RECENT EARTHQUAKES AND NEW CONCEPTS FOR EARTHQUAKE-RESISTANT DESIGN

Akira Wada

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President, Japan Society of Seismic Isolation

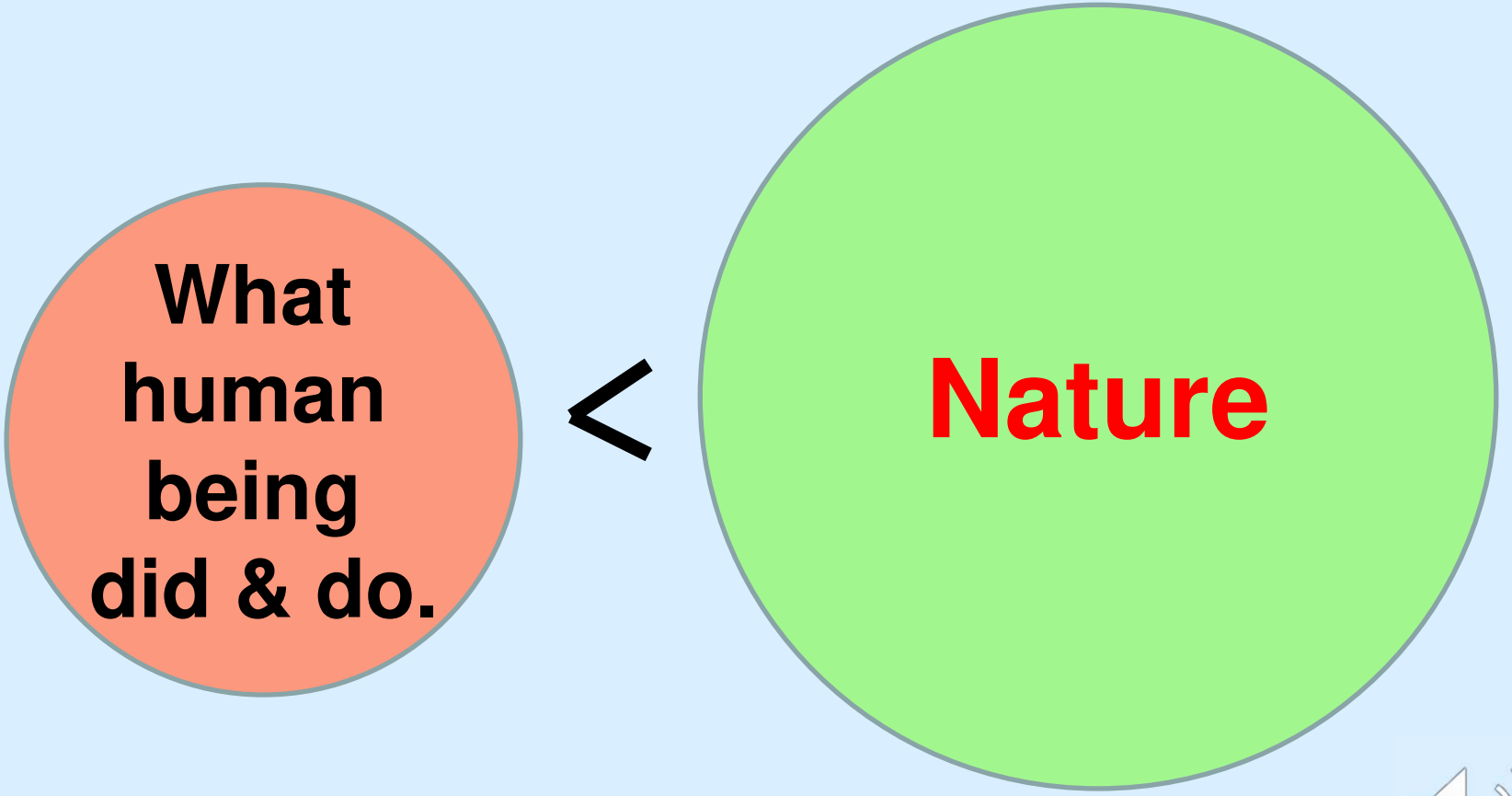
Thank you very much.

I hope to learn many things from Kyrgyz and
We are long friends together.

Before discuss about structures

Fukushima Dai-ichi Nuclear Power Plants

Why natural disasters happen?



Why natural disasters happen?

What researchers & Engineers discussed.

