

Group 2A

Real-time damage evaluation system for buildings

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Objectives of G2A

2A.1 Develop a safety limit evaluation method for Peruvian buildings

2A.2 Develop a real-time hospital building damage evaluation system

We hold online group meetings monthly.

Members

- Japan side
 1. Koichi KUSUNOKI
 2. Masaomi TESHIGAWARA
 3. Tomohisa MUKAI
 4. Yo HIBINO
 5. Yusuke MAIDA
 6. Chen CHEN
 7. Zelin WANG
 8. Muñoz Flores Andre
- Peru side
 1. ZAVALA Carlos
 2. DIAZ Miguel
 3. REYNA Roy
 4. AYALA Maximo
 5. MOSCOSO Edisson
 6. LAVADO Luis
 7. HONMA Claudia
 8. FLORES Erika

Once earthquake happen...



Rapid Inspection is needed

- After an earthquake...

Residual seismic capacity should be evaluated

Without adequate residual seismic capacity

To reduce enormous harm due to an aftershock

With adequate residual seismic capacity

To reduce the number of refugees



Present situation of the quick Inspection

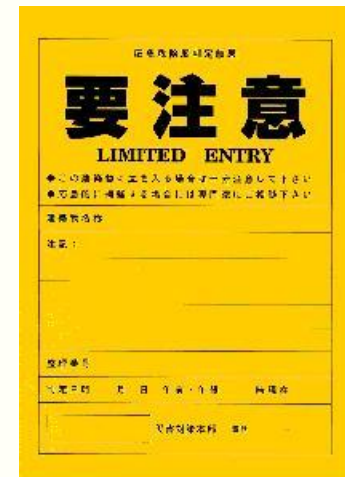
- Investigated by visual observation by engineers...

