1st Peru-Japan Workshop on Enhancement of Earthquake and Tsunami Disaster Mitigation Technology

The Role of Innovation in Reducing the Regional Seismic Risk in Latin-America

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Background

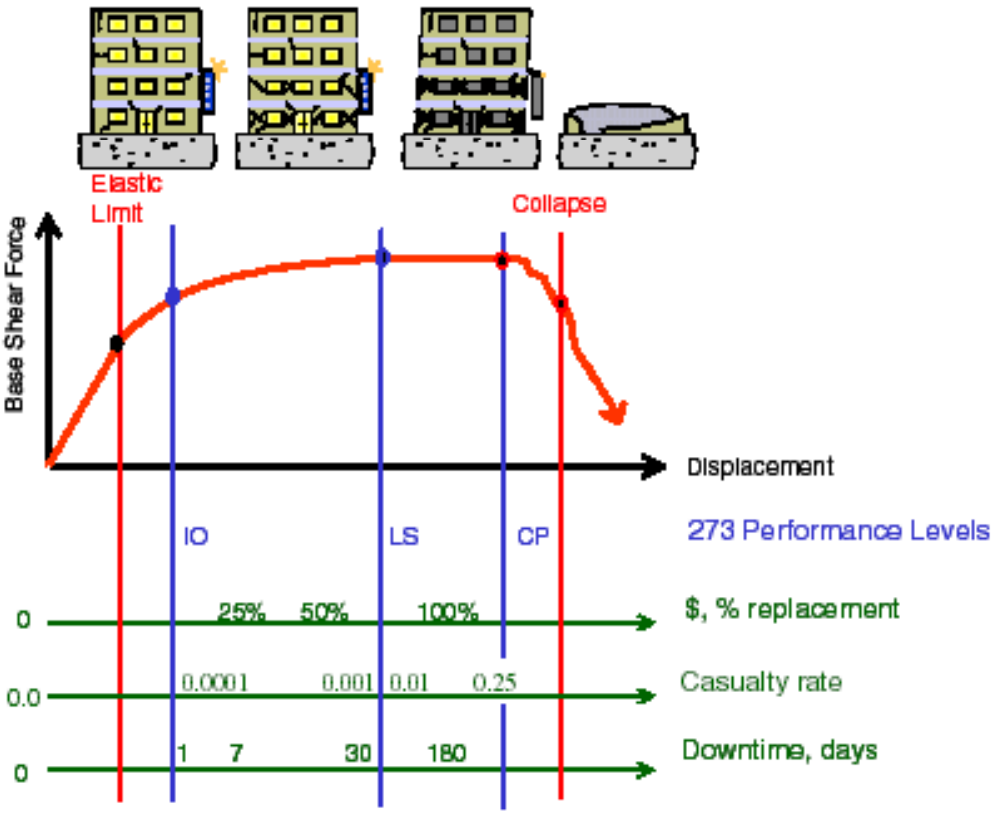
The many urgent problems faced by Latin-American countries drain their energy away from the formulation and development of innovative and efficient structural solutions for earthquake-resistance.

Innovation on Seismic Resistance: Damage Control

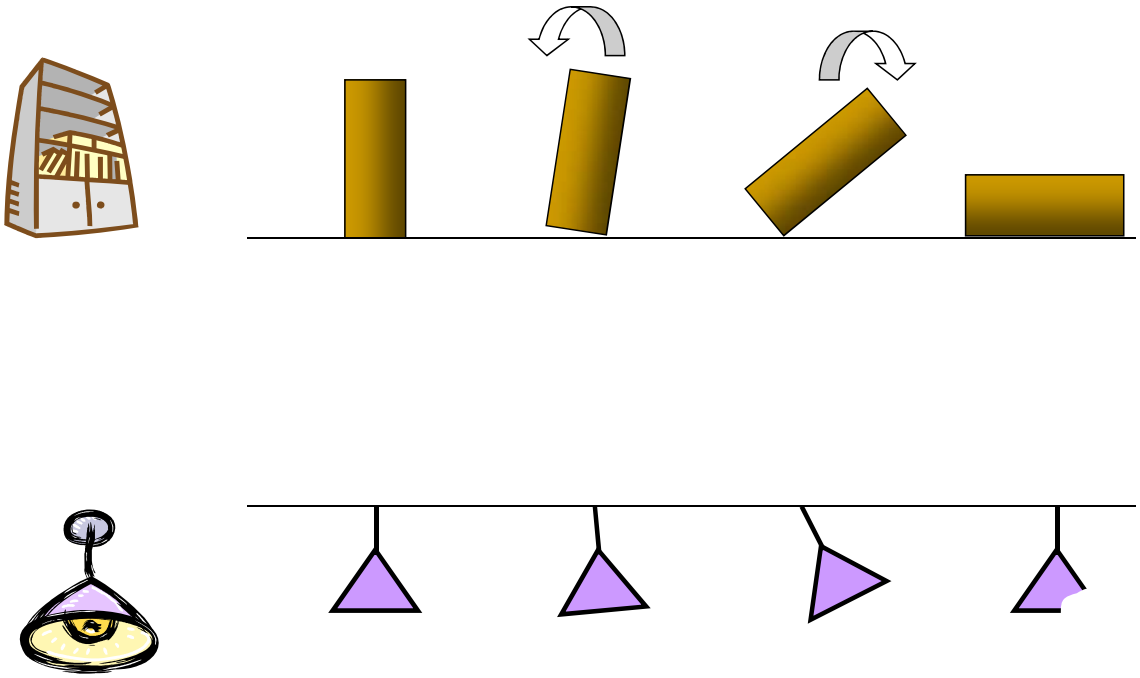
The level of damage suffered by the structural and non-structural elements, as well as the contents of earthquake-resistant buildings depends on their displacement, velocity and acceleration demands.

