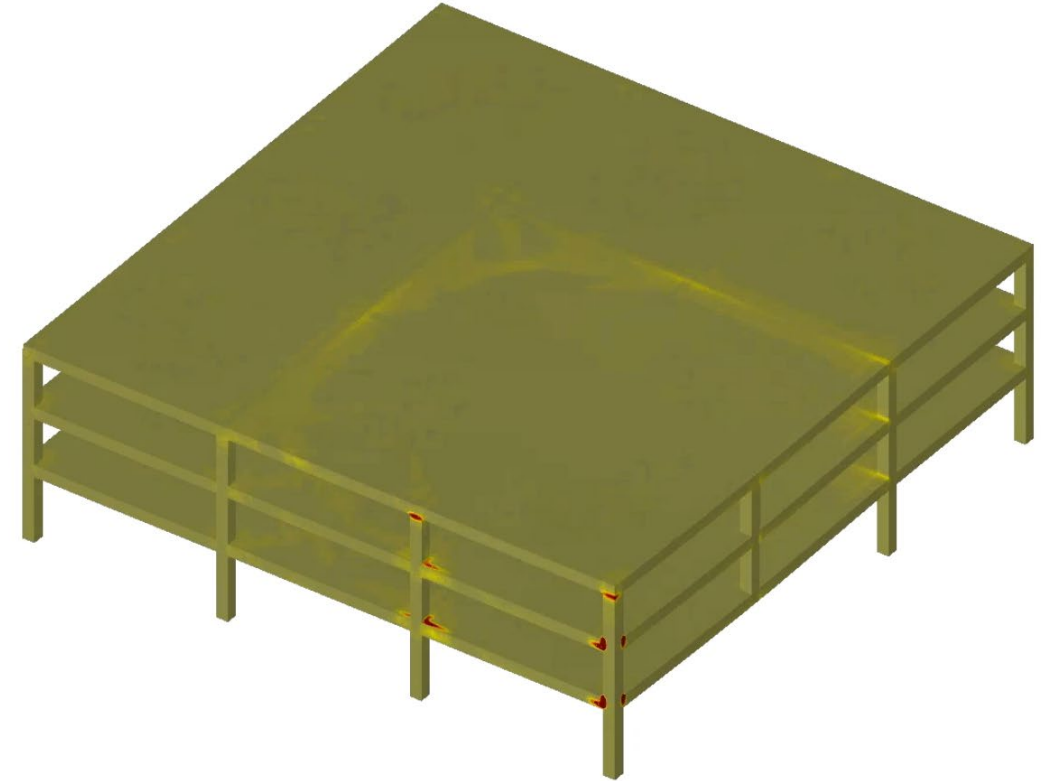




# Limitations of continuity



Continuity is effective



Continuity is ineffective

## Limitations

### Scenarios when current philosophies are ineffective

#### Large initial failures:

Failure of several columns;  
Failure slab over one or more bays

#### Wide-span slabs:

Precast construction;  
Posttensioned slabs;

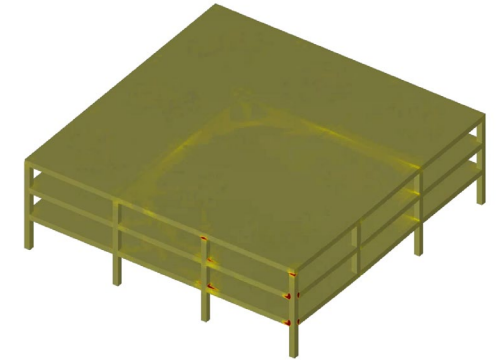
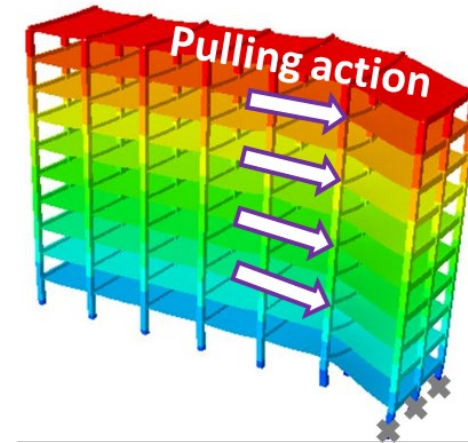
### Continuity

