

Observed Response of Seismically Isolated Buildings during the 2016 Kumamoto Earthquake

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Outline

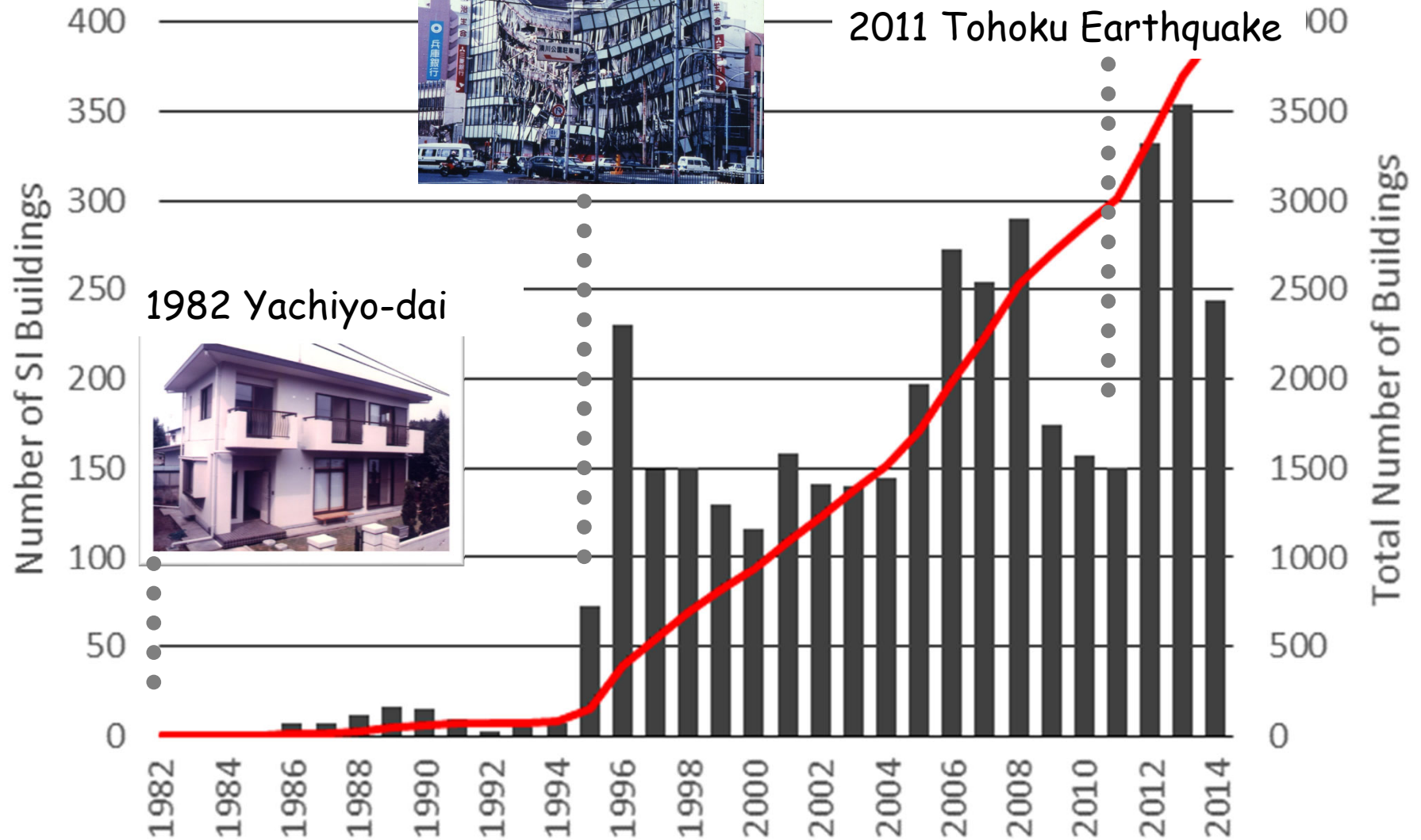
1. Applications of Seismic Isolation Technology in Japan
2. Damages of Conventional Buildings during 2016 Kumamoto Earthquake
3. Response of Seismically Isolated Buildings in Kumamoto Area
4. Conclusions

Number of SI buildings in Japan

1995 Kobe Earthquake



2011 Tohoku Earthquake

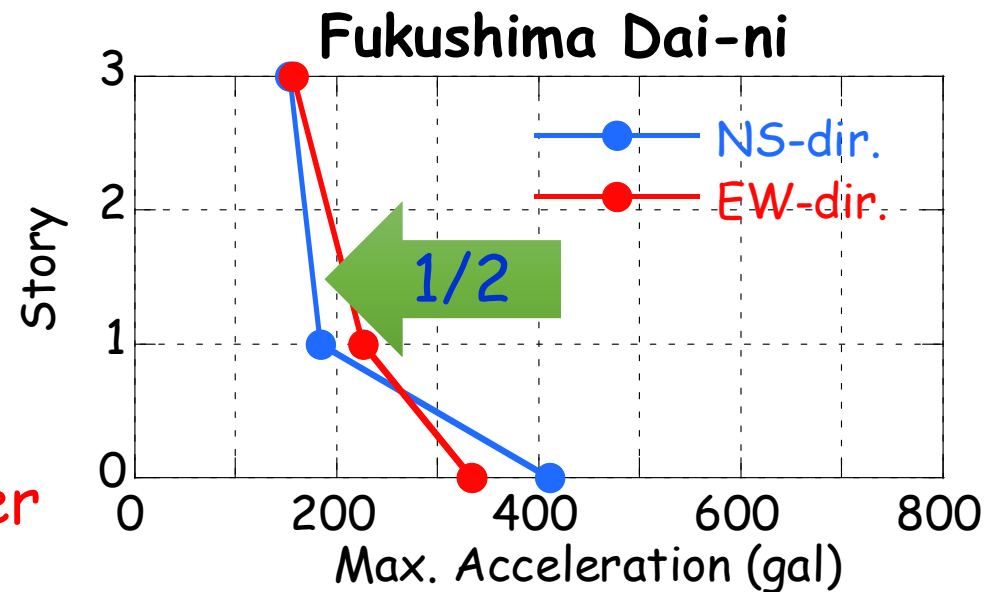
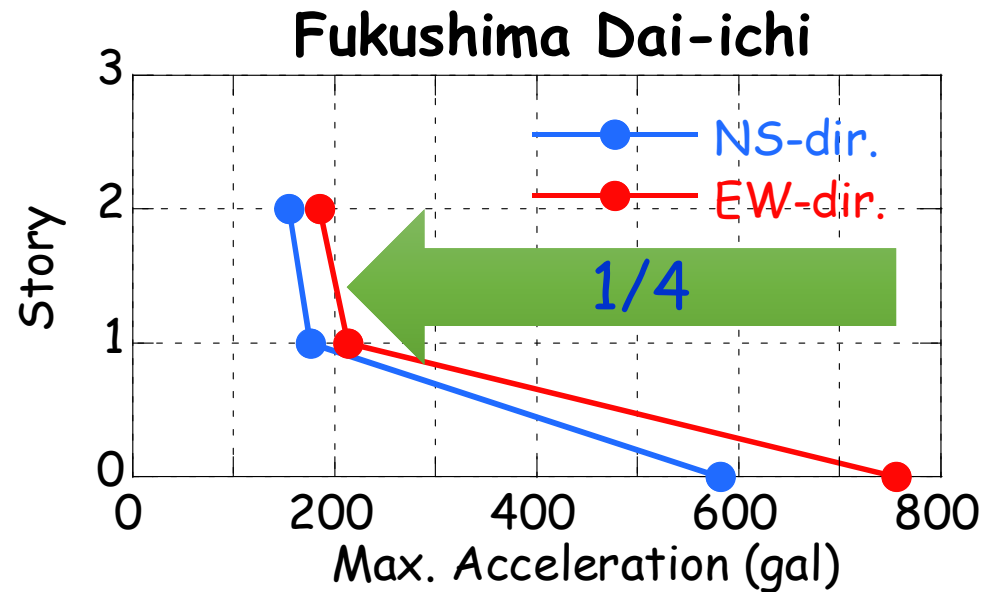