<

Nature

Start to discuss about recent earthquakes

Tainan Earthquake 20160206


清
封
工廠


SK200
KOMATSU
KOBELCO
武益工程行


Kumamoto Earthquake 20160414

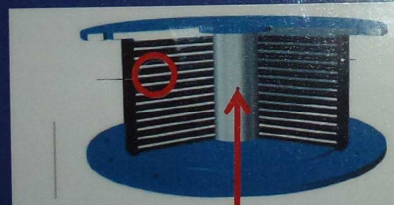

Seismic Isolated Hospital
Maximum displacement is 45cm

■免震装置配置計画

【内部鋼板】
＋
【　ゴム　】

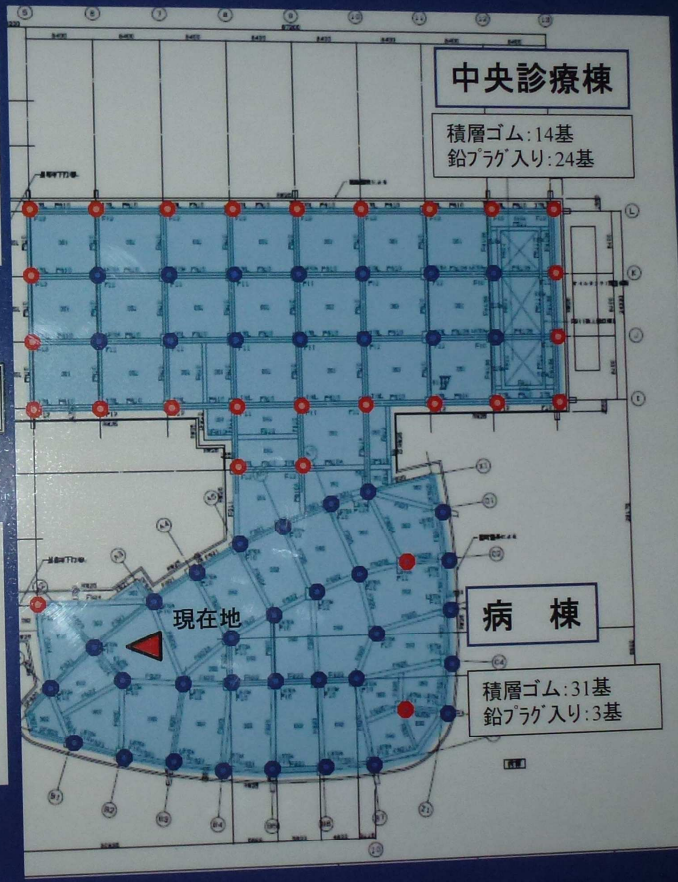
【被覆ゴム】
ゴムで被覆し劣化を防止

● I 70 L　（昭和電線）
積層ゴムアイソレーター

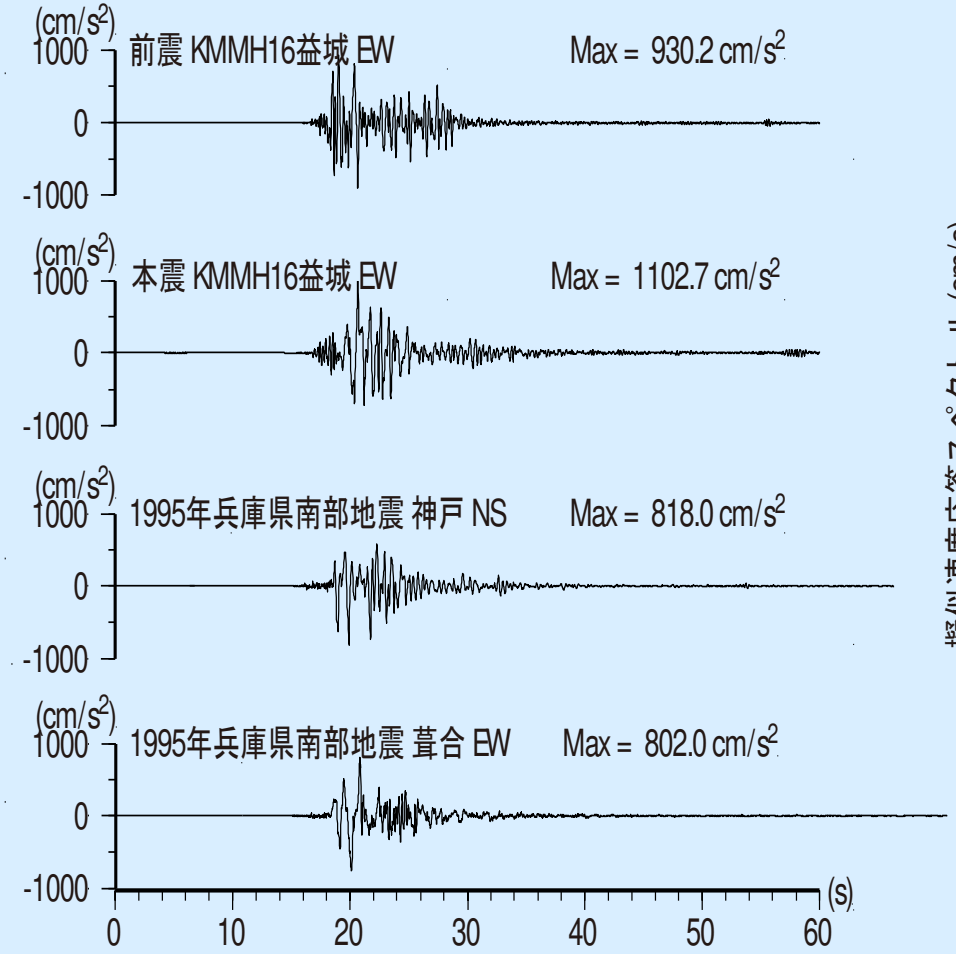


【鉛プラグ】
減衰材料として優れた
特性と耐久性を

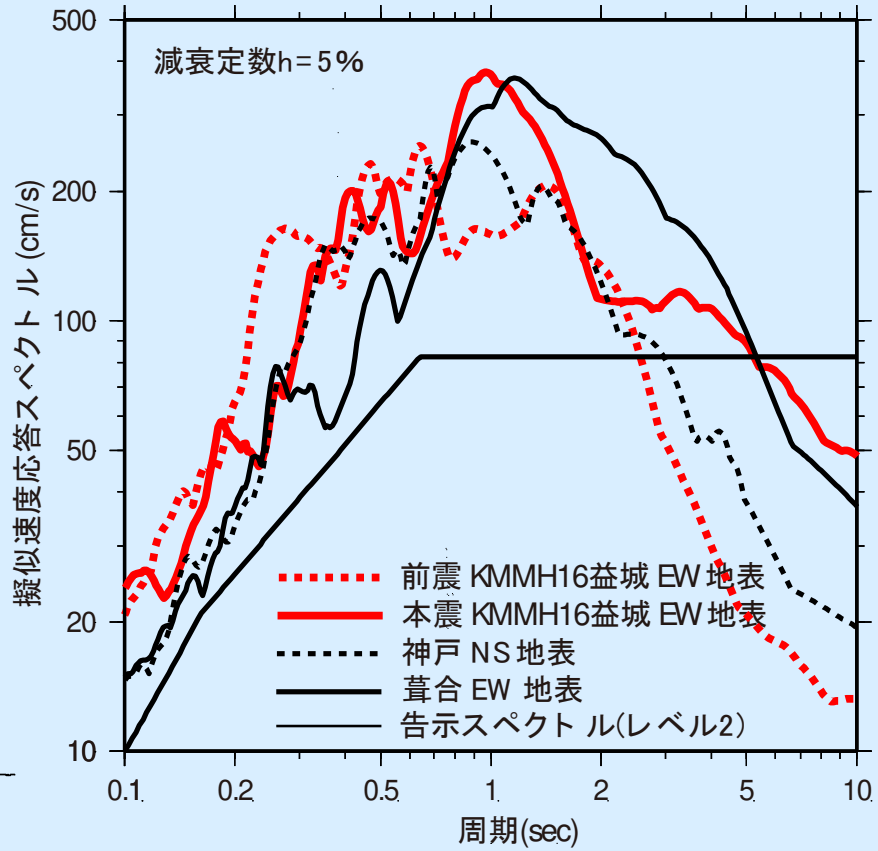
● LB 70 A　（オイレス）
鉛プラグ入り積層ゴムアイソレーター



前震：4月14日21時26分頃に発生したM6.5の地震
本震：4月16日01時25分頃に発生したM7.3の地震



加速度波形



擬似速度応答Spectram


KOBE SHOCKS THE WORLD
On January 17, 1995

Damages of reinforced concrete structure designed by ductile structure concepts defined in 1981 new seismic design codes

Kobe Earthquake 1995

株式会社新井組　１９９５年技術研究報告集より

株式会社新井組　１９９５年技術研究報告集より

Perfectly Demolished after 1995 Earthquake

株式会社新井組　１９９５年技術研究報告集より

East Japan Earthquake at 2011

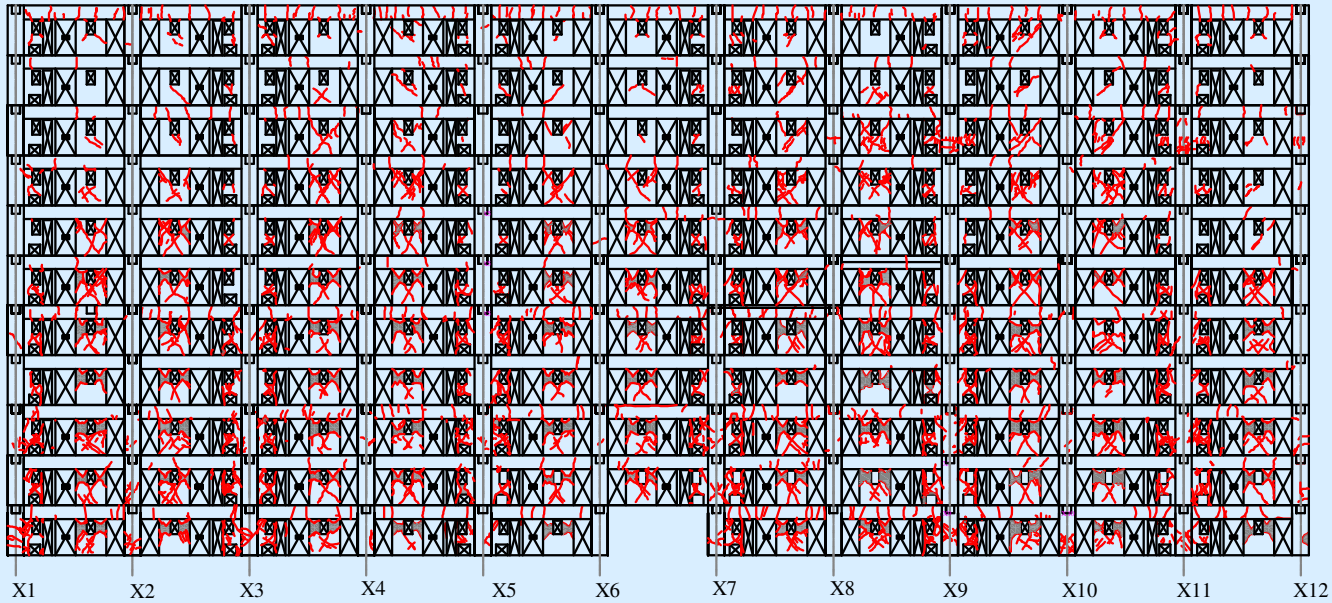
Residual displacements of 14 story Steel Concrete Apartment Building in Sendai-City