Local failure pulls other zones

Increases risk of disproportionate collapse

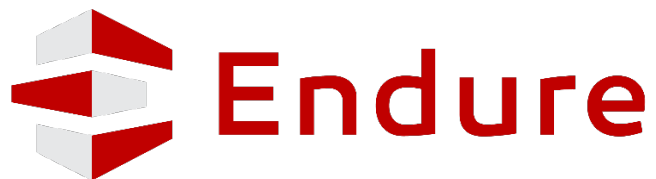
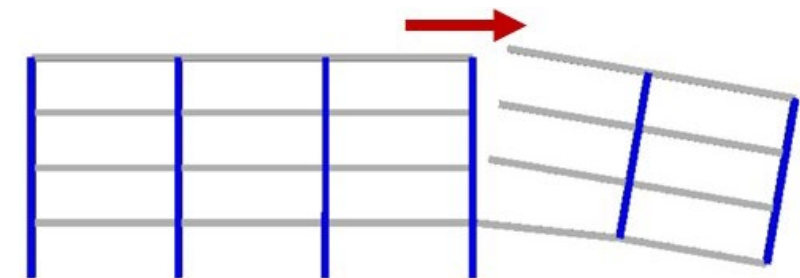
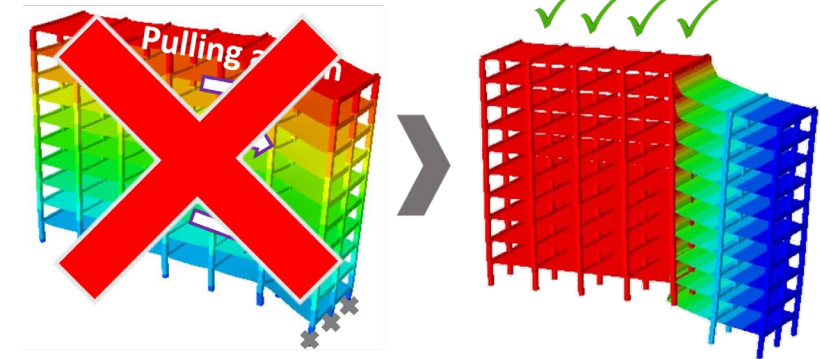
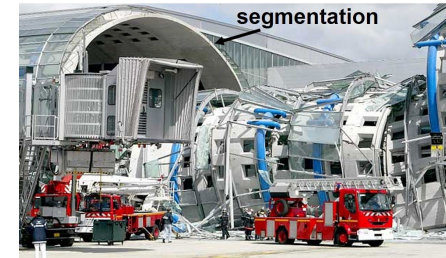