2011 Tohoku Earthquake

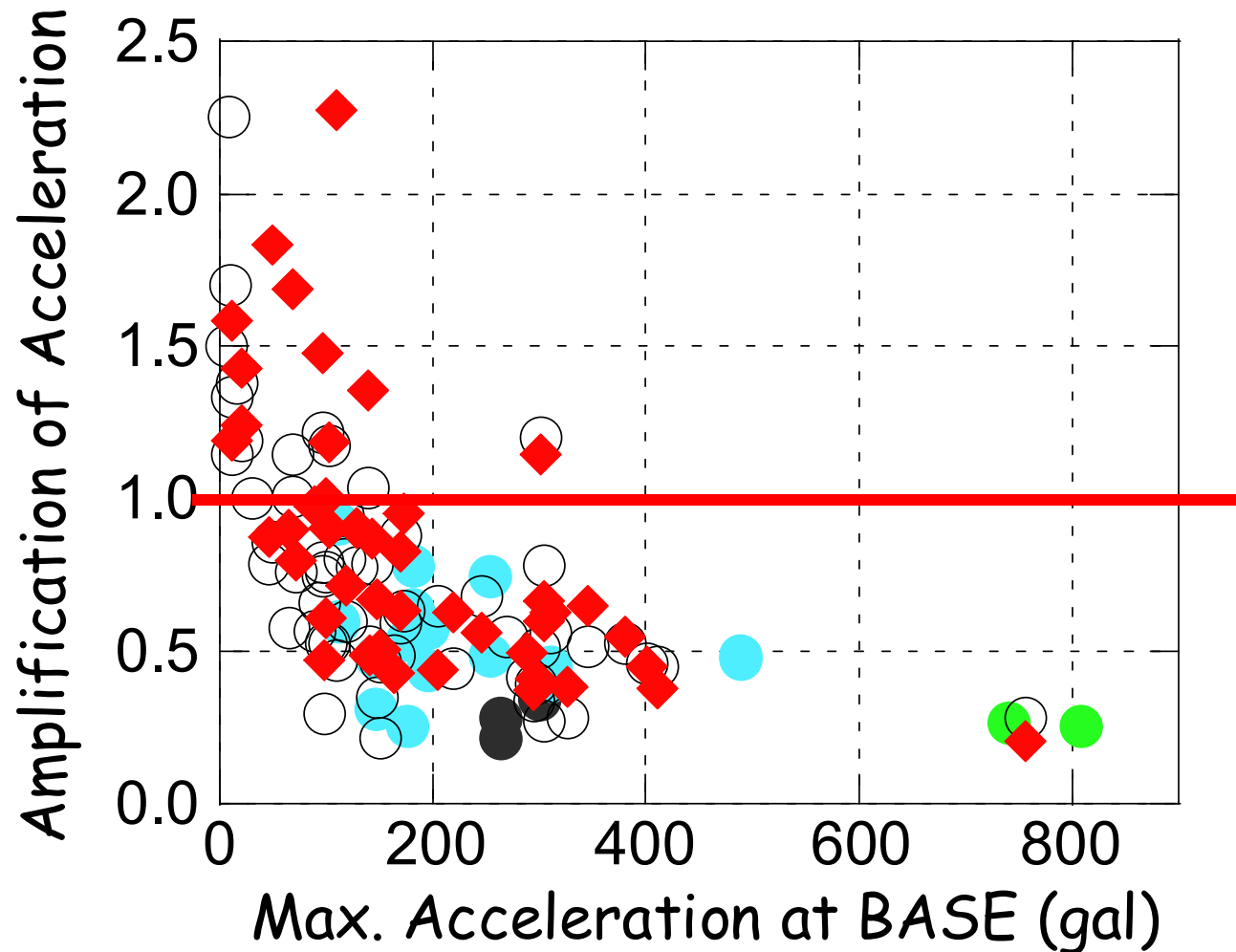
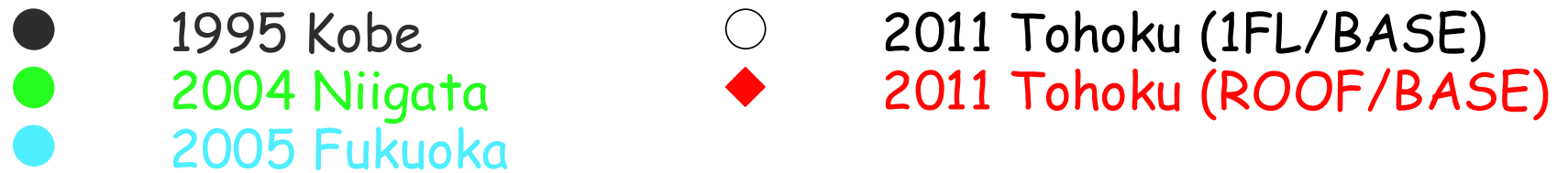