It needs many days to investigate

19 days for 46,000 buildings with 5,068 engineers

Many “Limited Entry” judgment

The judgment can vary
according to engineers' experiences



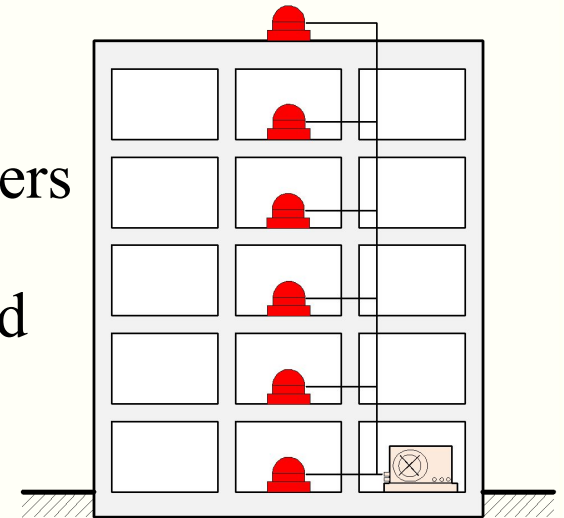
New damage classification system

Performance and demand curves are measured

Place few inexpensive accelerometers

Derive displacement from measured acceleration

Evaluate by comparing these curves



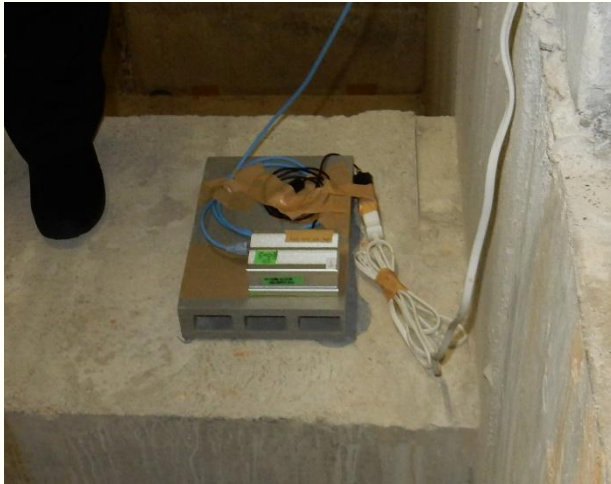