**New research is necessary**



## Endure

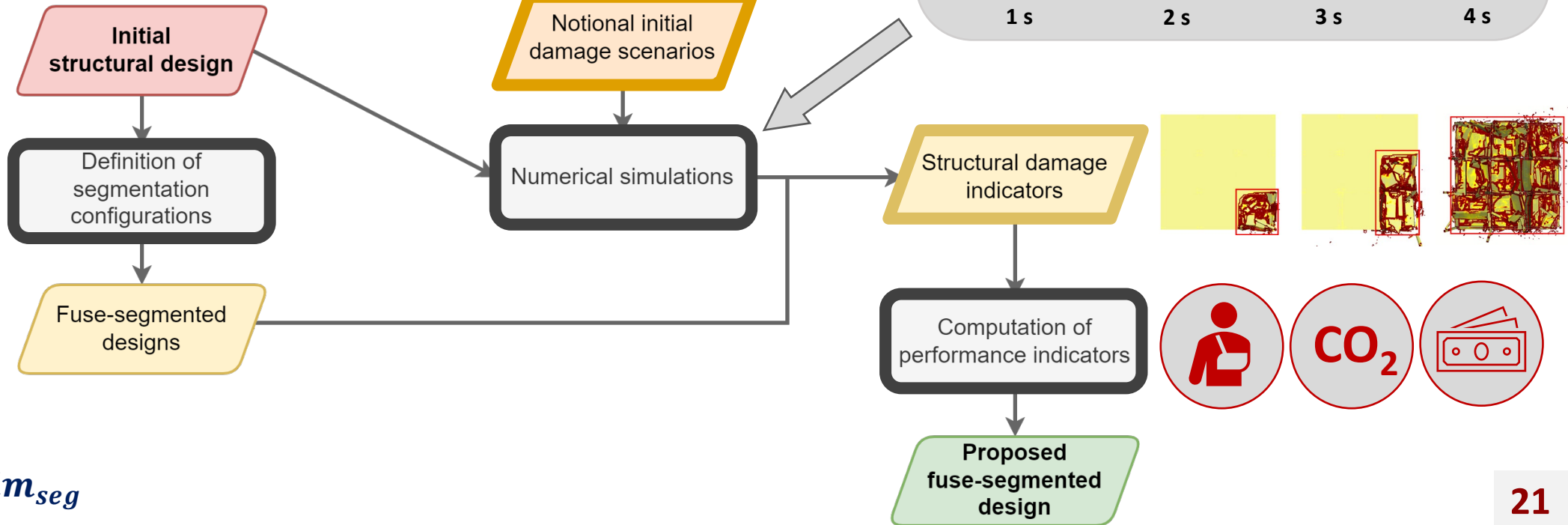
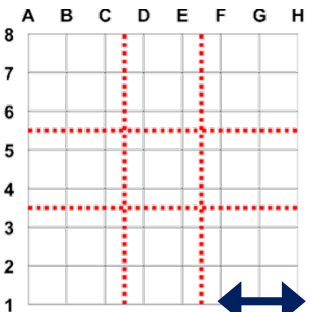
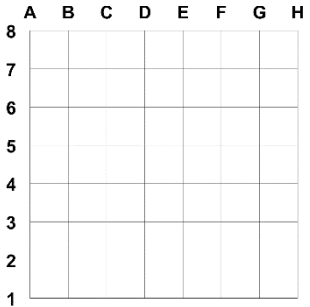
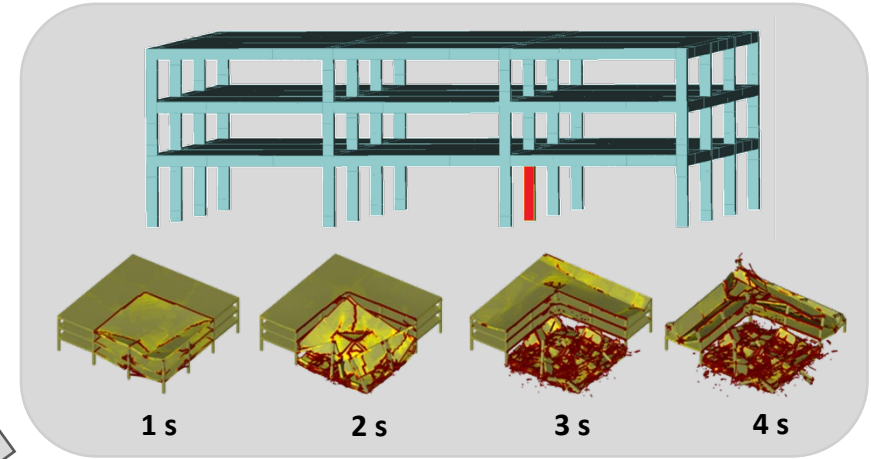
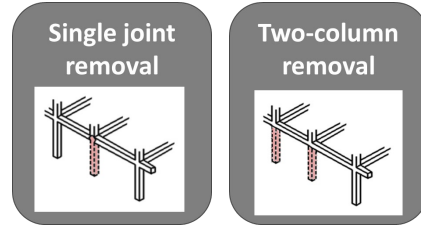
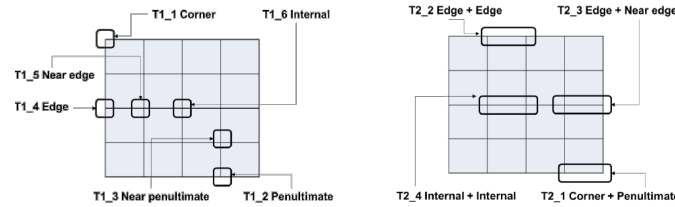
Call	ERC Consolidator Grant 2020
Acronym	Endure
Title	Fuse-based segmentation design: Avoiding failure propagation in building structures
Budget	2.509.375 €
Where	ICITECH - UPV
When	2022-2026