Emergency Operation
Center at
Fukushima NPP

Isolation System:
NRB + LRB + Oil Damper



Amplification Factor of Observed Acceleration

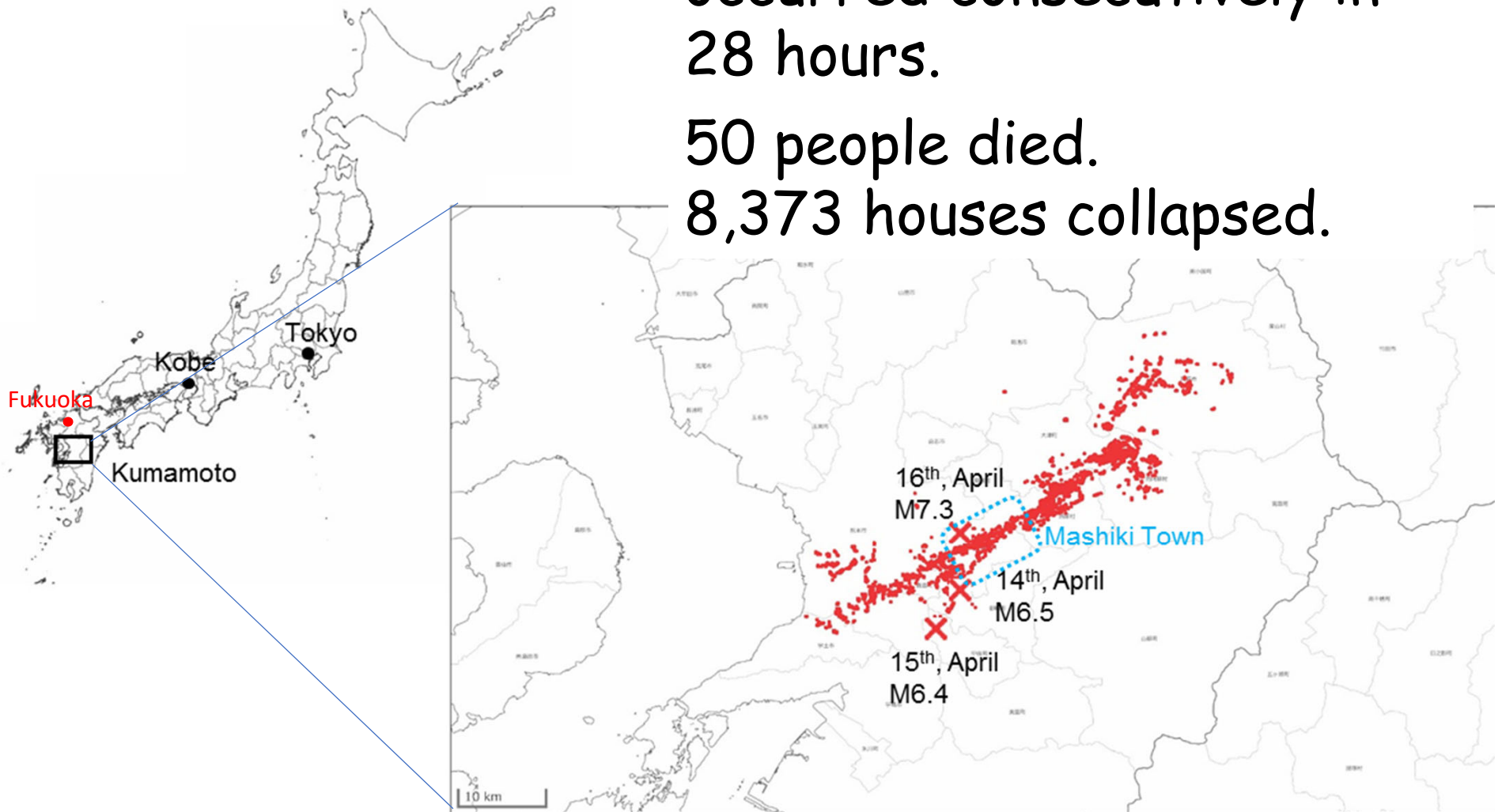


2016 Kumamoto Earthquake

Two large earthquakes has occurred consecutively in 28 hours.

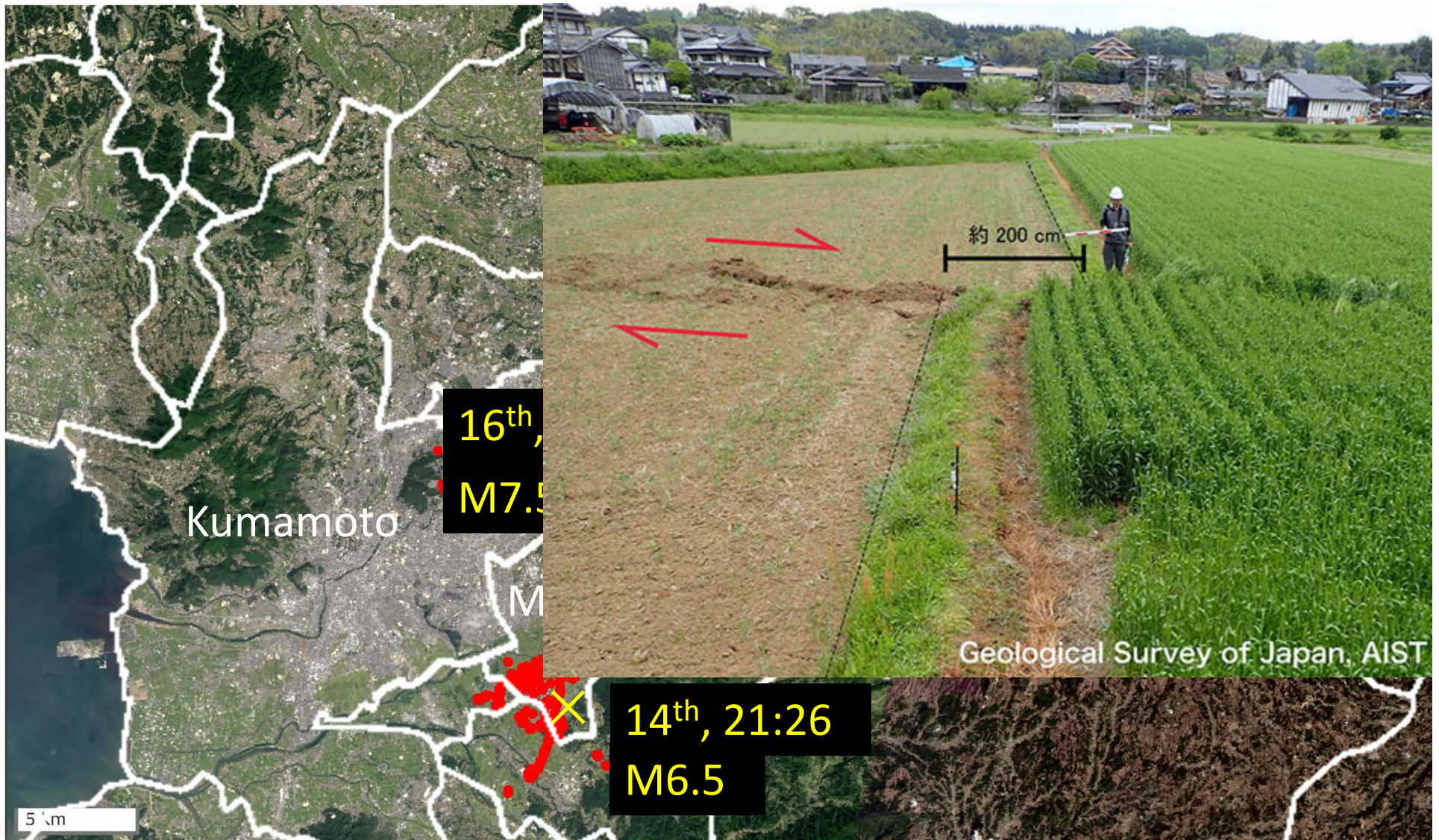
50 people died.

8,373 houses collapsed.