A lower level of response implies a lower level of damage.

Structural and non-structural damage control requires displacement-control



Contents damage control requires velocity and acceleration-control

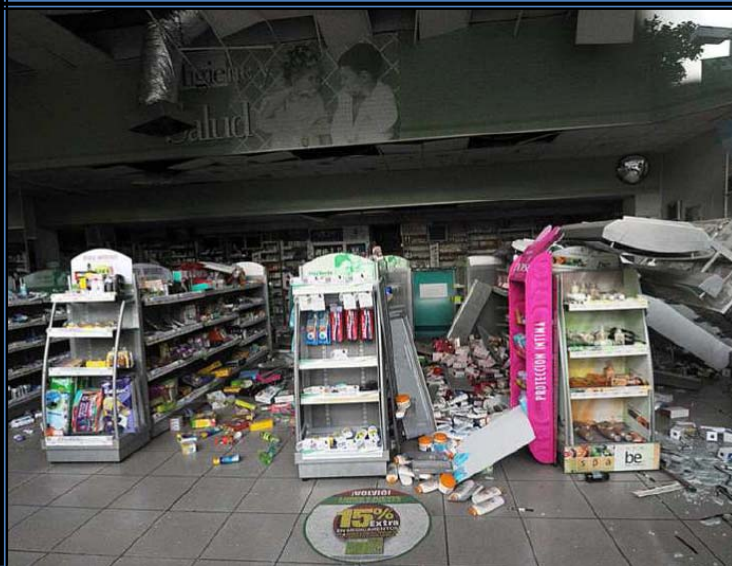


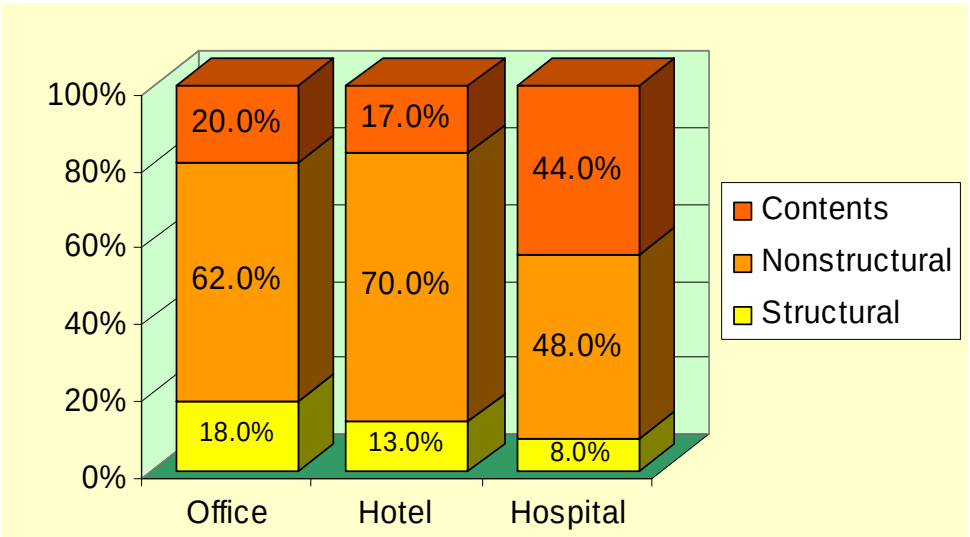
Mexico

United States

Taiwan

Chile





After Miranda and Taghavi

The economic losses due to damage to contents can be significant.

Innovation in terms of earthquake resistance implies that the structural properties of a building need to be designed in order to control, within acceptable economical and technical constraints, the dynamic response of that building during the design seismic input (ground motion).

World-wide Tendencies

Do more with less…

NORTHRIDGE 1994

Recently, American experts estimated that braced frames concentrate 40% of the comercial steel market in California. This system accounted for less than 10% of the market a decade ago (Uriz and Mahin).