Residual displacements of 14 story Steel Concrete Apartment Building in Sendai-City

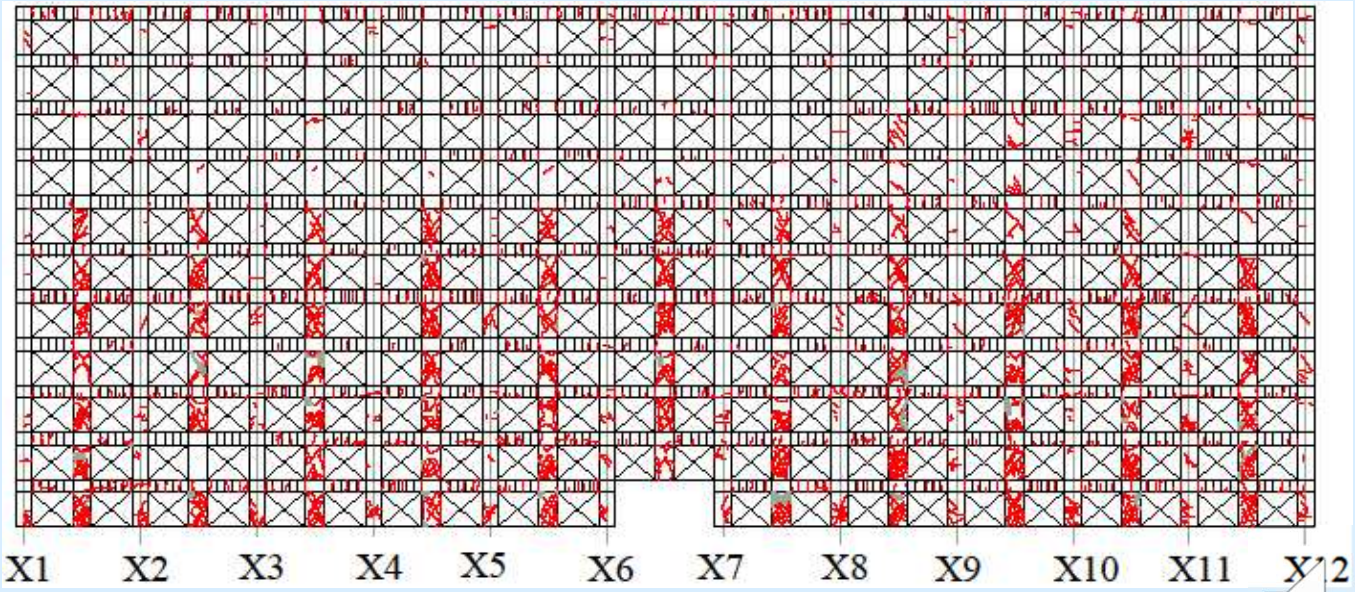
12 story Steel Concrete Apartment Building of Sendai-City

Courtesy of Prof. Yasushi Sanada, Osaka University

West Frame



East Frame



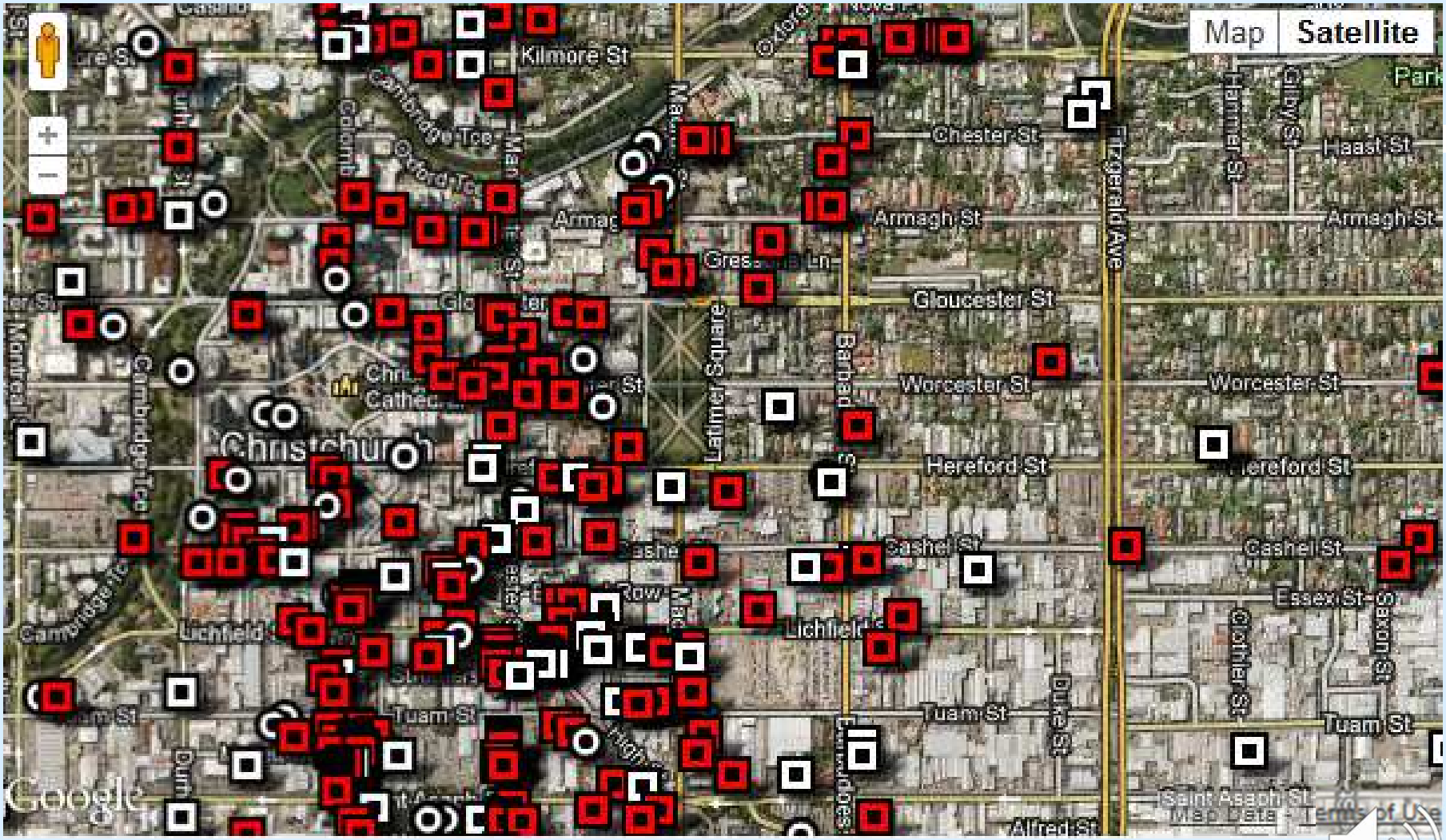
Courtesy of Prof. Yasushi Sanada, Osaka University

Christchurch before 2011 Earthquake

Christchurch after 2011 Earthquake

2010-2011 Earthquake Sequence

Courtesy of Prof. Gregory MacRae



http://www.stuff.co.nz/the-press/news/christchurch-earthquake-2011/5282824/Quake-damaged-buildings-map

Our responsibility and mission were not satisfied

Professors recommend
Ductile Frames
to students.