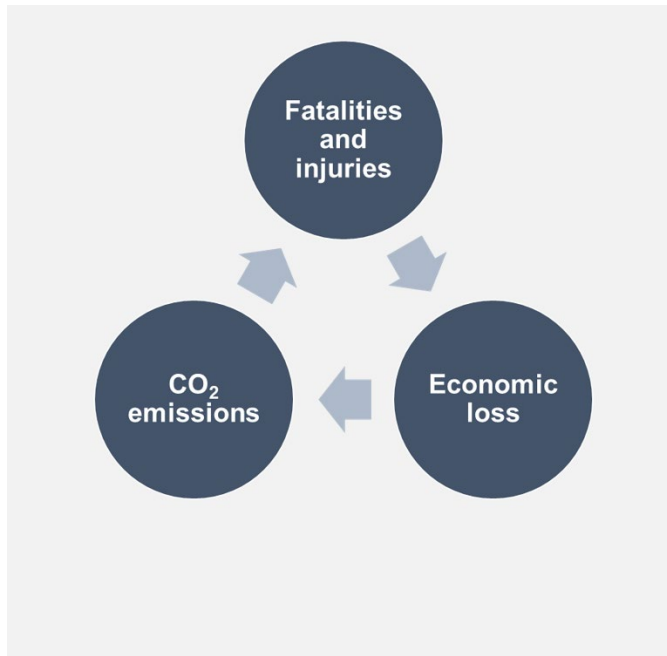
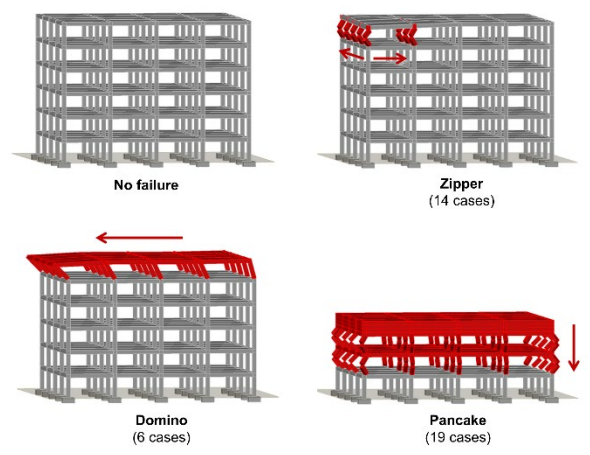
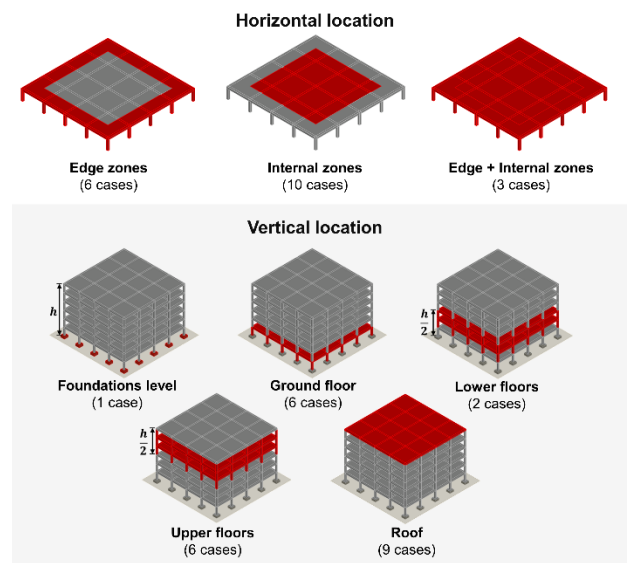
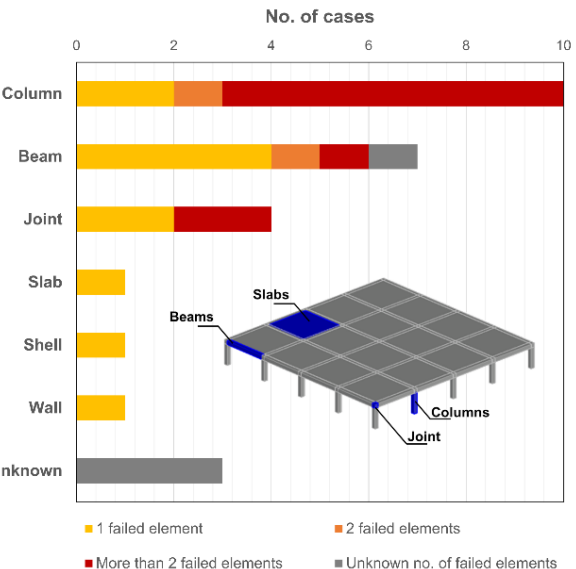
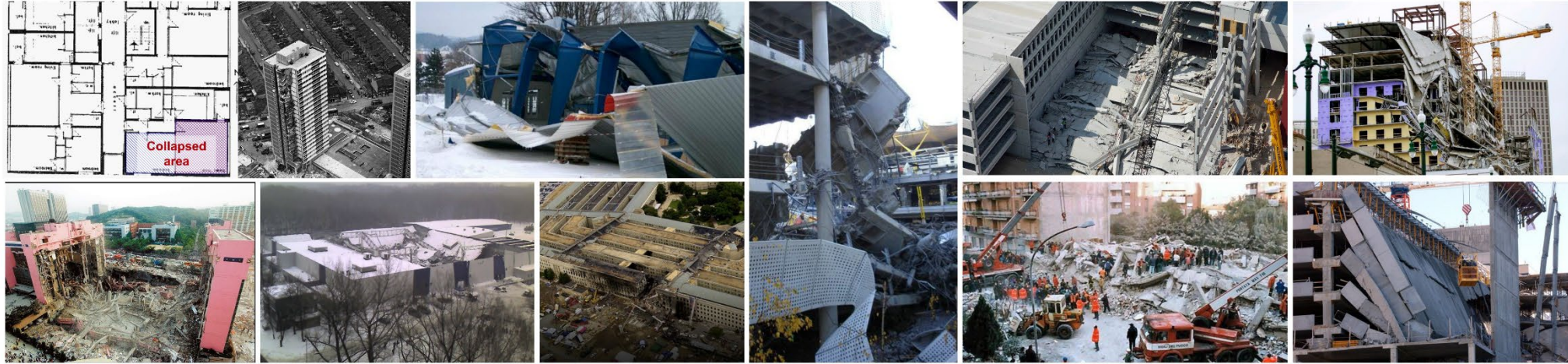
European Research Council  
Established by the European Commission