Since 1999, approximately 70% of the buildings built in Japan with heights larger than 60 meters have been designed according to the concept of damage tolerant structure (Wada, Huang and Bertero).

KOBE 1995

SUSTAINABLE STRUCTURAL ENGINEERING

Hearst Tower

(diagrid)

20% Less weight

90% Recycled material

What about Latin-America?

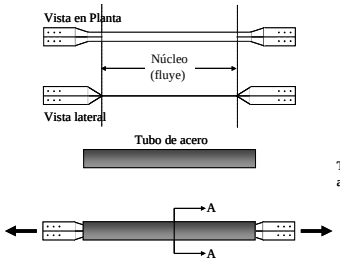
Do more with less…

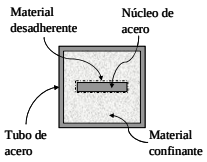
Within a context of sustainable development, Latin-Americans need to be capable of designing and building earthquake-resistant structural systems that are or have:

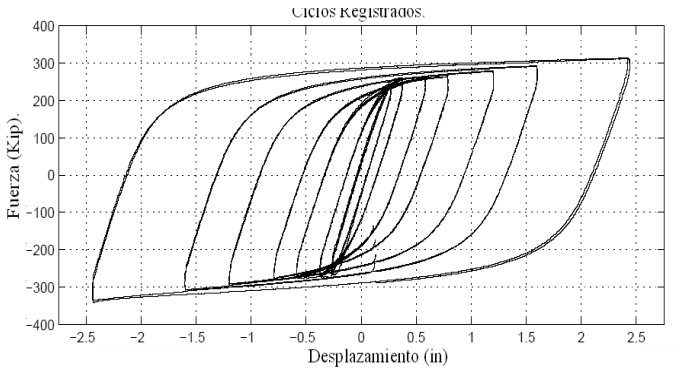
1.Lighter
2.Safer
3.Larger life span

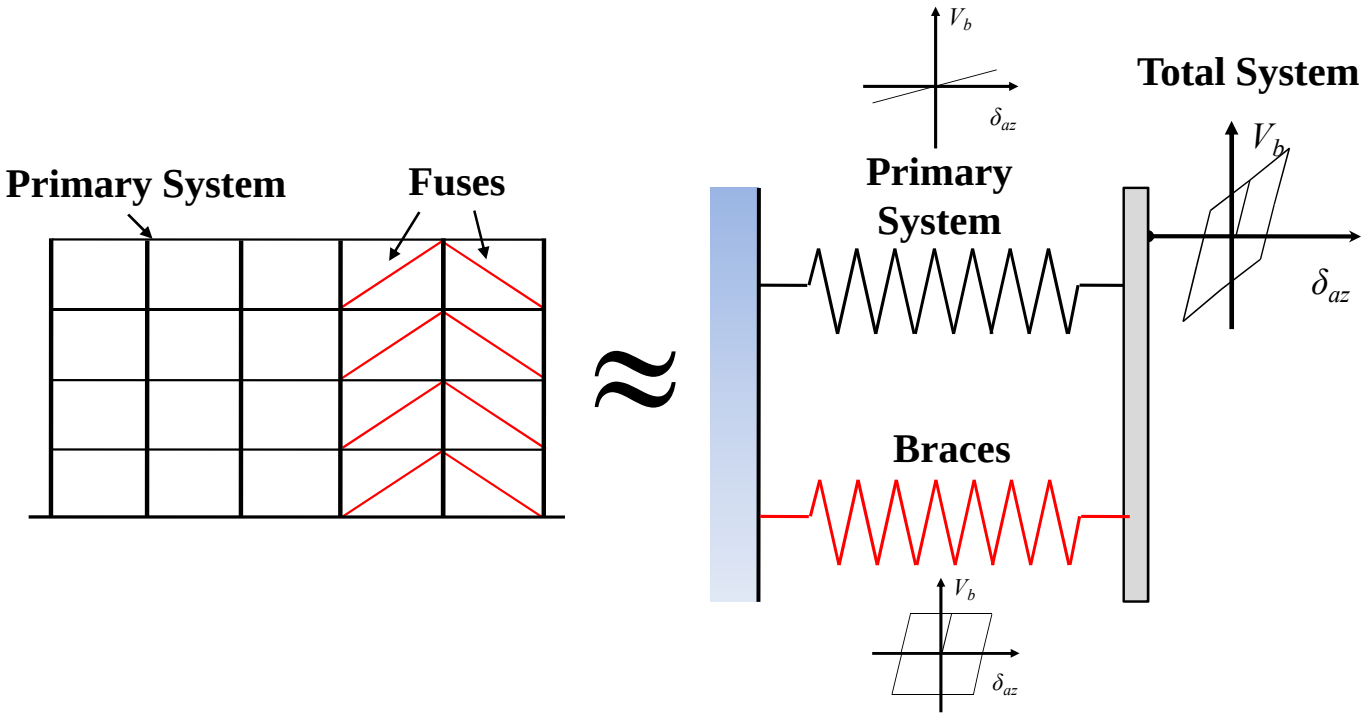
A promising approach to accomplish this is that of *damage tolerant structure*.