Ductility is Damage 1/2

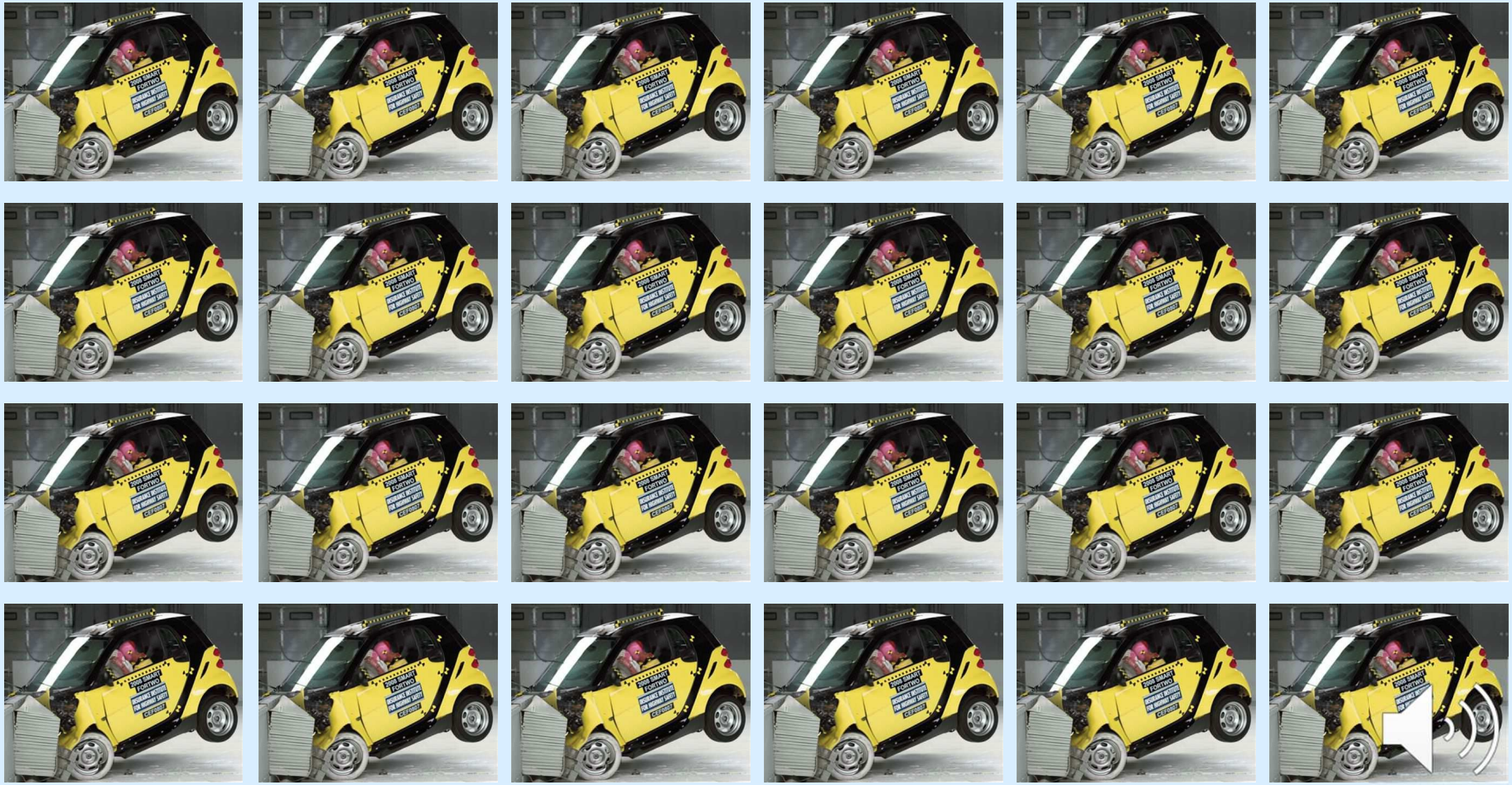
- The R factors are 2 to 8 in the USA.
- Almost all structural engineers rely on the plastic deformability of beams, columns and walls of building structures during seismic design of structures.
- The ductility as plastic deformation of frames is the damage of structures.

Ductility is Damage 2/2

- The damage of structures are easy to recognize and understand for young boys and girls to old ladies and gentlemen.
- Normal people don’t want to live in the damaged buildings. Then, these damaged buildings become to be demolished after the big earthquake.

“Designed to protect life in extreme event, but damage is expected”
Prof. Stephen Mahin said.

Protect people life, but damages of so many buildings are expected.



Current Seismic Design

H. Only Human life to be safe

B. Building cannot use after repair

C. No Continuous Use after earthquake

We can not make our city sustainable and resilience against big earthquake.

We need to change our seismic design concept.

New Seismic Design

H. Human life have to be safe

B. Building can use after some repaired

C. Continuous Use just after earthquake

Against Small and Medium Earthquake ----

We can satisfy H, B and C easily.

Against Big Earthquake -----

We have to satisfy H and B, some case C

New Seismic Structures

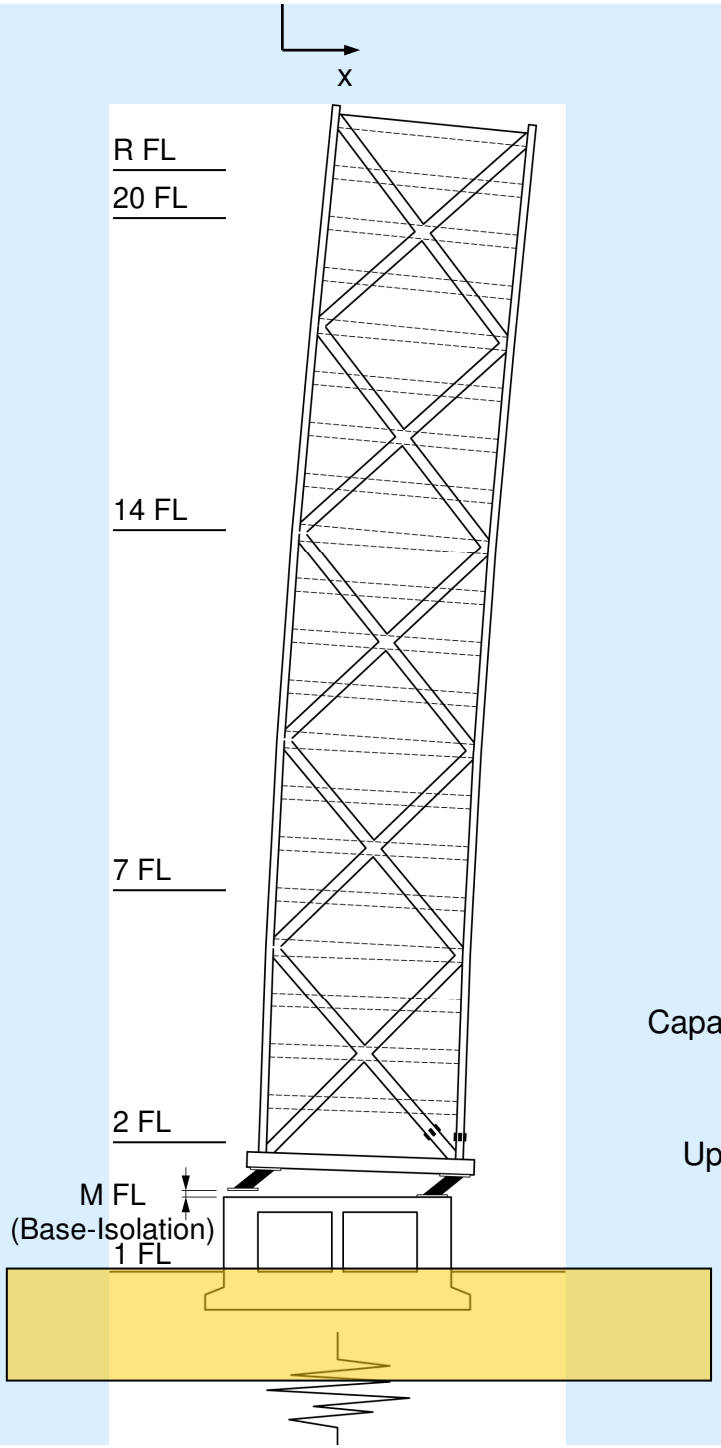
- Seismic Isolated Structures
- Passive Controlled Structures
- Stepping Columns Structures
- Elastic Joints of Pre-casted RC
- Other Good Structures

