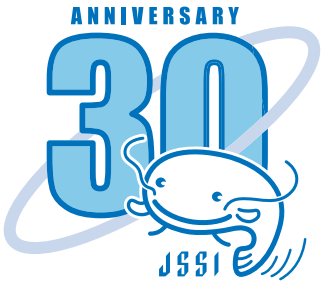


The Japan Society of Seismic Isolation

INDEX

Date of issue: October 2023, printed 500 copies

1 About the Japan Society of Seismic Isolation

Profile of the Japan Society of Seismic Isolation

President Akinobu Nakazawa

Executive Director Yoshihisa Kitamura

Membership (July 31, 2023)
Class 1 Regular Members
: 87 companies
Class 2 Regular Members
: 236 persons
Supporting members
: 114 companies

Prospectus
To promote the proper use of seismic isolation structures by academic experts, design firms, construction companies, and manufacturers of seismic isolation components.
An organization capable of accurately promoting and guiding the improvement of technology and assurance of safety in design, construction, materials, maintenance, etc., by enhancing research and studies on seismic isolation structures.
Contribute to the development of seismic isolation technology and the construction of safe, high-quality buildings, contribute to the development of seismic isolation technology and the construction of safe and high quality buildings, thereby contributing to the improvement of people's lives

History of the JSSI

1993	General Meeting for Establishment
1999	Established as a public interest corporation approved by the Ministry of Construction
2011	Became a general incorporated association
2023	30th anniversary

Activity

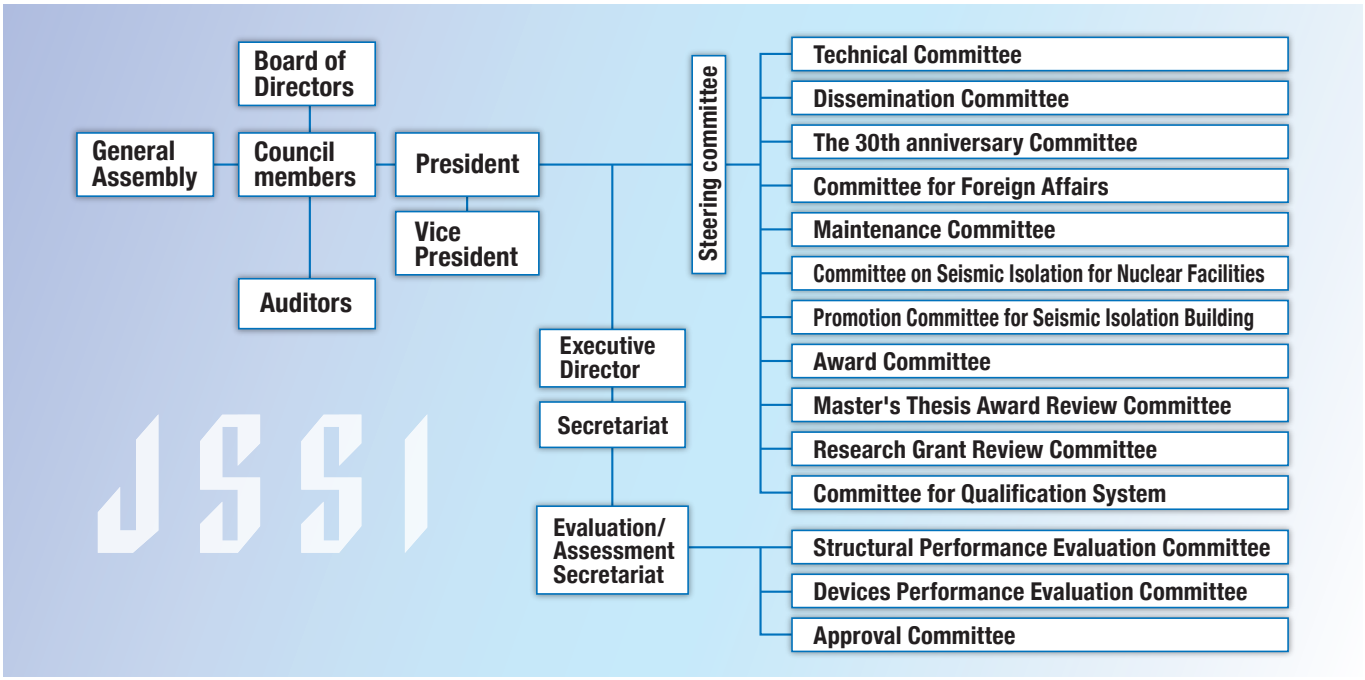
Performance Evaluation Committee for Structures
Designated by the MLIT, in Japan Article 20, Item 1 of the Building Standards Law Performance evaluation work for buildings using time history response analysis such as seismic isolation / vibration control buildings or super high-rise buildings with a height of over 60m.

Performance Evaluation Committee for Devices
Performance evaluation services for building materials such as seismic isolation devices that are certified under Article 37, Paragraph 2 of the Building Standards Act

Commendation/subsidy system
JSSI Award and Master's Thesis Award are presented

Qualification system
JSSI conducts lectures and examinations for qualifications of "Seismic Isolation Building Construction Management Engineer" and "Seismic Isolation Building Inspection Engineer" certified by JSSI, as well as certify qualified persons, issue registration certificates, and hold renewal seminars.
It has been recognized as an indispensable qualification for the construction and maintenance of seismic isolation buildings in Japan.