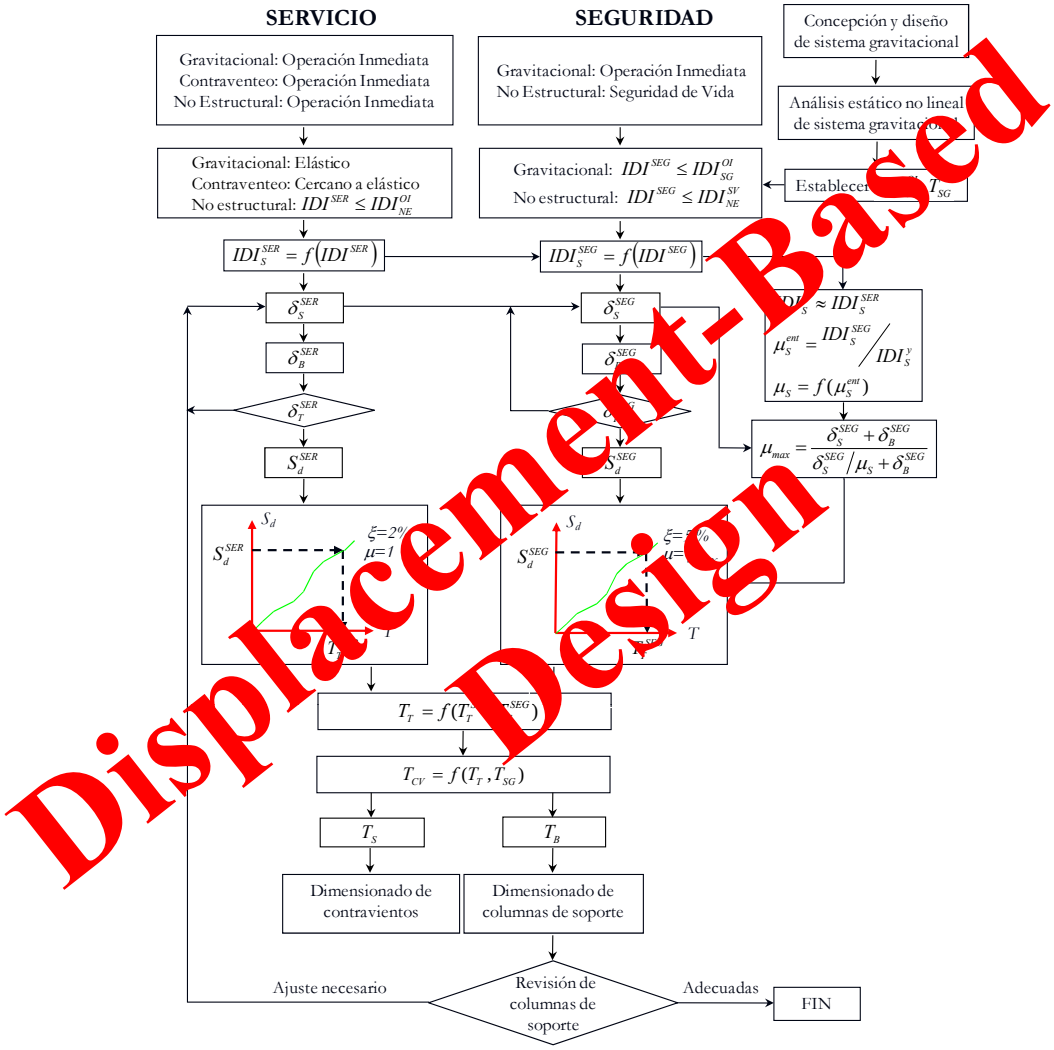
The concept of *damage tolerance* implies that structural damage due to earthquake, which has to be controlled within acceptable thresholds, concentrates in specific structural elements, known as sacrificial elements. Their function is to constitute themselves in structural fuses that protect the primary or gravitational system.