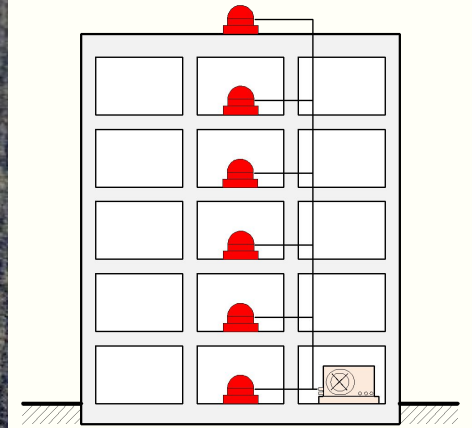
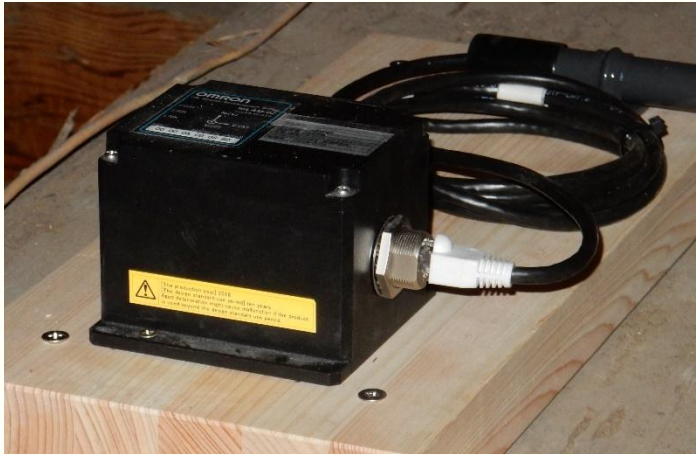
Simplified SHM

It is worth to apply

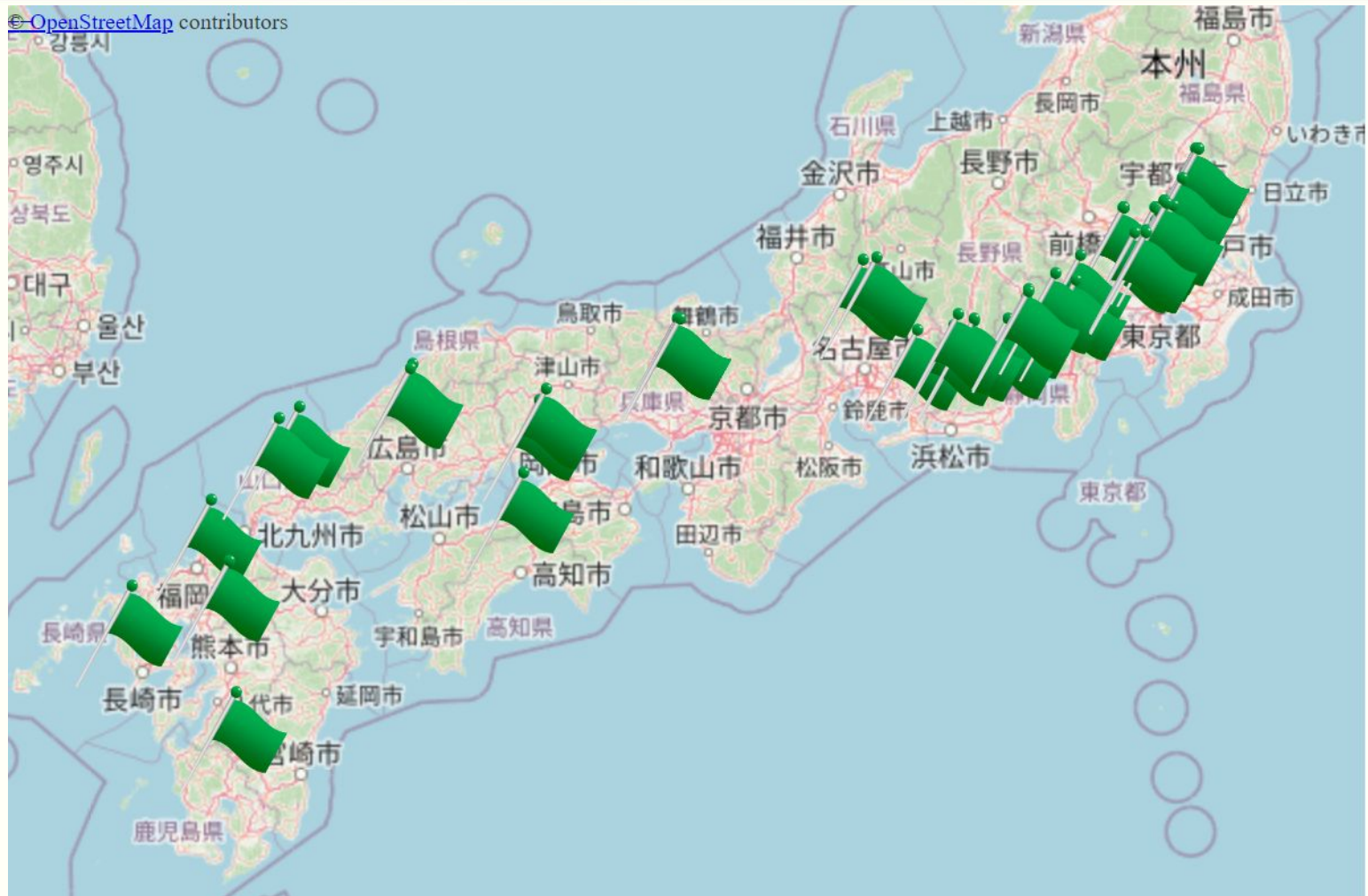
- For example, concern of the high-rise building owner is “business continuity”.
 - “Elastic or non-elastic” evaluation is the most important for owners
 - If it is evaluated as damaged, the damage level somehow does not interest them.
- Shelter needs to be evaluated its safety quickly.