Shosoin more than 1300 years ago years

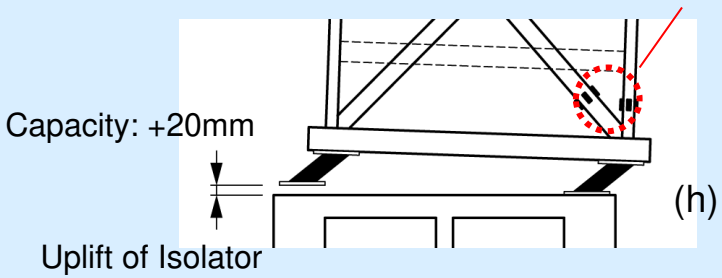
Shosoin more than 1300 years ago

years

Seismic isolated twin steel tall building in TITech

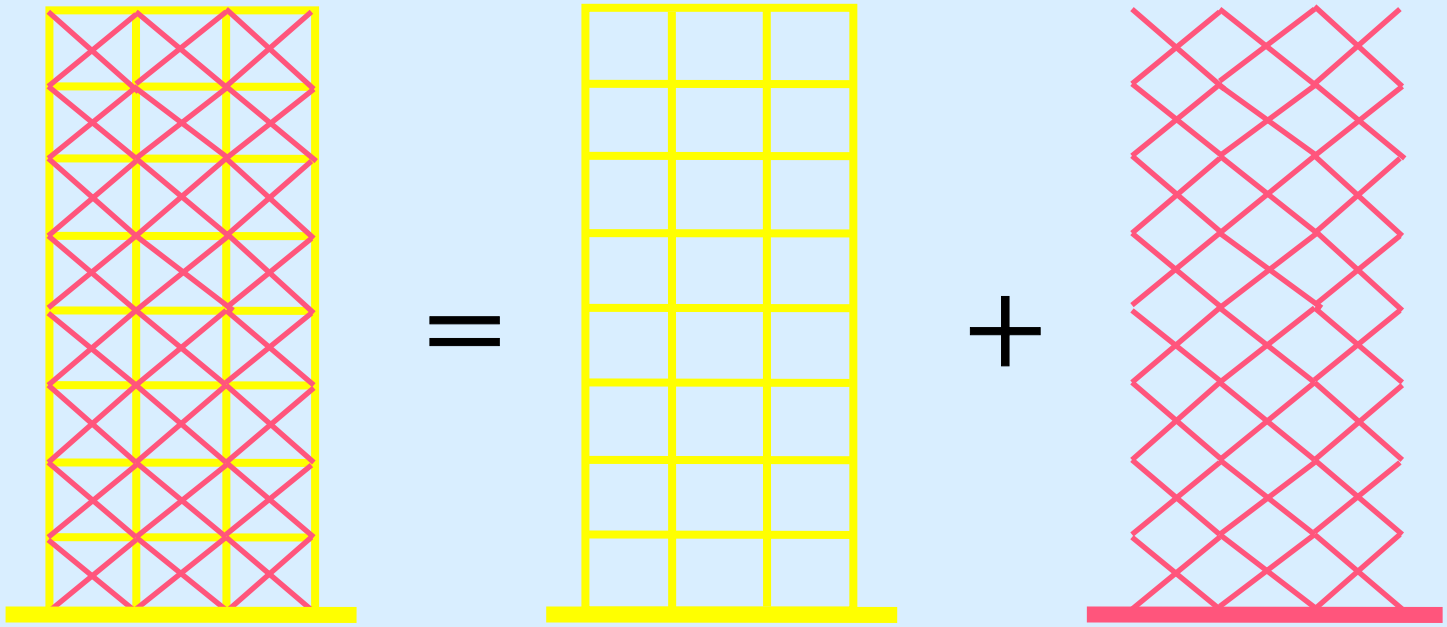


Seismic Isolated Steel Tall Building constructing in TITech Now



4 Stepping Columns

Damage Controlled Structures



Building Structures

Primary Structure

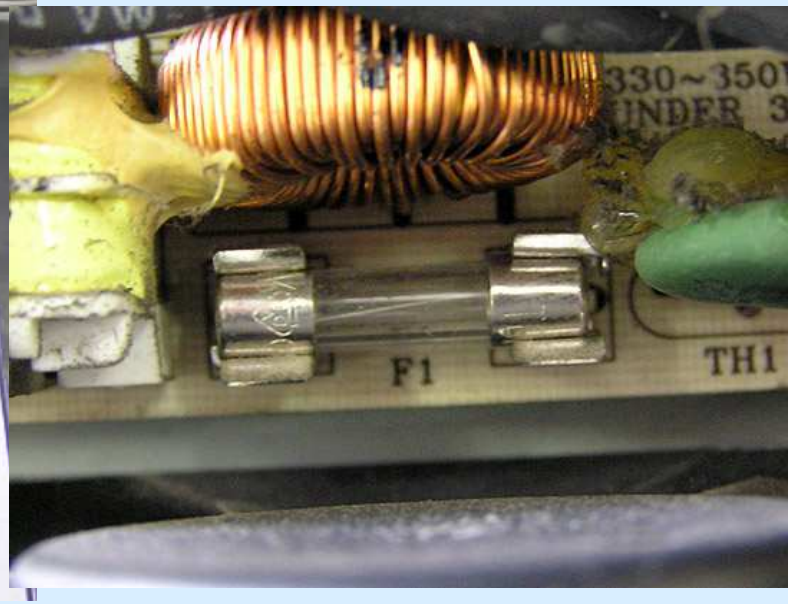
(To Support Vertical Load)

Seismic Members

(To absorb earthquake energy)