# A performance-based approach

## Design framework



## Analysis of past failures



# Designing & testing structural fuses

Designing, manufacturing & testing fuses

WP2. Designing, manufacturing and testing fuses

Computational modelling

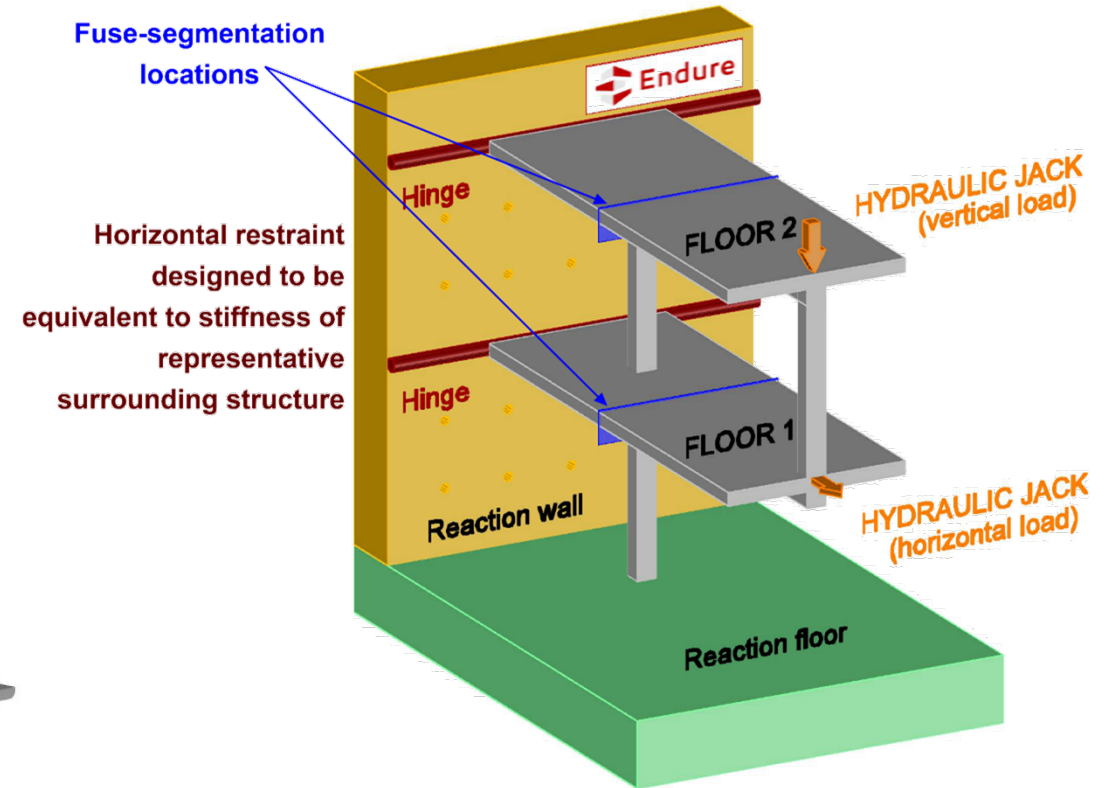
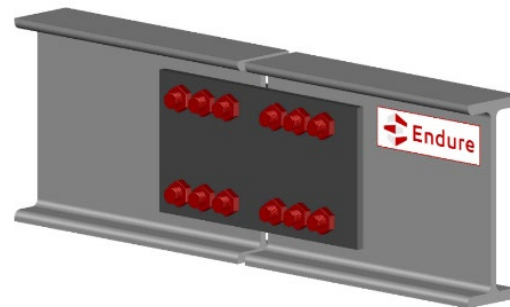