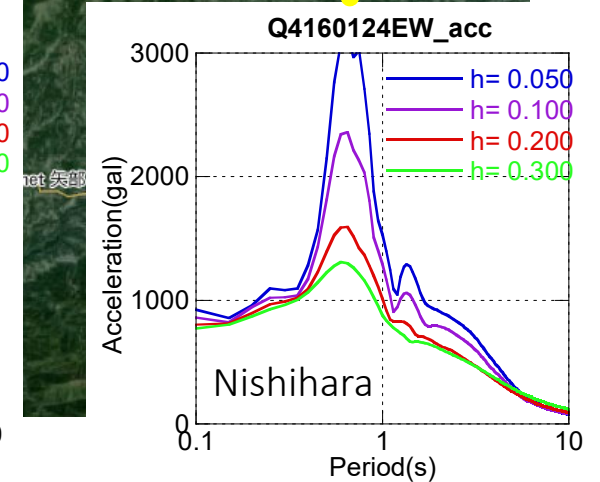
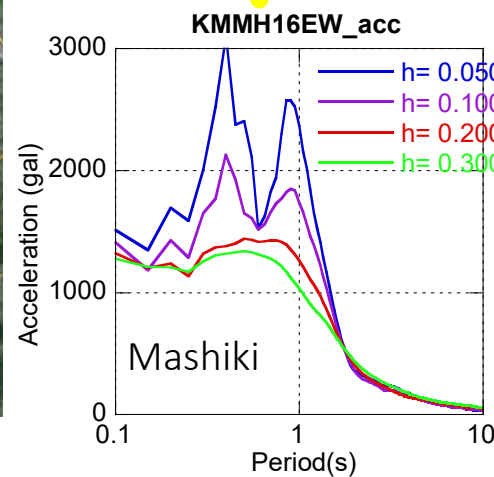
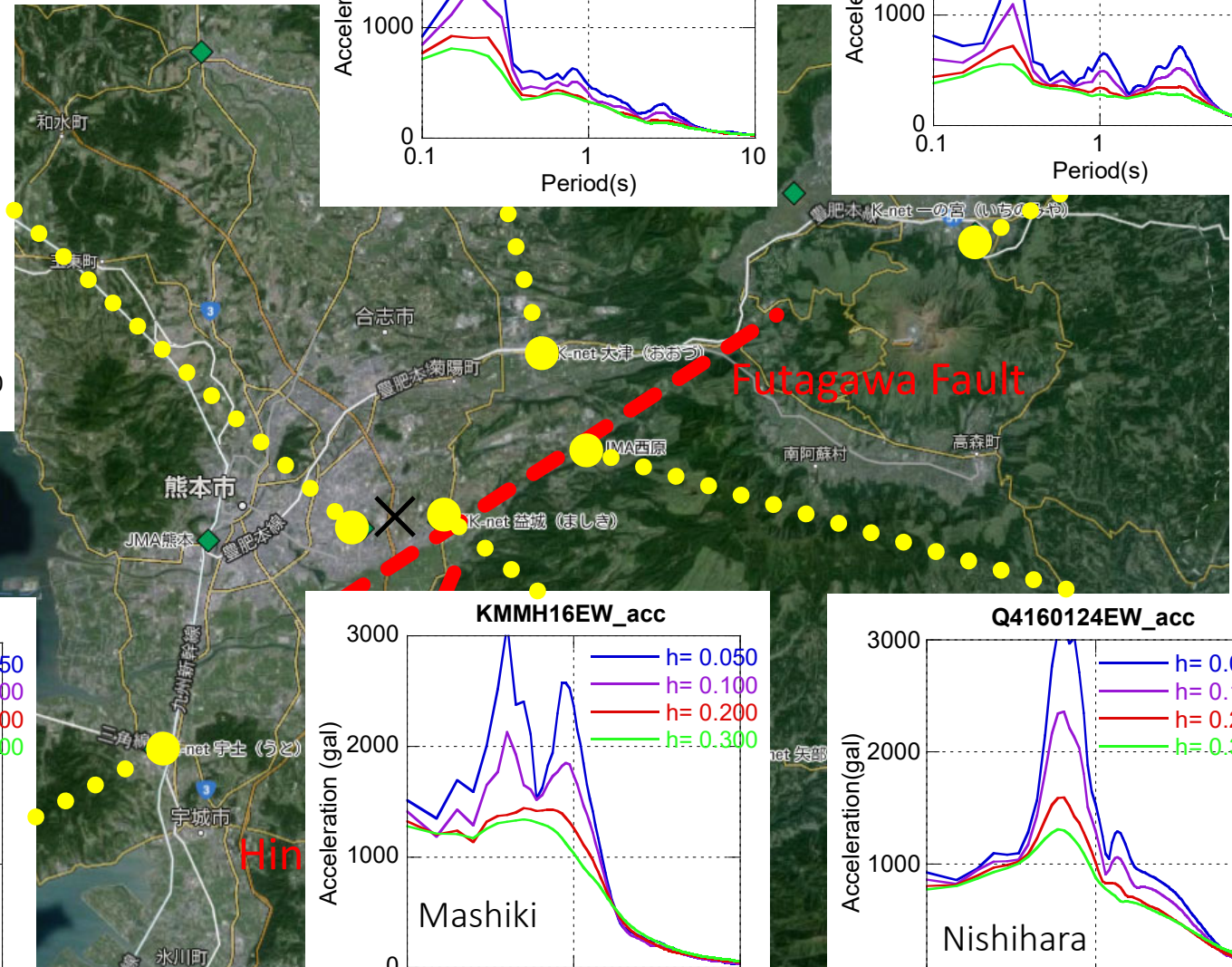
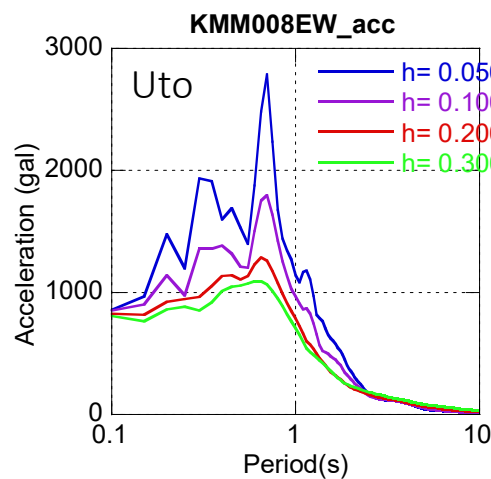
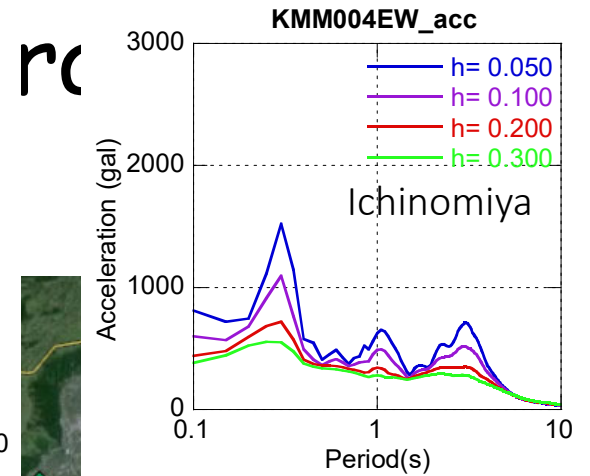
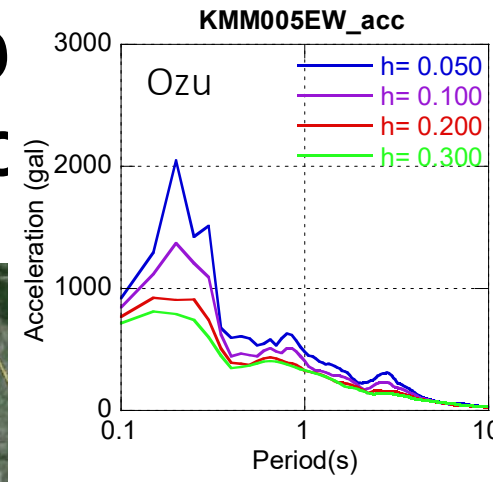
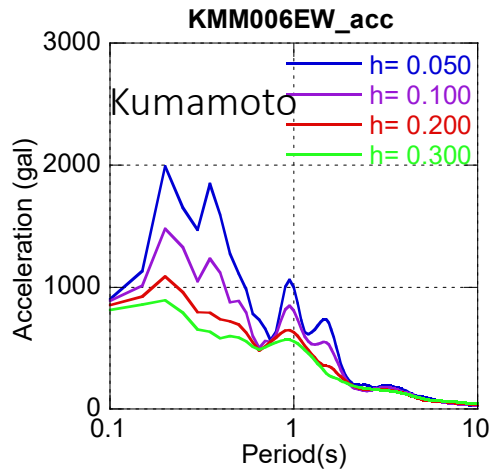


Fault cracks appeared on the ground

investigated by the Geospatial Information Authority of Japan



Earthquake Resp (Main Shock, EW-c





Damage of Expansion Joints

Many damages occurred even in relatively new reinforced concrete apartments.

Collapse of old reinforced concrete building

Seismic reinforcement of old buildings is urgent.



Relatively new wooden houses were also collapsed
in Mashiki town



Damage of City Hall



Damage of the city hall
Facilities that become
disaster bases are required
to have higher earthquake
resistance and function
maintenance.