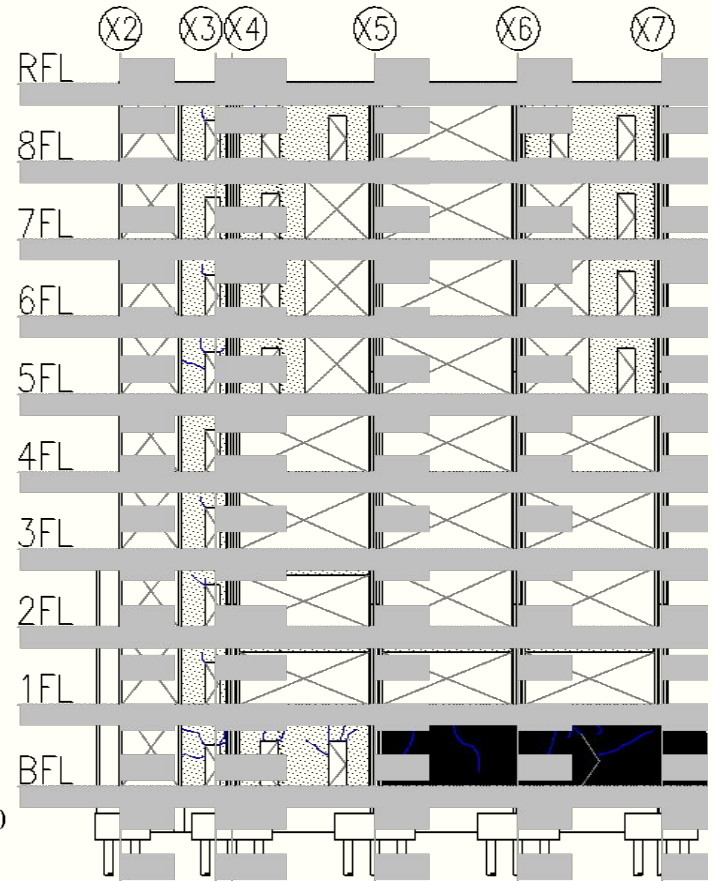
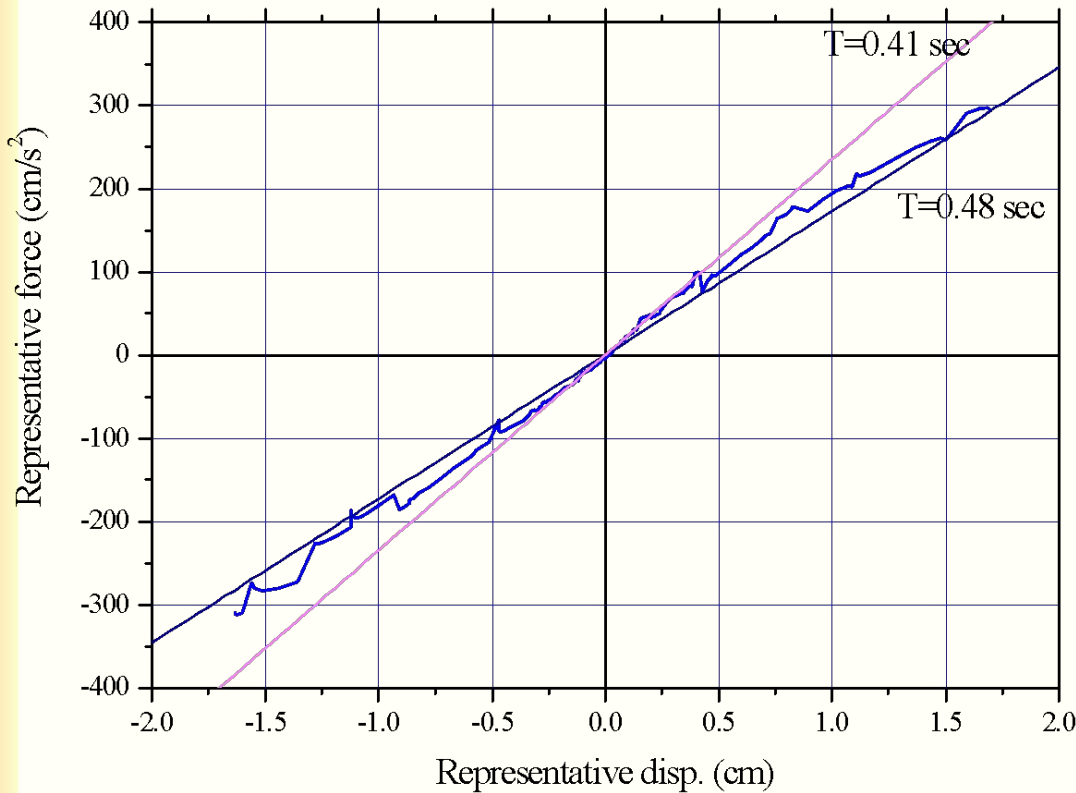
Place sensors in the buildings