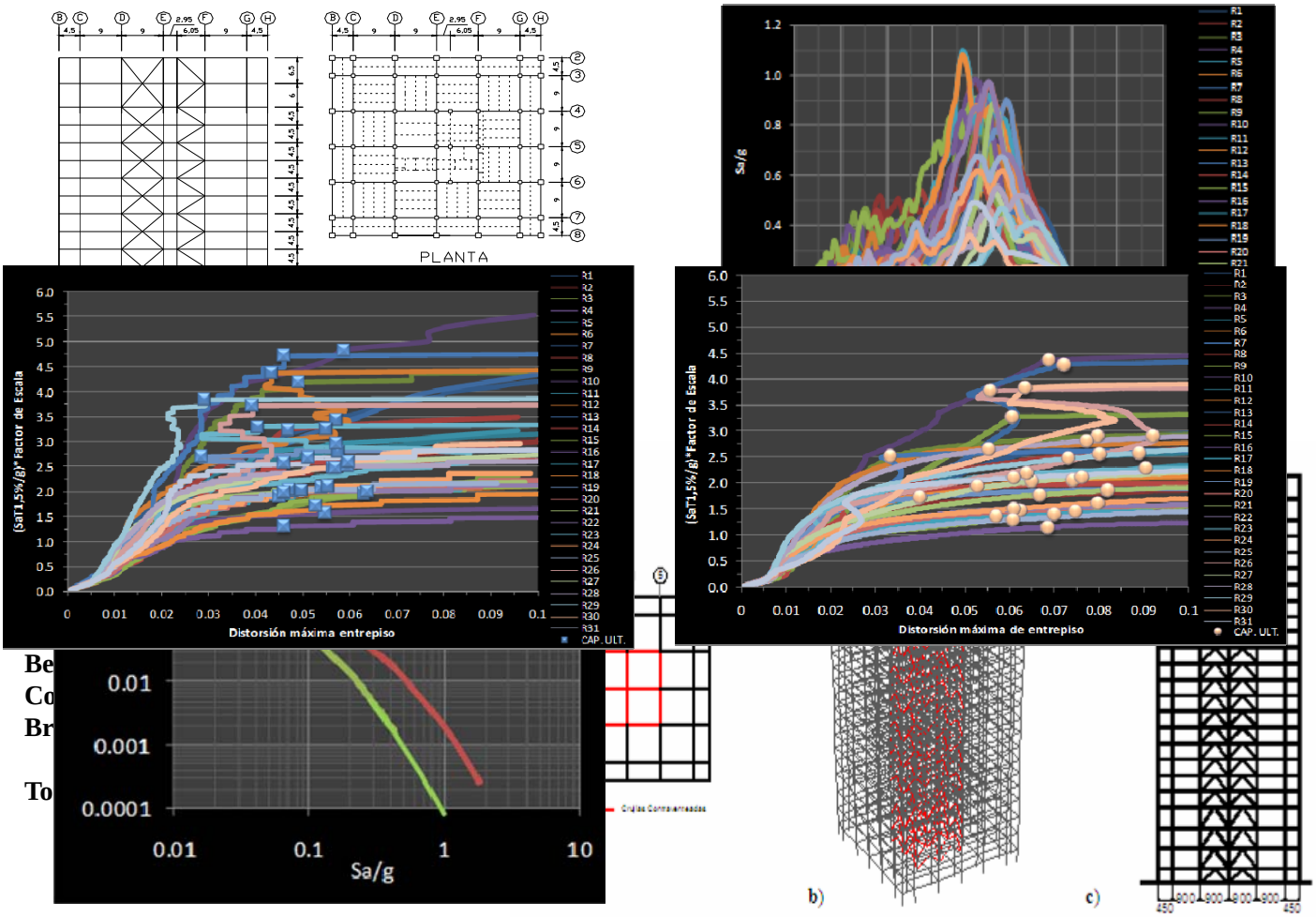












Be
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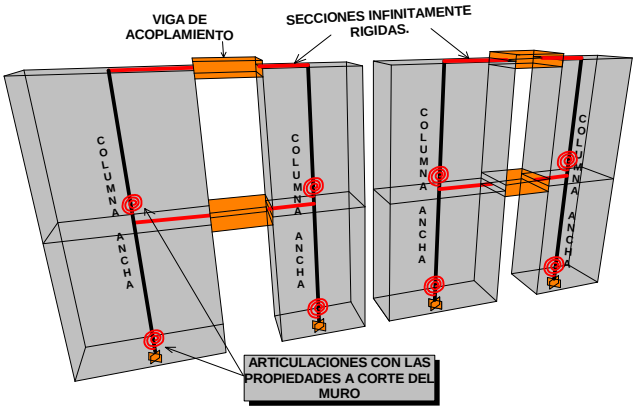
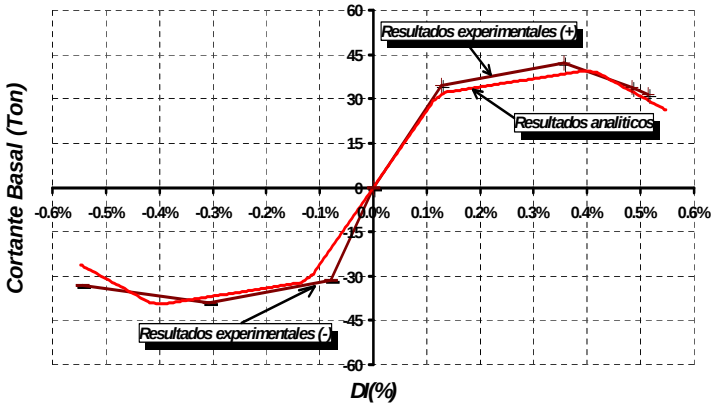
Confidence Levels