In the seismic isolation
hospital, the function is
maintained after the
earthquake without damage,
and medical practice can
continue

Base Isolated Hospital without damage



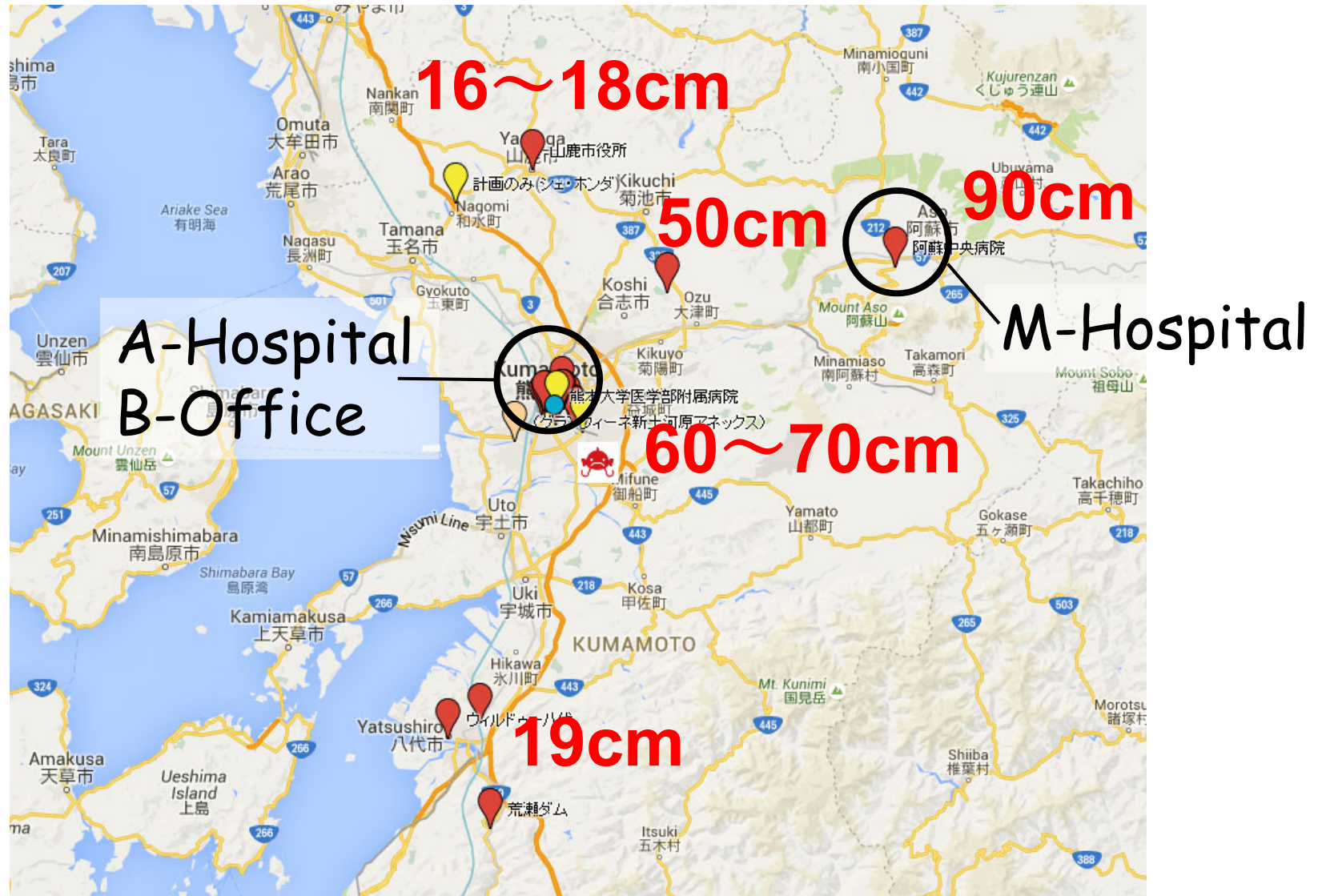
Summary of Seismically Isolated Buildings in Kumamoto Pref.

✓ **24** Seismically Isolated Buildings
including 4 under construction

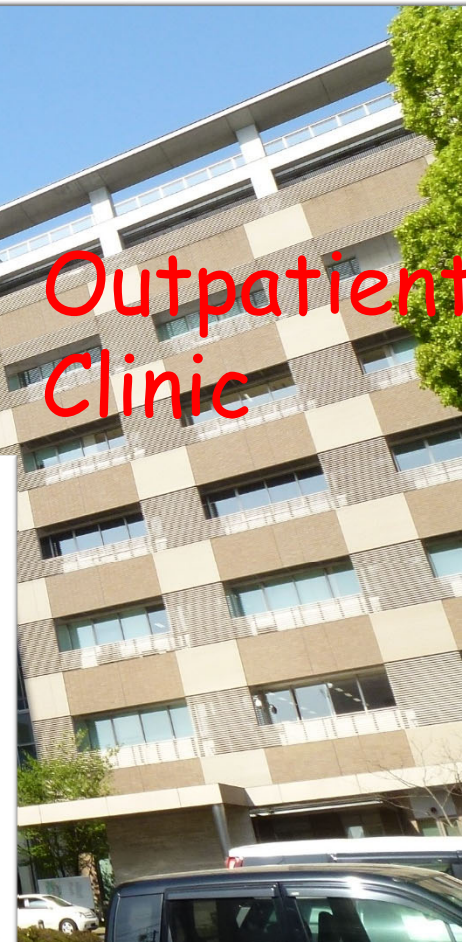
Uses	Apartment 12	Hospital 7	Office, Warehouse 5
Story	1~4F 3	5F~10F 6	11F~15F 15
Location (City)	Kumamoto 18	Yatsushiro, Yamaga 4	Other 2

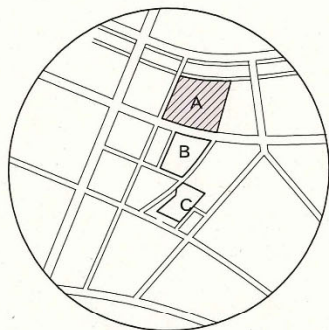
Location of Seismically Isolated Buildings and Max. Deformation

(Deformation shows a double amplitude)

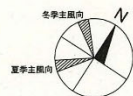


A-Hospital (2 buildings)