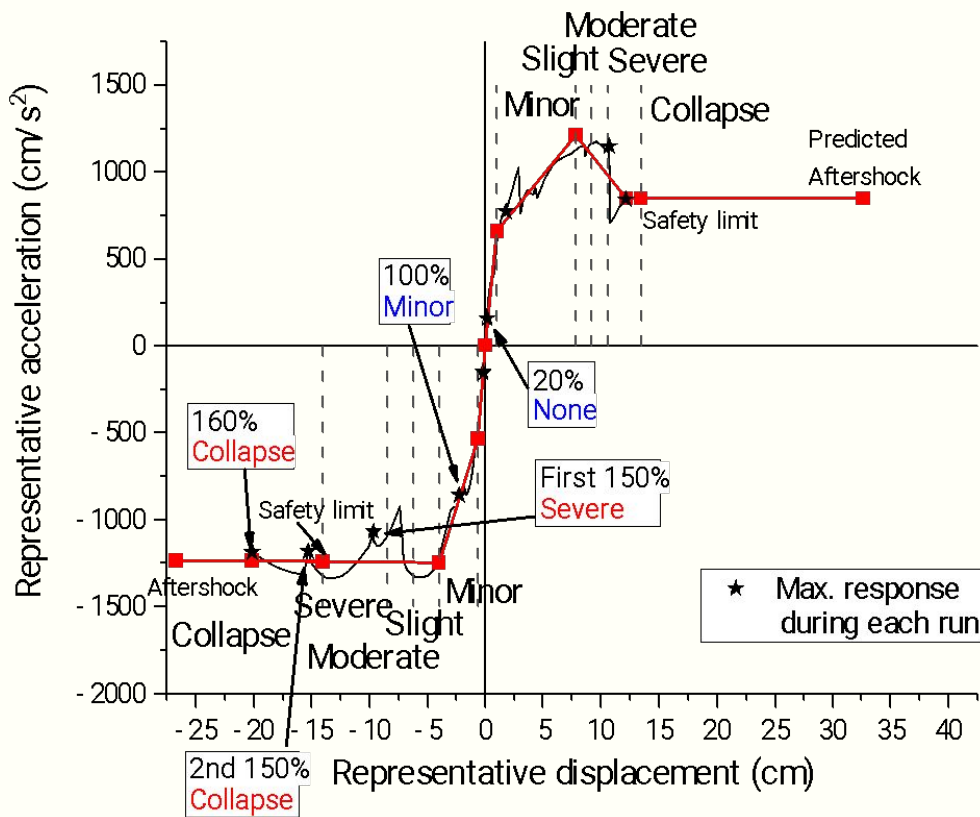
Instrumented buildings



Example: The 2011 Tohoku EQ.

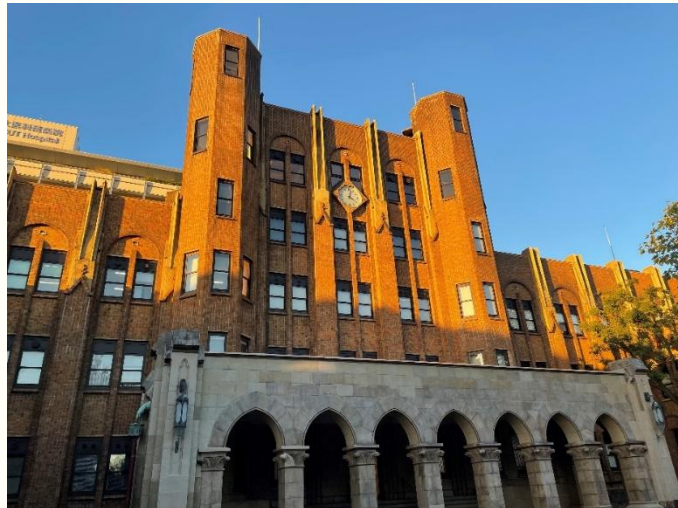


Example: Shaking Table Test

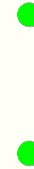
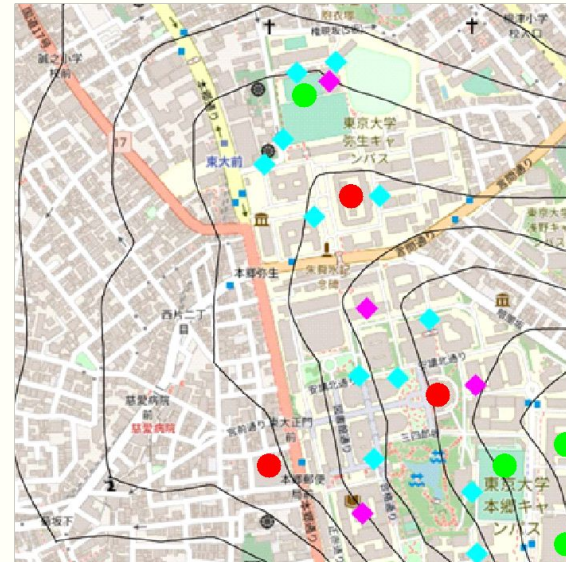
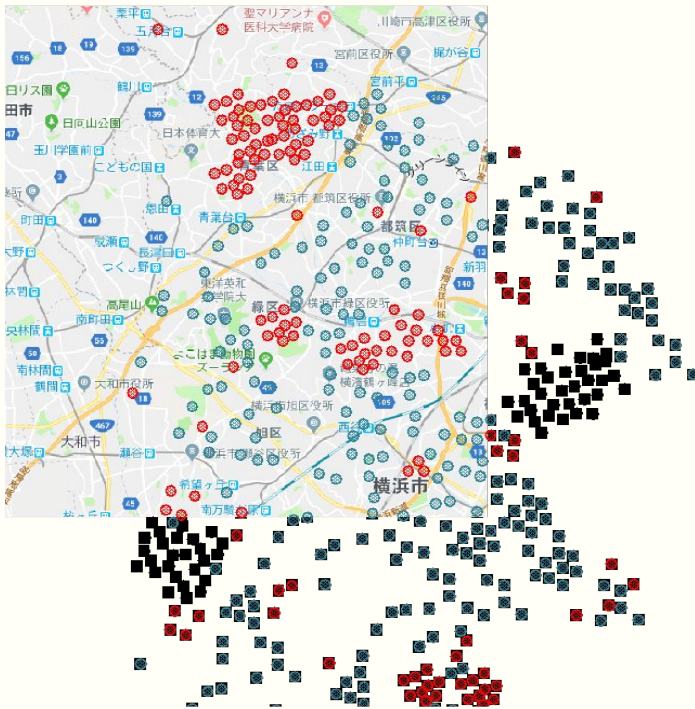