Building	Service	Life Safety	Collapse prevention
Innovative	42 %	92 %	99 %
Traditional	7 %	53 %	94 %

Do more with less…

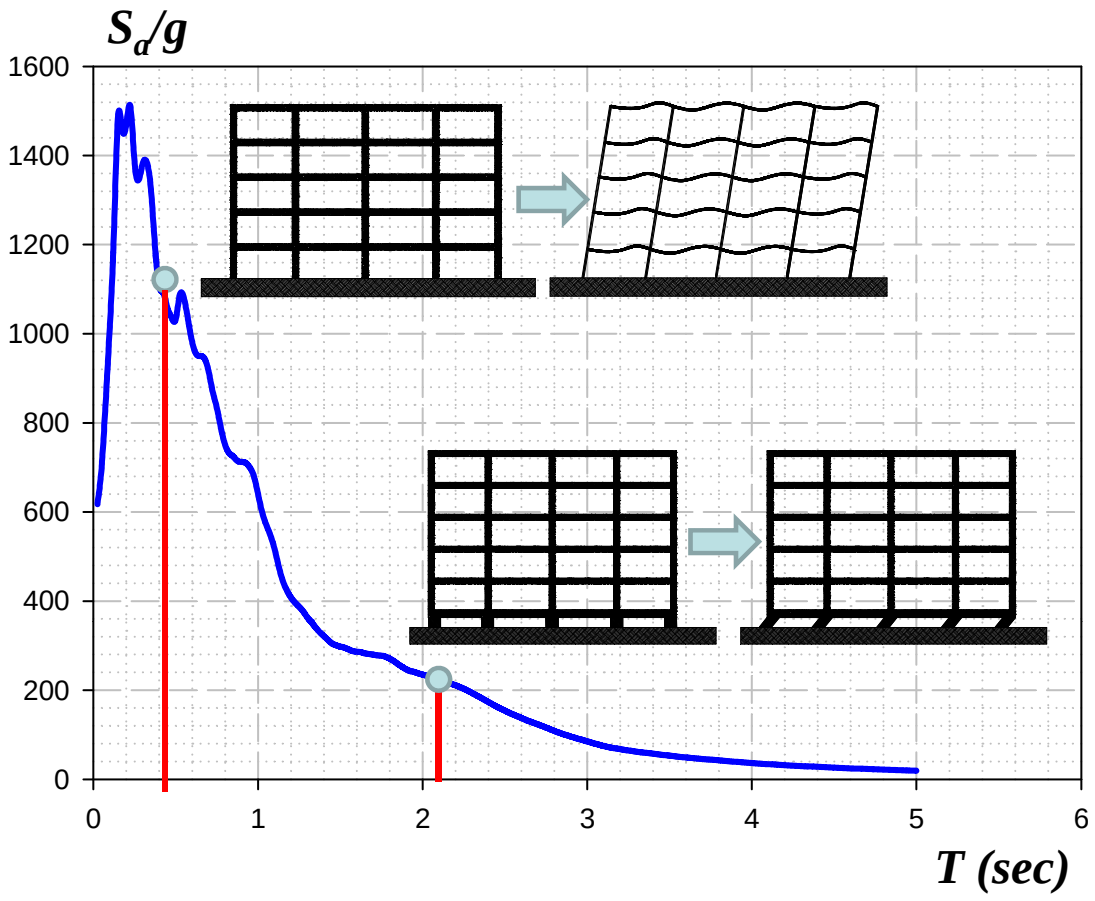
Innovation can be applied to our traditional structural systems!





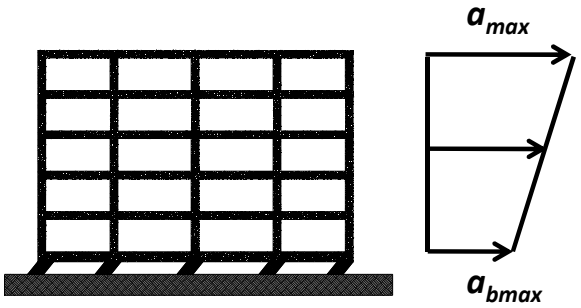
Specimen 3D (Alcocer 1993)

What about contents?
Acceleration-based Design!