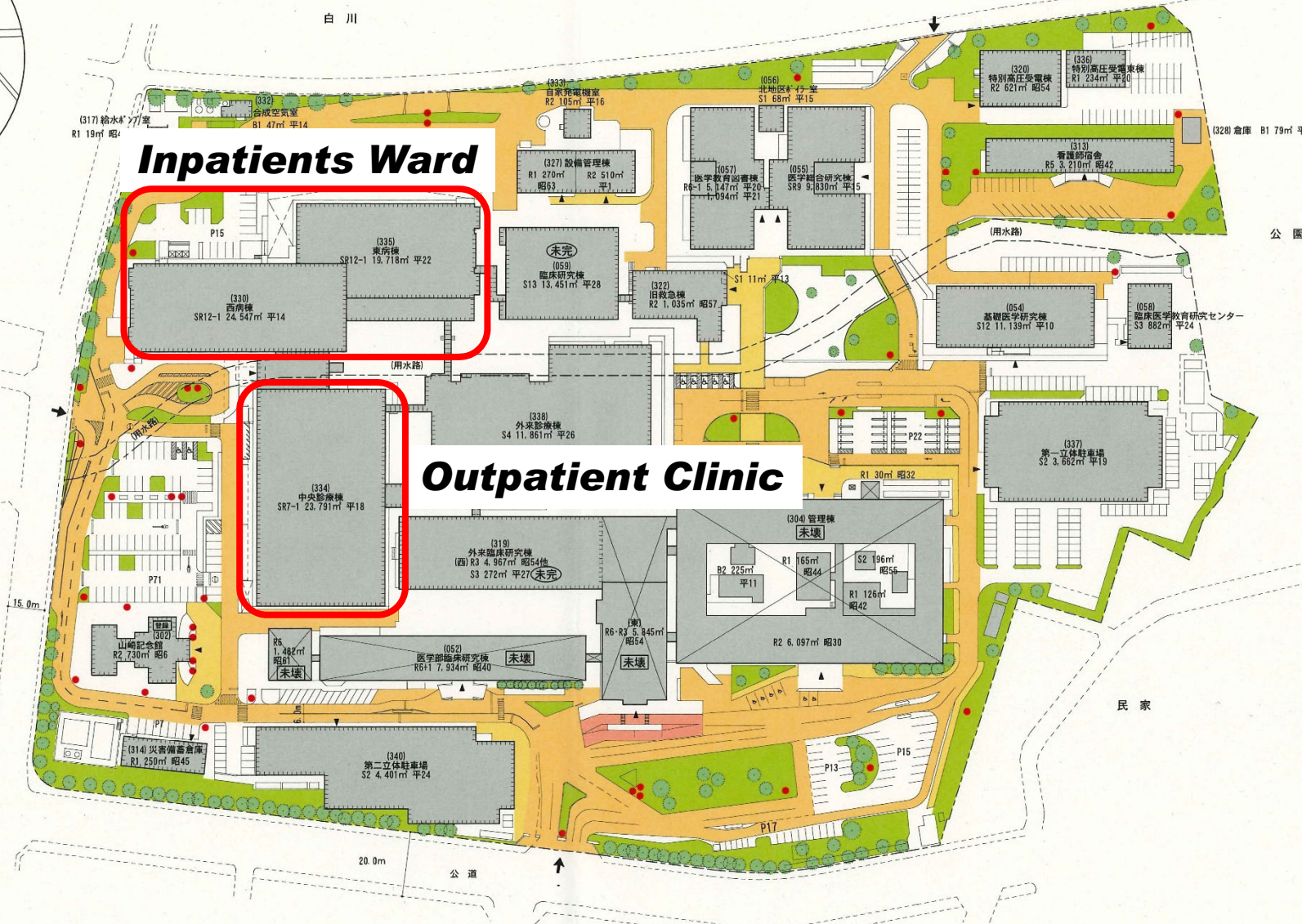




(団地キープラン A)



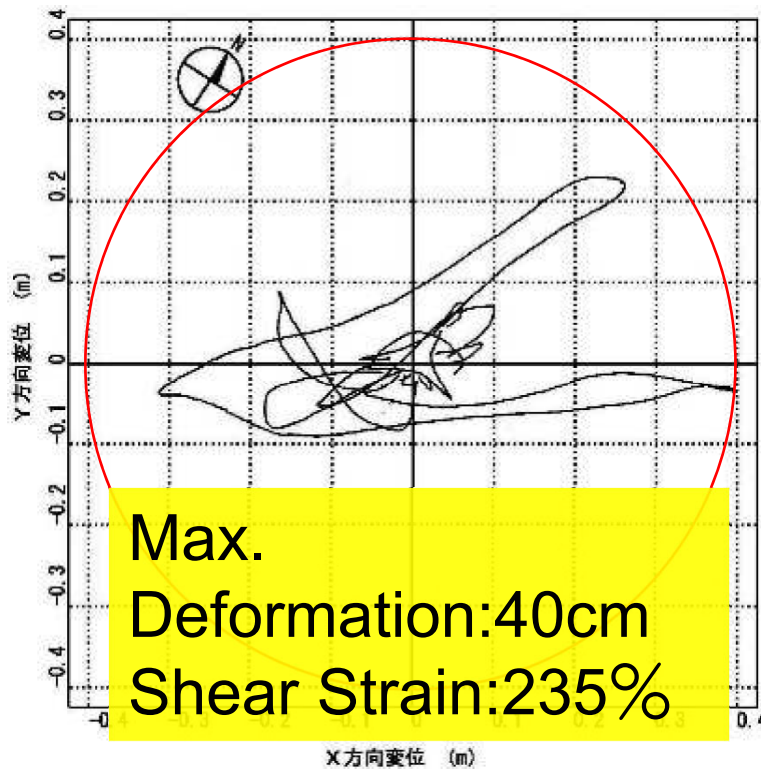
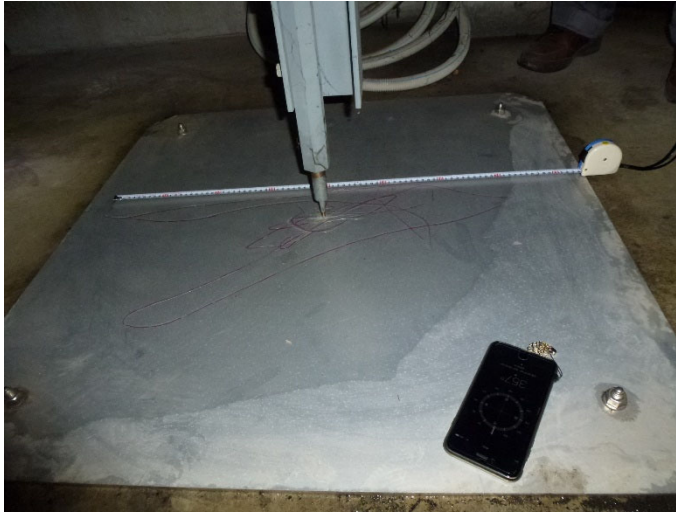
民 家