Schedule

- New inexpensive sensor will be tested to evaluate its capability.
- Select the target buildings and collect the building information.
- We also continue instrumentation in Japan, as well.



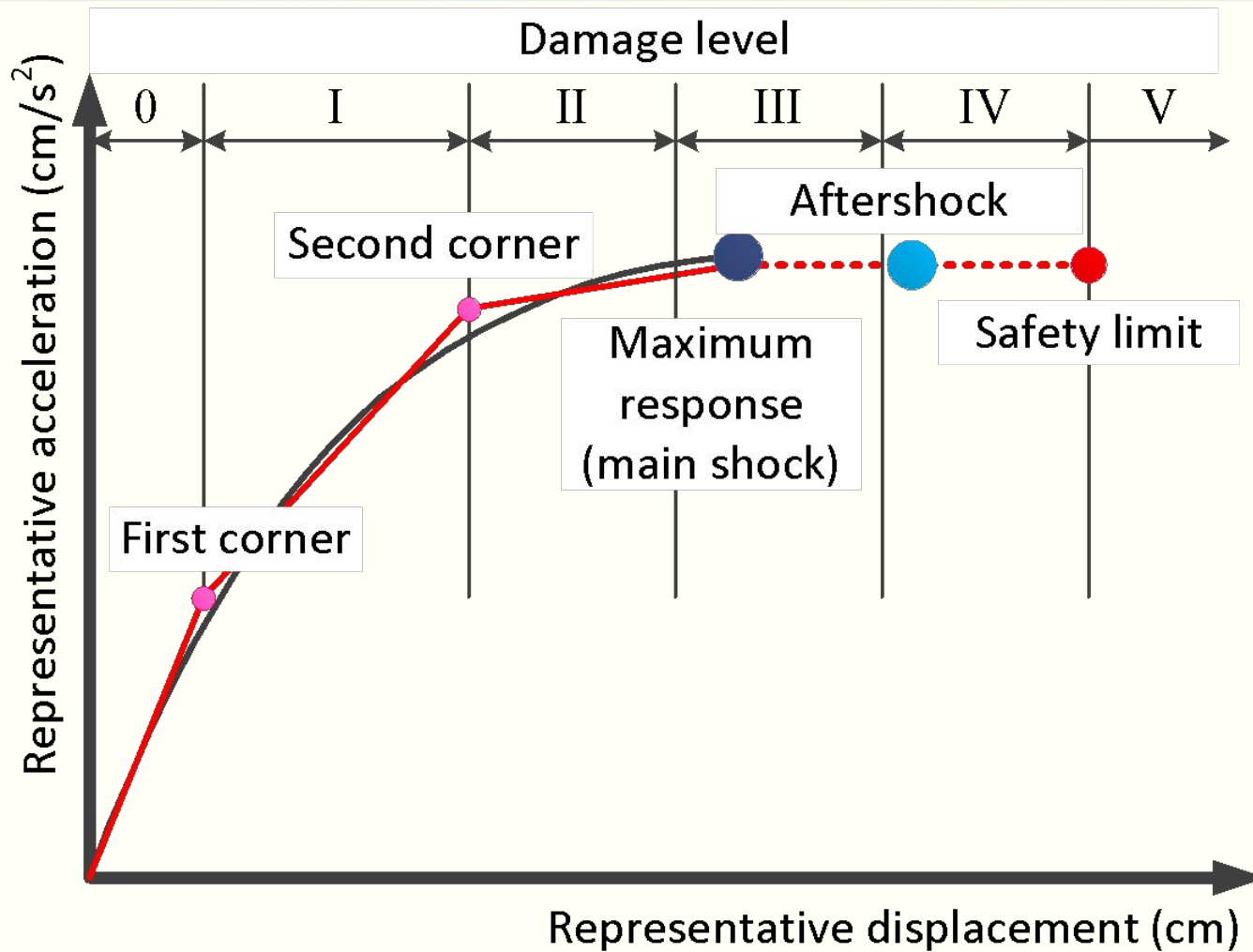
Countermeasure tool



Grasp the damage distribution

With detailed PGA contour

Damage classification w/ SHM



Buildings

- **Target Area Districts:** *Barranco, Chorrillos, Villa El Salvador, Santiago de Surco, San Juan de Miraflores, Villa Maria del Triunfo*



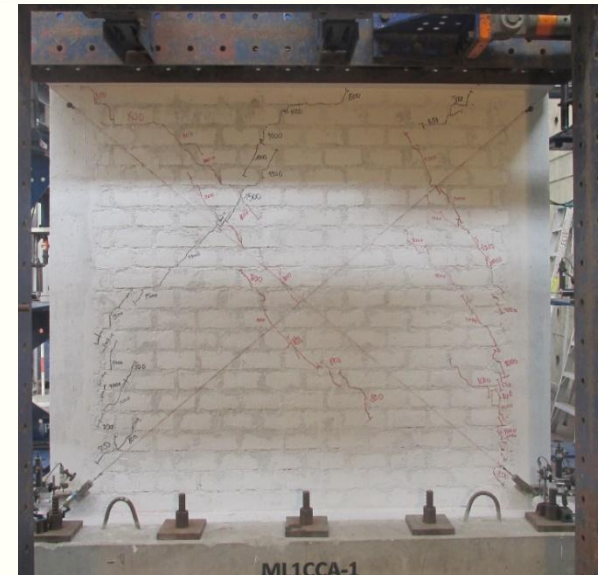
Buildings

- **Target Area Districts:** *Barranco, Chorrillos, Villa El Salvador, Santiago de Surco, San Juan de Miraflores, Villa Maria del Triunfo*

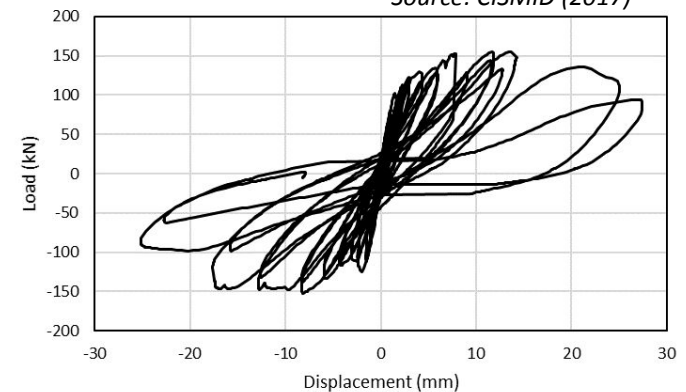


Database

- A database of the experimental tests conducted all over the world is developed to investigate how much deformation Peruvian buildings can sustain.
- Confined non-reinforced masonry walls with clay bricks
 - Industrial bricks (19 walls)
 - Handmade bricks (9 walls)
 - Tubular bricks (7 walls)
- Cyclic lateral load with constant axial load tests of 35 masonry walls.



Source: CISMID (2017)



Schedule

- Analyze bending and shear behavior step by step.
- Improvement of capacity curve analytical model.
- Apply the developed method to typical masonry buildings and predict its safety limit state.

Week	Mar				Apr				May				Jun				Jul				Aug				Set				Oct				Nov				Dec				Jan			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Strenght and Deformation eq. Fitting	█	█	█	█																																								
Analysis of results																																												
Gathering of building plans																																												
Building modeling & analysis																																												
Analysis of results																																												
Thesis writing																																												
Preliminary review																																												
Correction																																												

We will start instrumentation this year!

Install sensors to COEN-INDECI



We will start installation to other buildings soon..



We should protect the next generations, our history, cultures, and buildings from earthquakes!