We have to learn good ideas from Nature

A Bumper protecting people and Bus

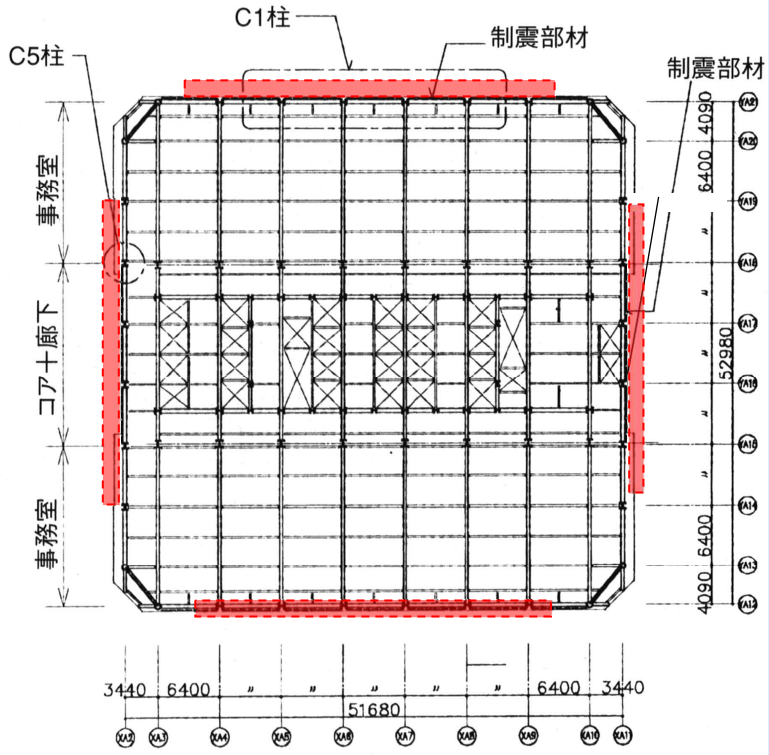


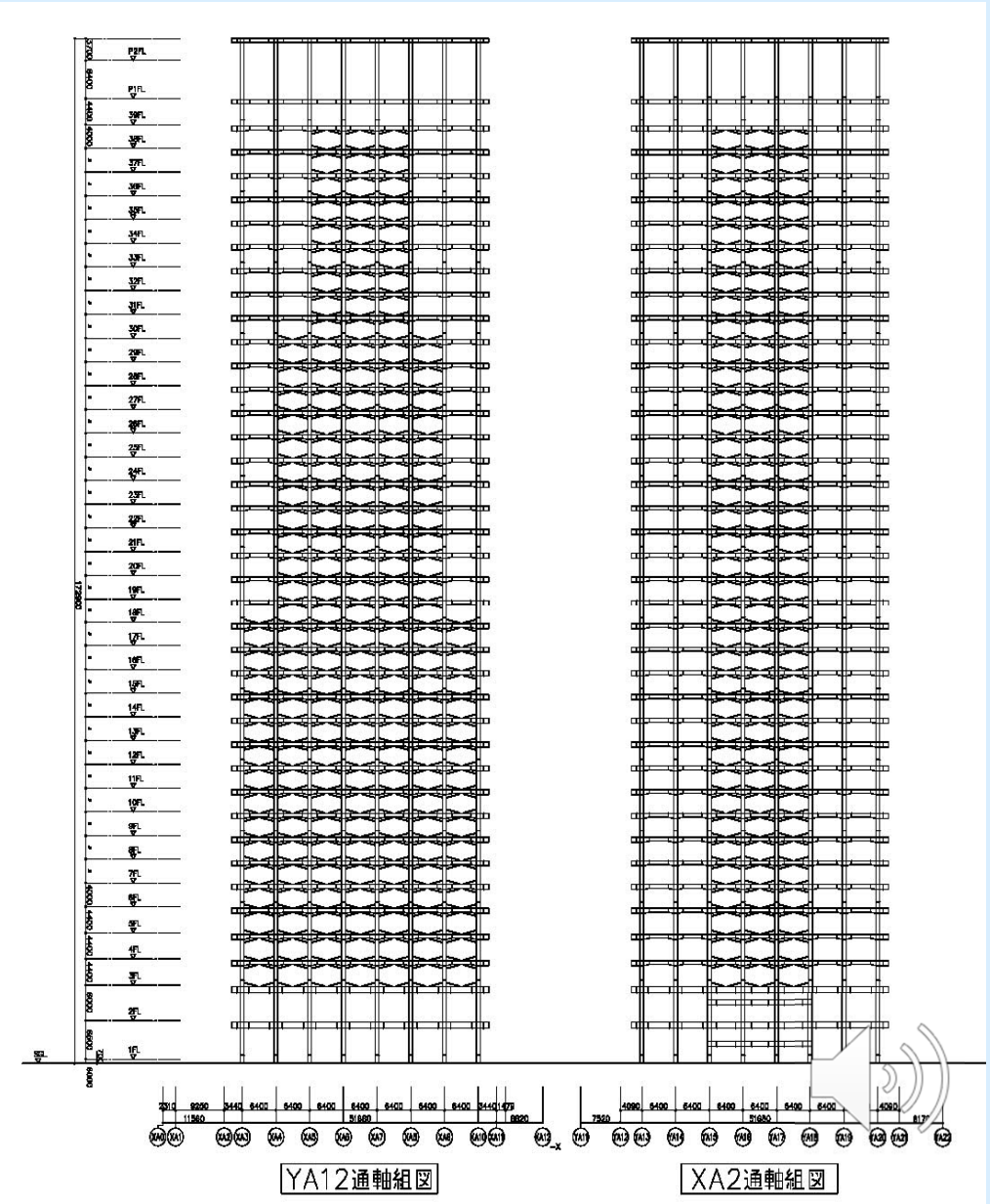
A Fuse protecting important PC

1987 to 1988

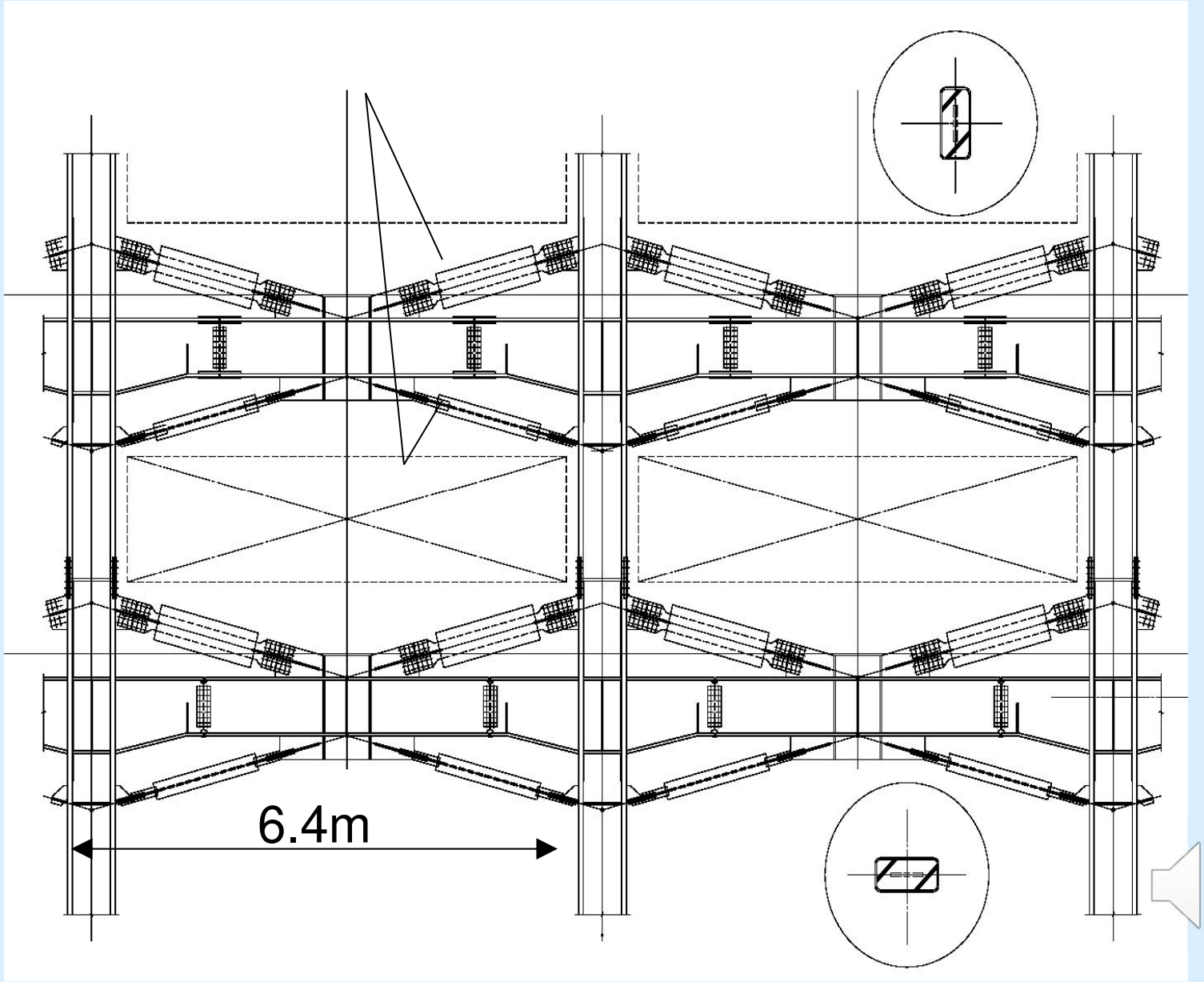
Buckling Restrained Braces

Framing Plan & Elevation

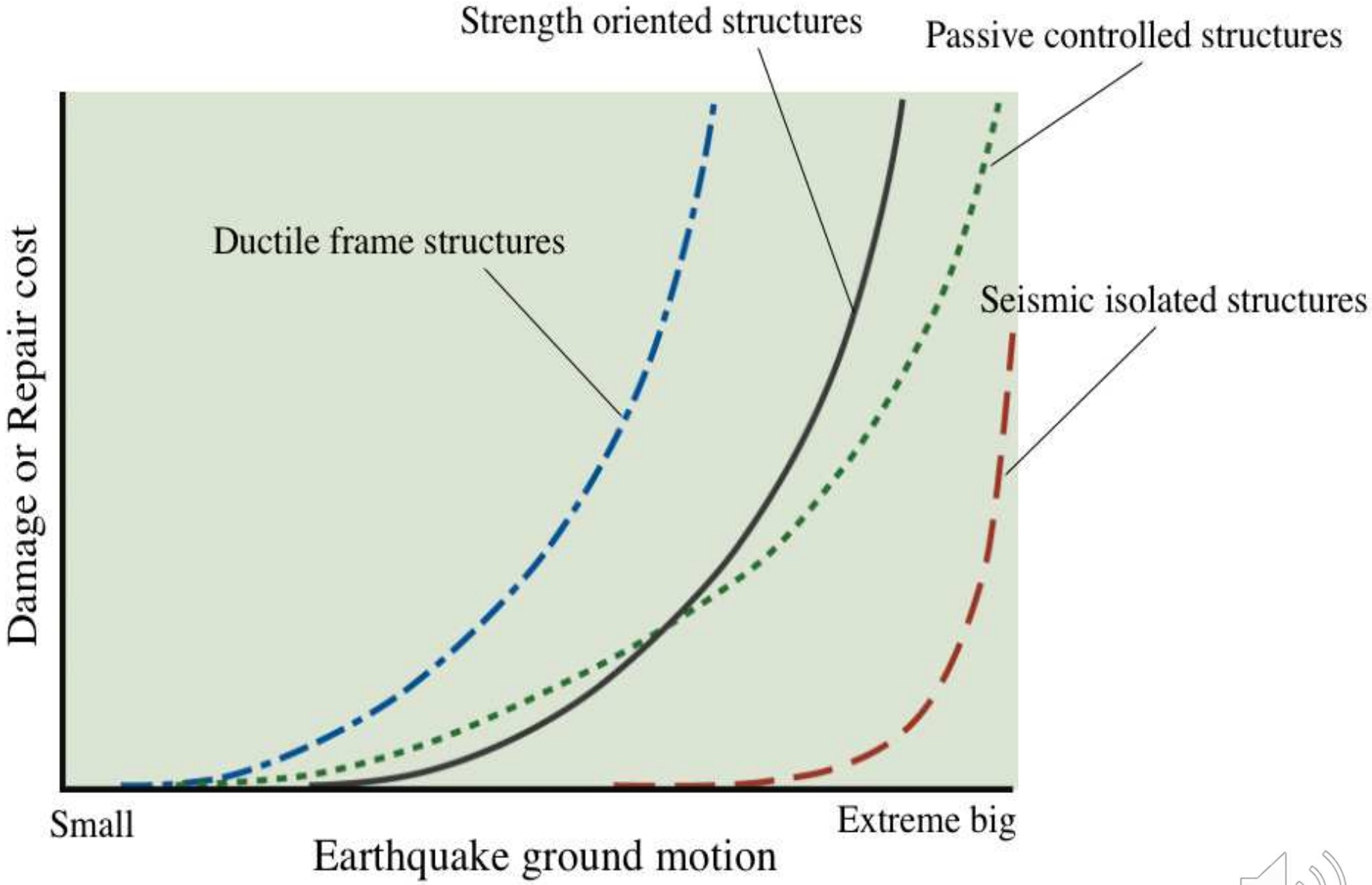




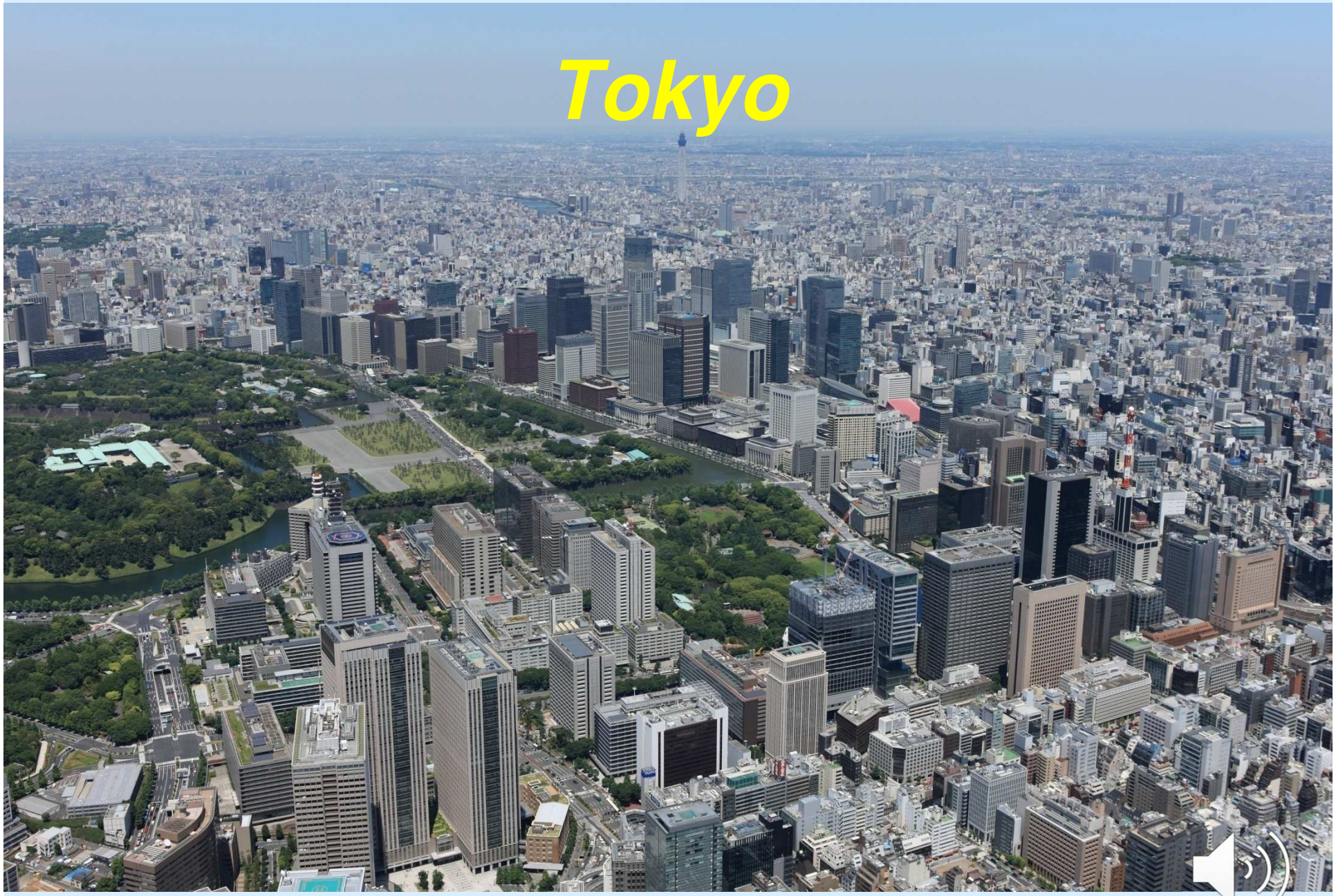
Detail of Unbonded Braces

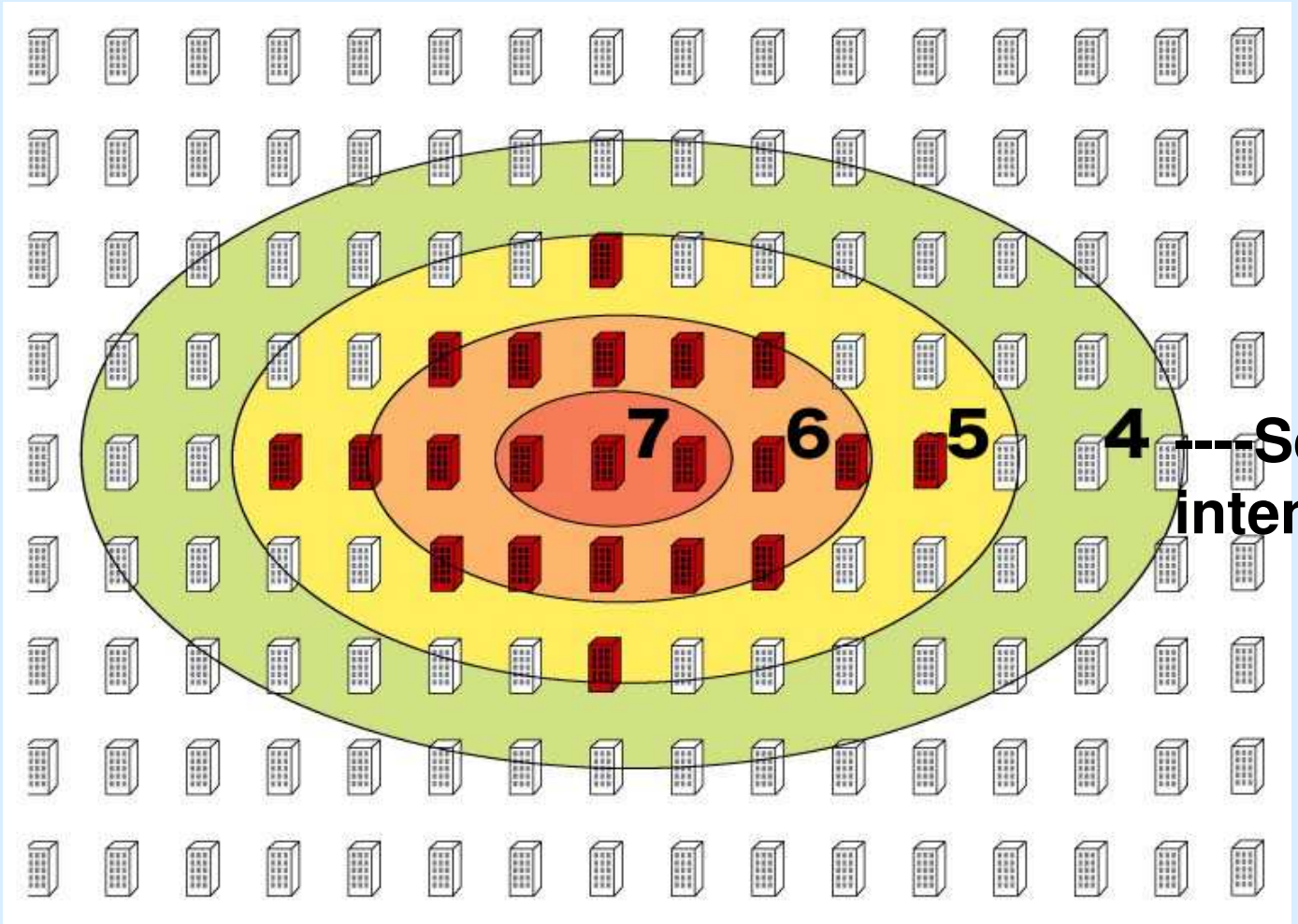


Many Unbonded Braces are Installed

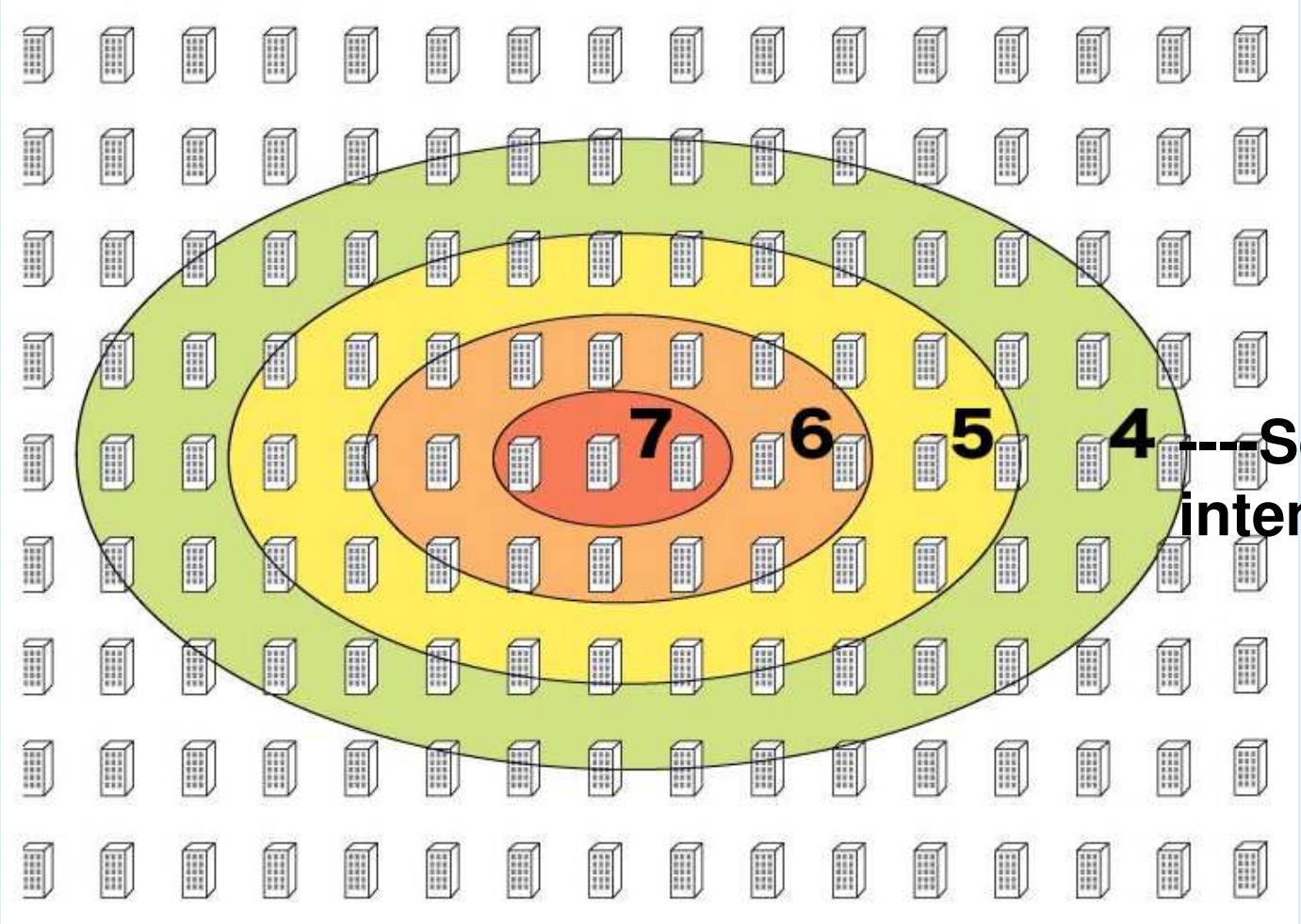

Strength oriented structures
Passive controlled structures
Ductile frame structures
Seismic isolated structures
Damage or Repair cost
Small
Extreme big
Earthquake ground motion


Tokyo


Tokyo



Damages of buildings in the city after big earthquake, in the case that all buildings were designed as ductile frame structure



Almost no damage of building in the city after big earthquake, in the case that all buildings were designed as seismic isolated structures.

Conclusion 3/3

- We have to consider not only resilience of a building, but also resilience of a city consist of many buildings.

- Then we can not recommended to make buildings rely to large ductility.

Prof. Robert Park

at Canterbury University

Prof. R. Park introduced ductile moment reinforced concrete frames in earthquake prone countries, but he have said at that time:

Prof. Robert Park

at Canterbury University

Prof. R. Park introduced ductile moment reinforced concrete frames in earthquake prone countries, but he have said at that time:

Ductility is not final goal.

We, structural engineers, have a mission to make the world a better place to live.

Thank you very much for your attention.

Akira Wada