Design and testing

Testing 2D frames



Parametric study





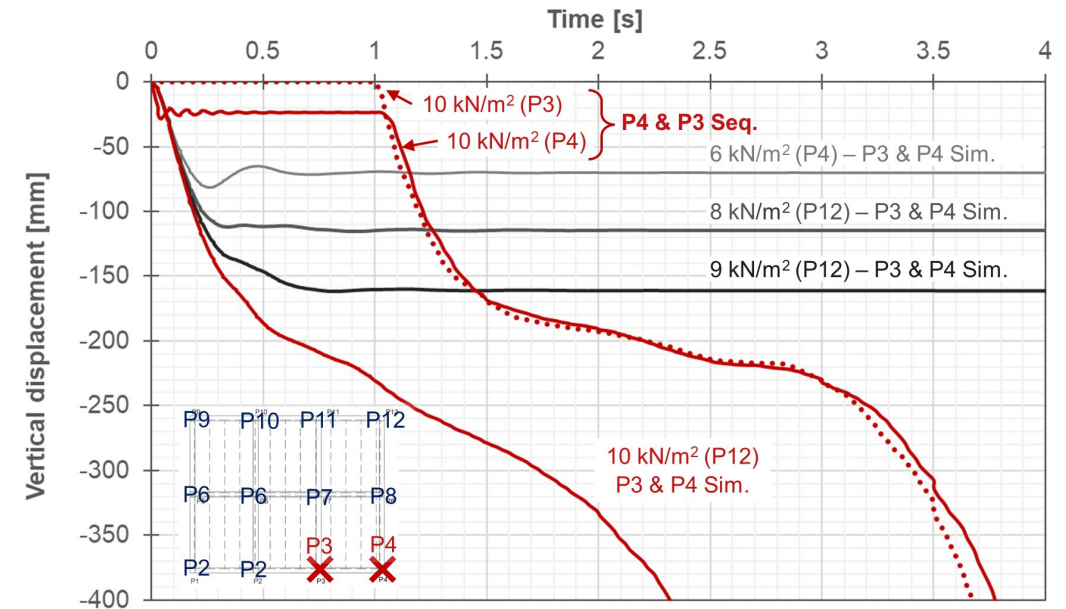
## Implementation & validation in real buildings

### WP3. Implementation and validation-testing on real buildings

Testing buildings

Evaluation

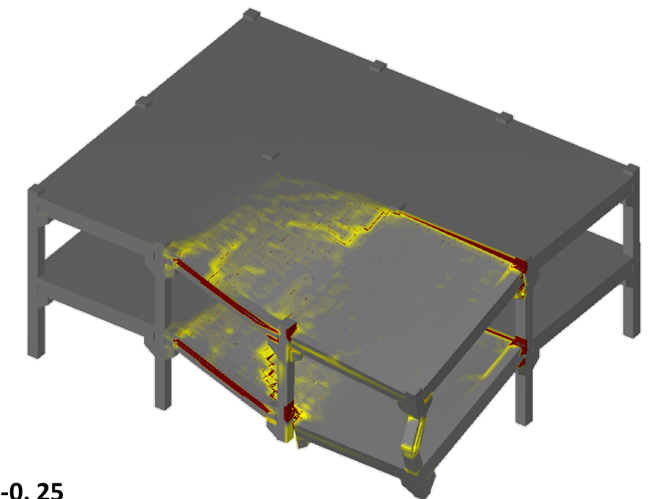
Fuse models



0.25

Principal Normal Strain in I-Dir 1

-0.25



## Acknowledgements



**European Research Council**

Established by the European Commission

This presentation is part of a project (Endure) that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 101000396)



# Thank you



<https://b-resilient.webs.upv.es/>