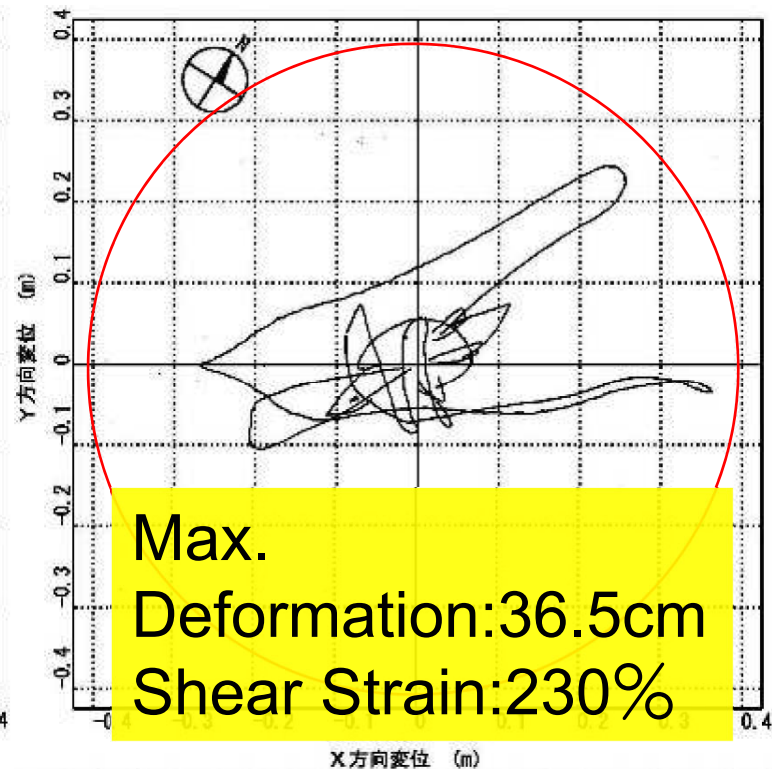
本荘団地 (北地区) 配置図

S=1/1, 500

Outpatient Clinic



Inpatient Ward





After Foreshock
April 15, 2016



After Main Shock
Just After Main Shock
April 16, '2016

Damage of Hand rail

B-Office Building



Scratch ^r

Building

40cm

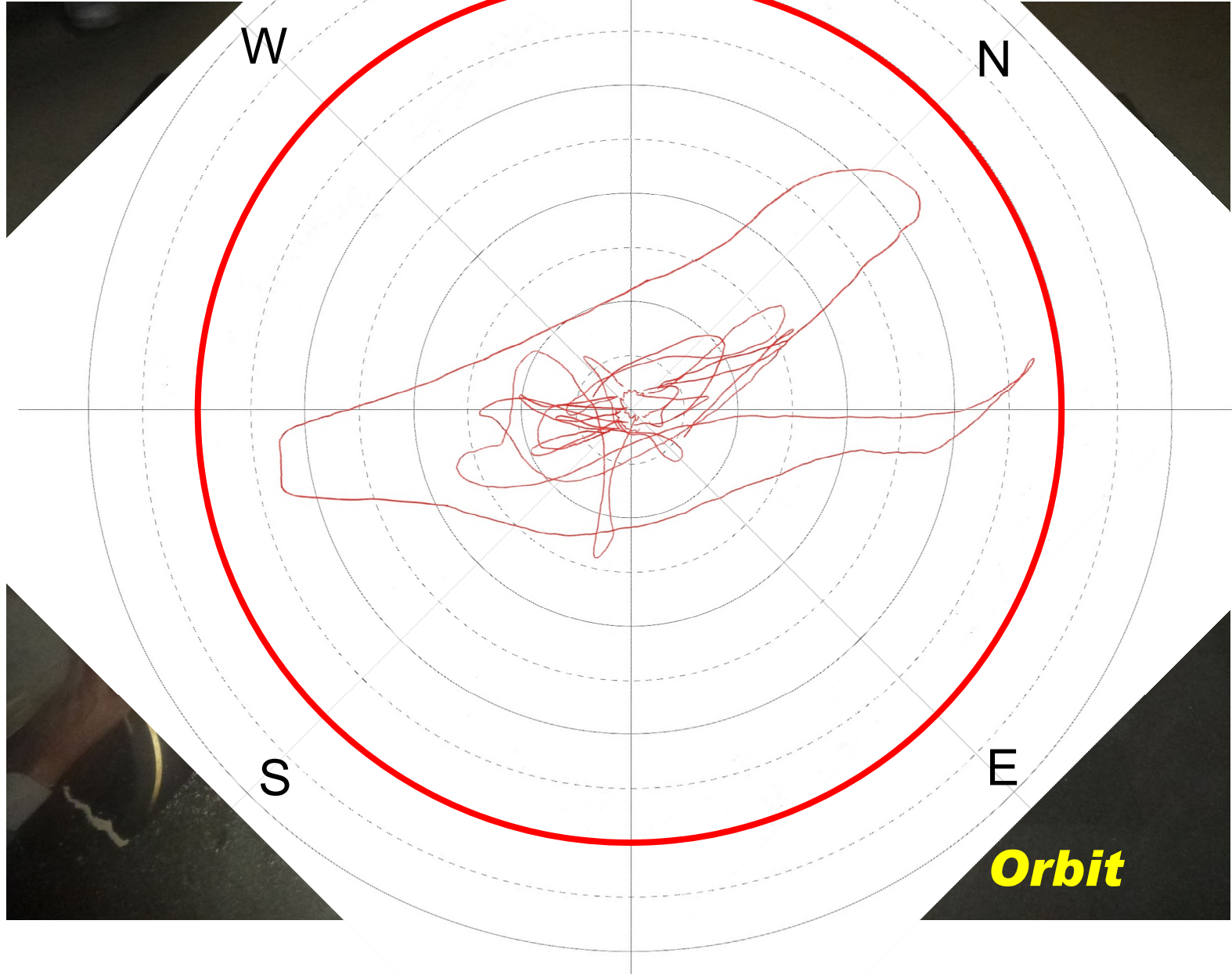
W

N

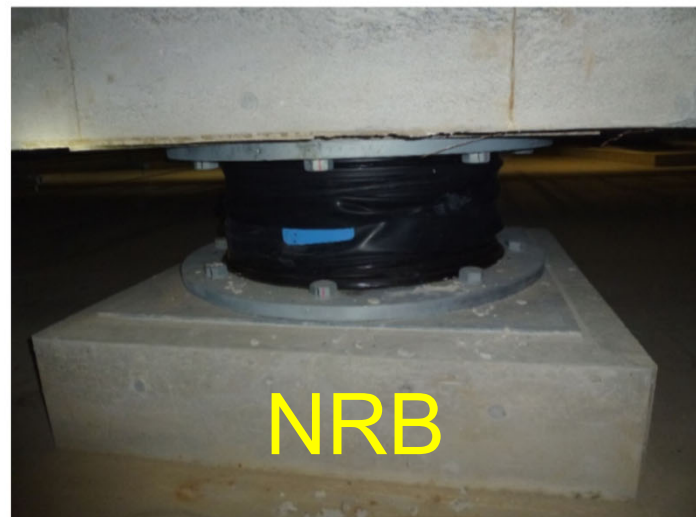
S

E

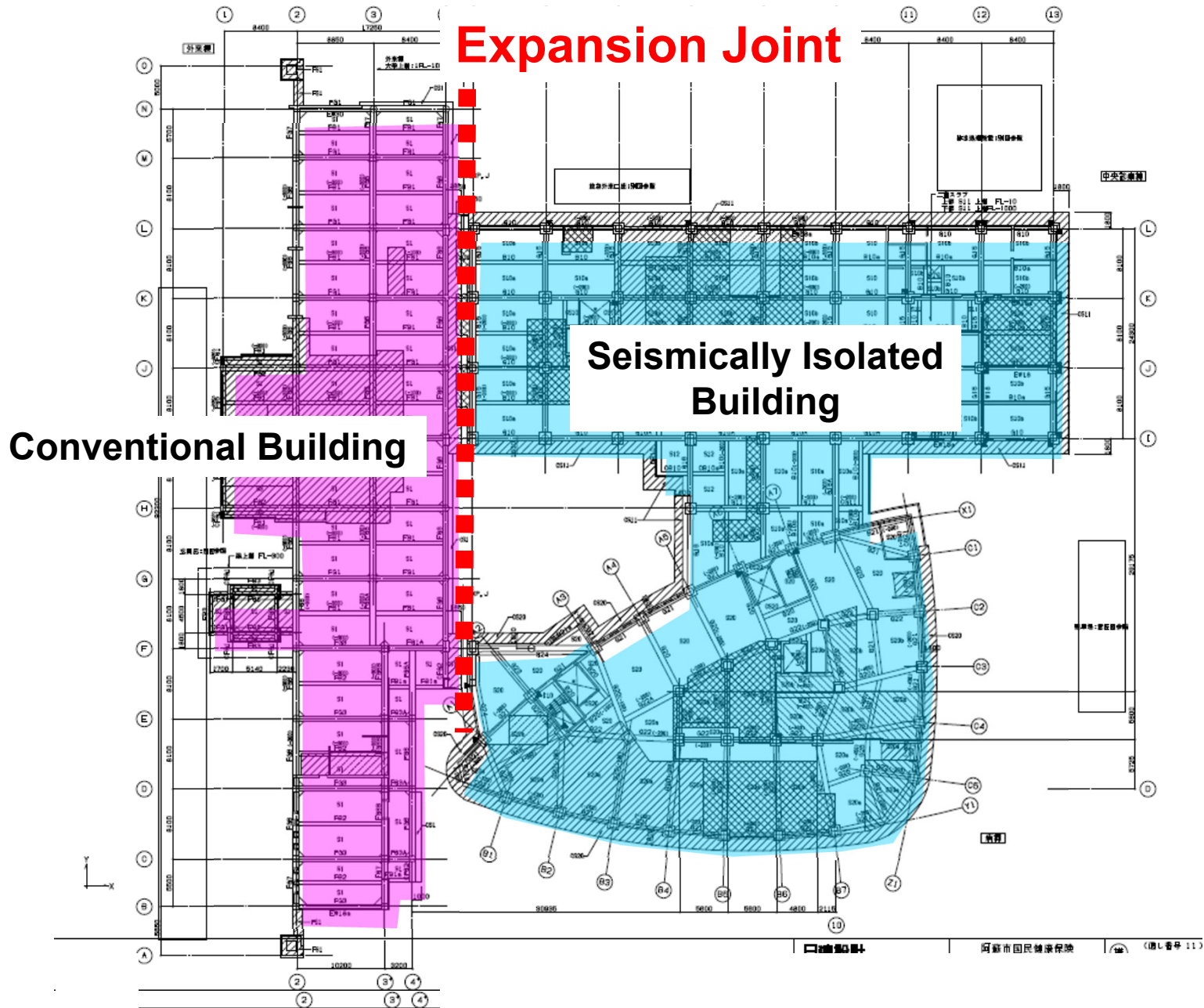
Orbit



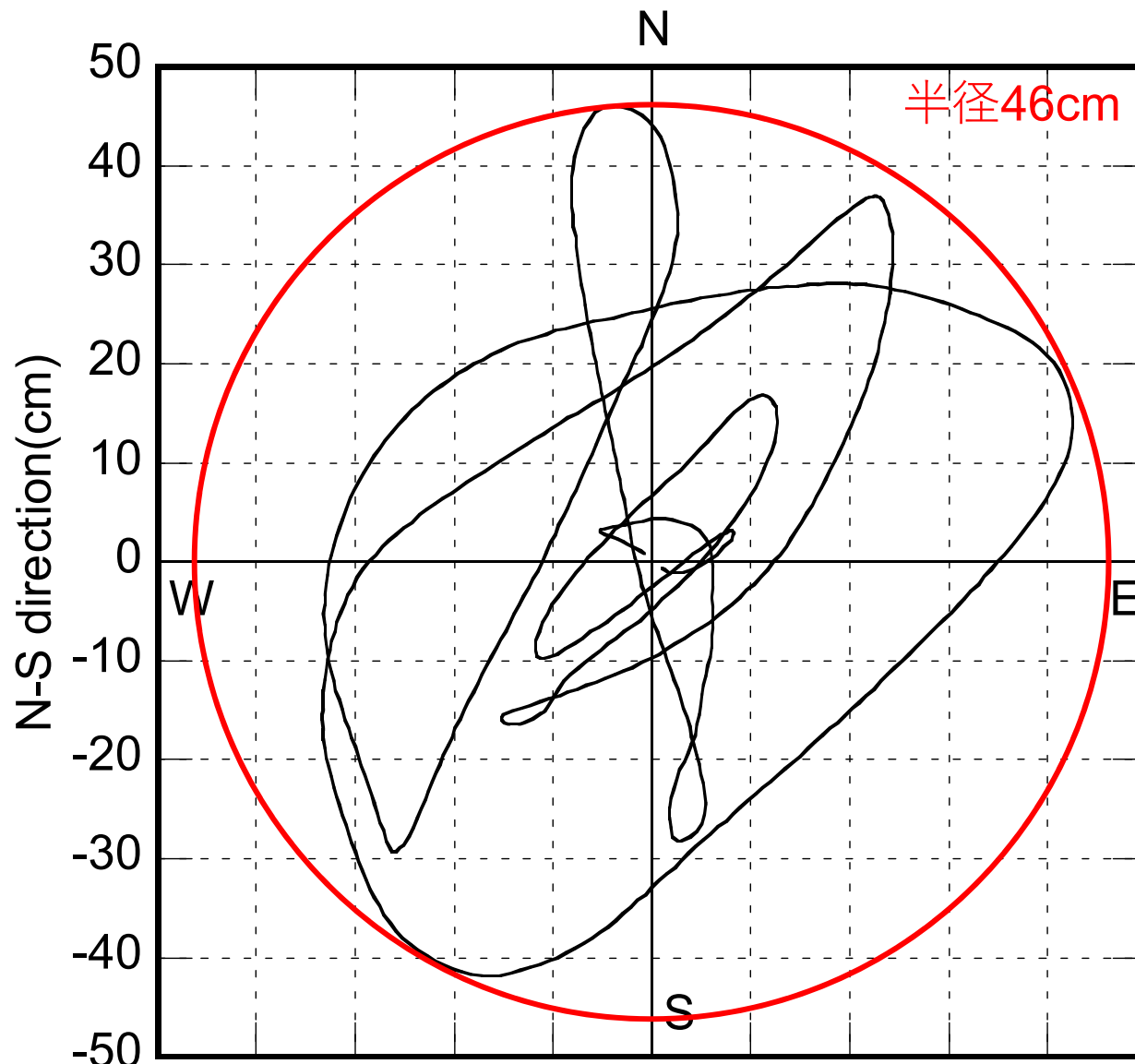
M-hospital