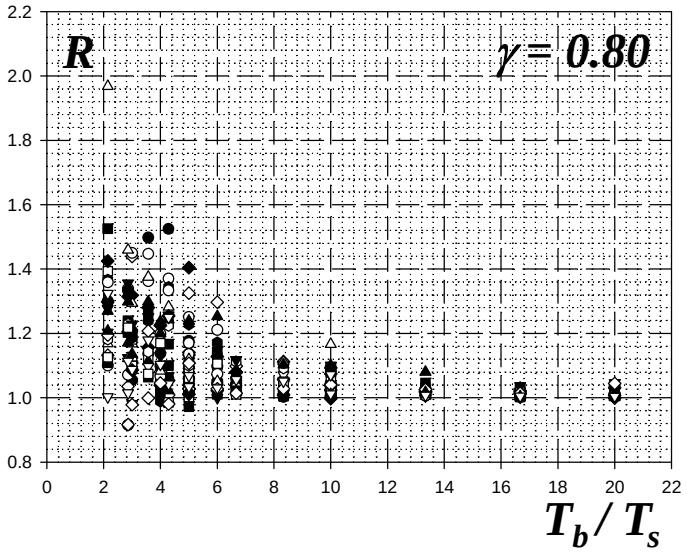


One way to avoid unacceptable damage in contents is to limit the maximum acceleration demands in the super-structure.

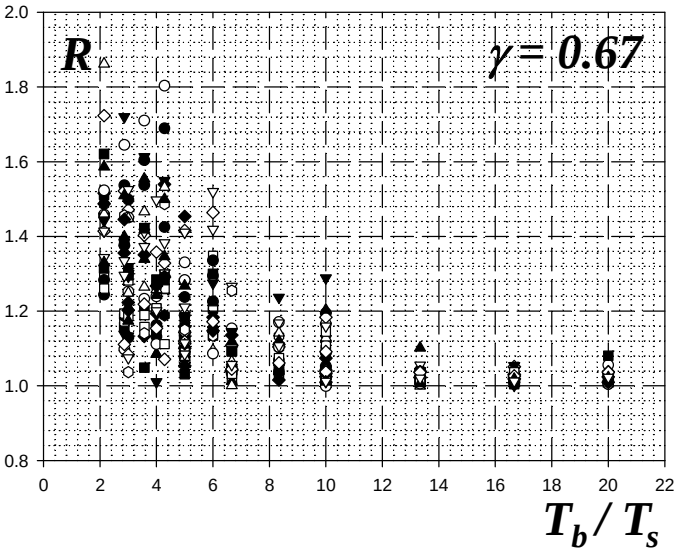
Consider the ratio of the maximum acceleration in the super-structure to that at the base:

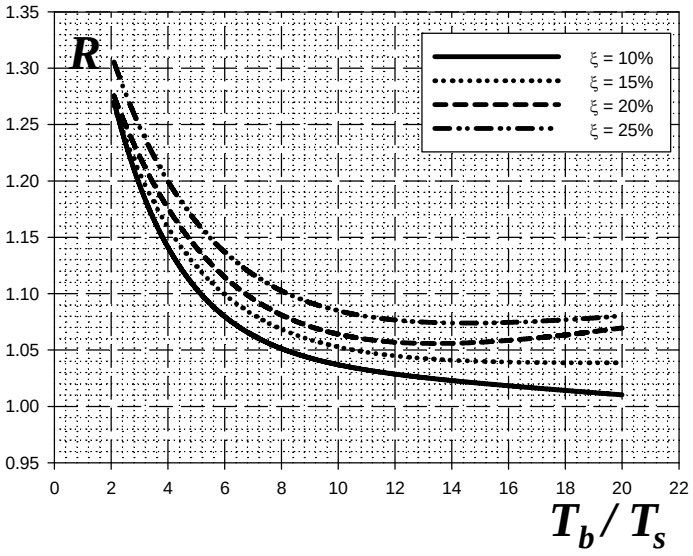


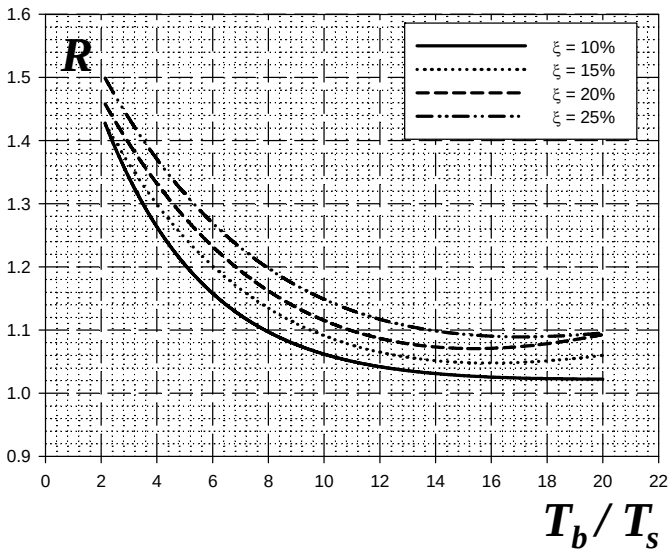
$$R = \frac{a_{max}}{a_{bmax}}$$



4-story base-isolated building

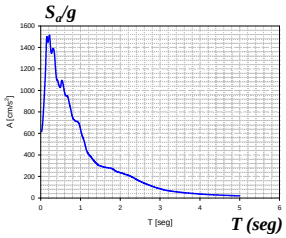


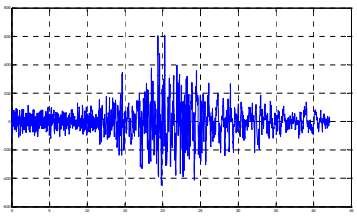




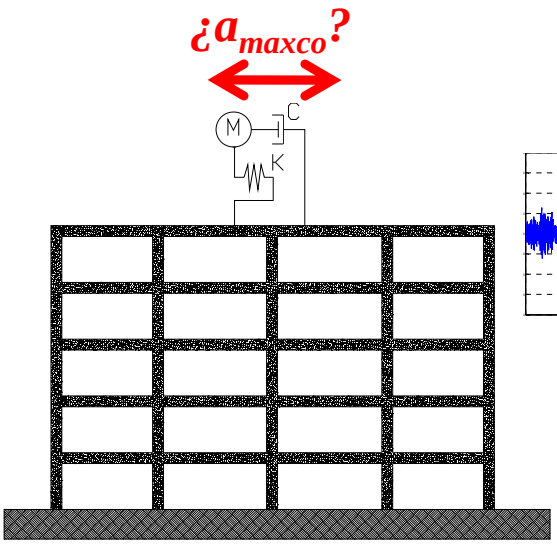
4-story base-isolated building

Acceleration control in contents

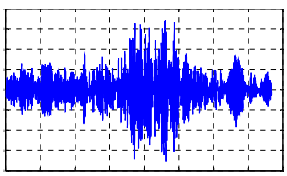




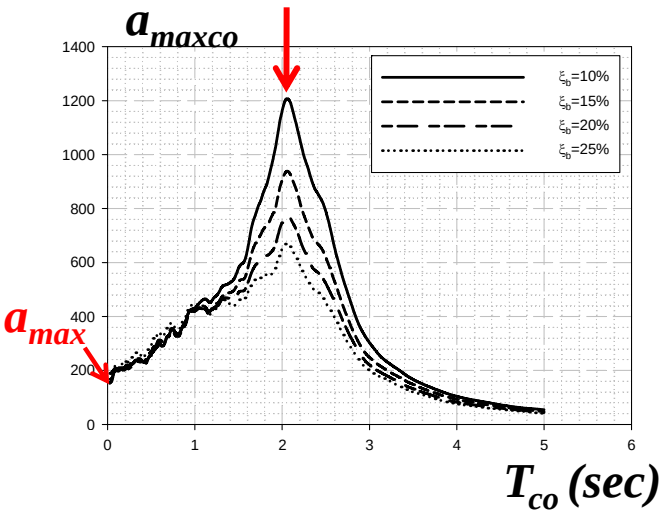
Ground motion



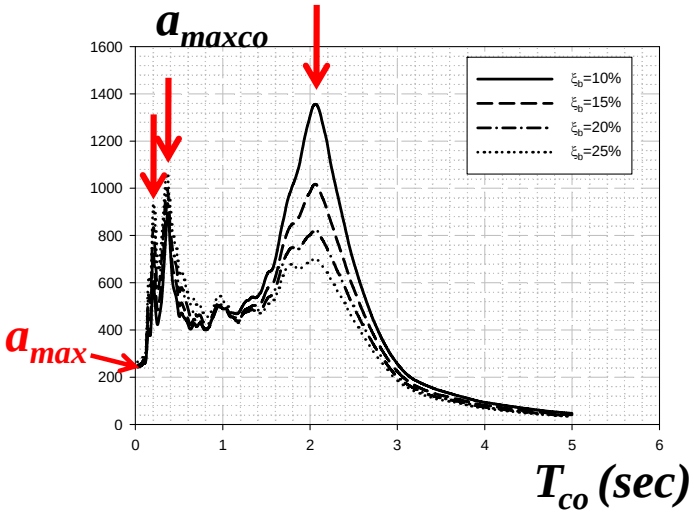
Floor Motion



Rigid super-structure



Flexible super-structure



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Reflection

Latin-Americans need to re-interpret what they have learned in the past with the purpose of changing their future.

It is important to develop new and local solutions to solve the huge needs of our region. We need to develop our technological potential through developing innovative design methodologies and structural systems that yield safe and efficient structural systems.

Latin-America
Technological Development
Sustainable Design