Plan of M-Hospital



Movement Trace of M-hospital



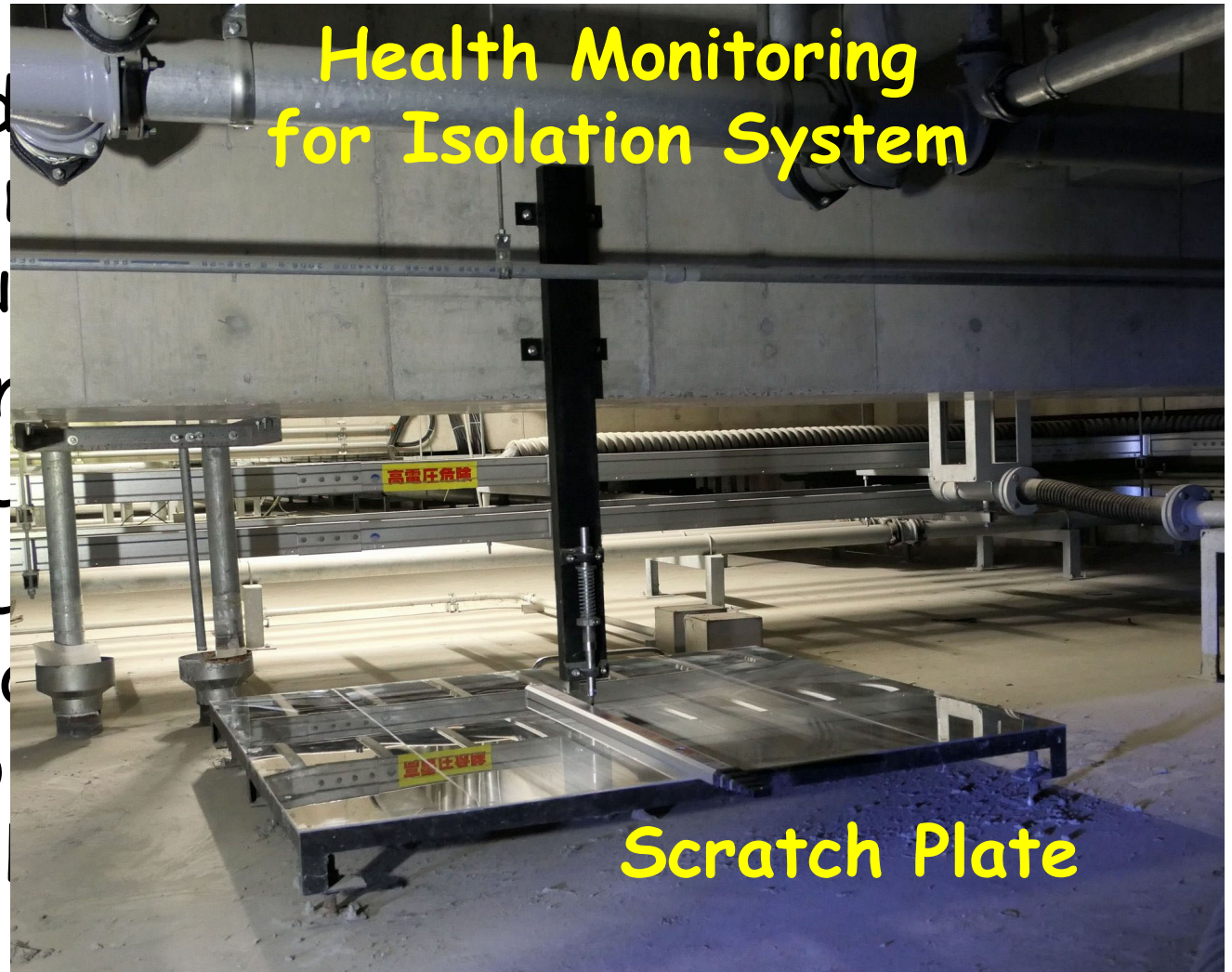
Max. Deformation 46cm (shear strain 330%)



Damage of Expansion Joint

Conclusions

- All seismically isolated buildings worked very well.
- All of buildings performed the performance of isolated buildings.
- Lack of concrete damages such as spalling.
- It is very useful to monitor responses of isolation system in order to improve seismic isolation.



Thank you for your attention