Organization (2023)



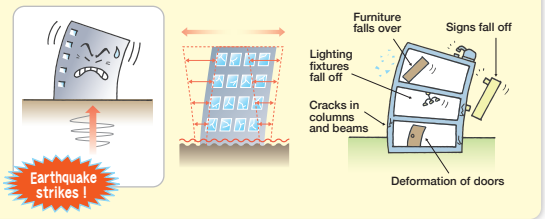
2 Effect of seismic isolation / vibration control

Effect of seismic isolation system

Conventional buildings and seismically isolated buildings during an earthquake

Conventional buildings

The tremors of an earthquake are transmitted directly to the building, when an earthquake hits, it shakes violently.

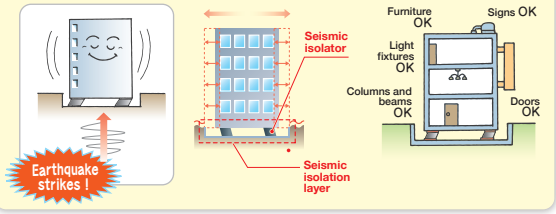


Condition inside the building

Buildings shake violently, furniture falls over, and people's lives are threatened.

Seismically isolated buildings

Dodge the shaking of an earthquake, when an earthquake hits, it shakes slowly



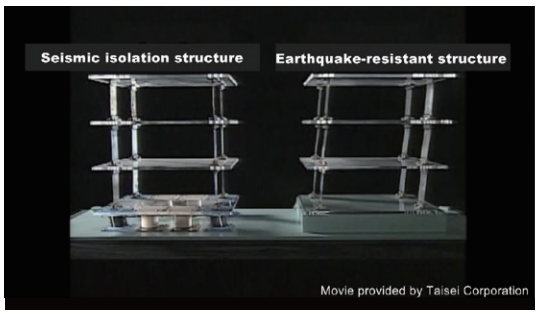
Condition inside the building

Since the seismic isolation device absorbs energy of the shaking, the shaking transmitted to the building is reduced then the furniture is less likely to topple over.

A seismically isolated building has a seismic isolation layer on the ground with seismic isolation devices, and the building is placed on the layer.
When an earthquake occurs, the seismic isolation device absorbs energy of the shaking of the earthquake, making it difficult for the shaking of the earthquake to be transmitted to the building.
Only a small amount of the shaking of the earthquake that could not be absorbed by the seismic isolation device is transmitted to the building.

Related Information
https://www.jssi.or.jp/english/si/doc/SI_booklet.pdf

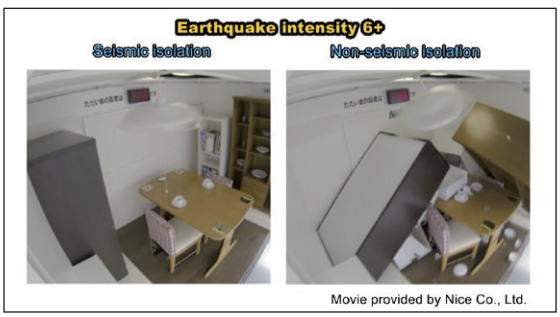
Differences in shaking between seismic isolation and earthquake-resistant structures



Seismic isolation structure shakes slowly when an earthquake hits

Movie
https://orange-molybdenum5953.znlc.jp/wordpress/wp-content/uploads/2022/05/movie.mp4

Indoor situation during earthquakes



The seismic isolation structure prevents furniture from falling over.

Movie
https://orange-molybdenum5953.znlc.jp/wordpress/wp-content/uploads/mov/yurehikaku.mp4

About seismic isolation devices

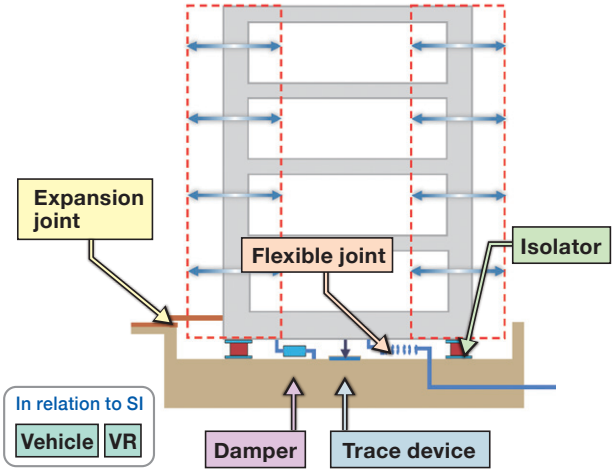
Seismic isolation devices include isolator and damper

In addition, the expansion joints installed around the building, trace device installed on the seismic isolation layer, flexible joints (flexible tubes), etc. are related to seismic isolation buildings.

In relation to seismic isolation, users can also experience the effects of seismic isolation by reproducing the shaking of a seismically isolated building during an earthquake using earthquake simulation vehicle and VR.

Related Information ▶
https://www.jssi.or.jp/seismicisolation_maker

Seismic isolation building and seismic isolation devices, location of related seismic isolation equipment

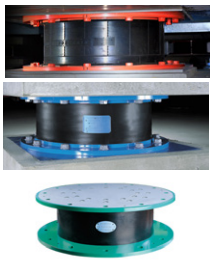


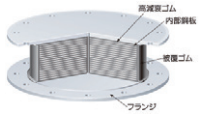
Seismic isolation devices Isolator

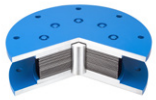
Laminated rubber, sliding, and rolling bearings supporting building loads.

Laminated rubber bearing

Integrally formed by laminating rubber and steel plates.

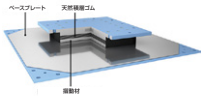

Laminated natural rubber bearing


Laminated high-damping rubber bearing


Laminated rubber bearing with tin plug


Laminated rubber bearing with lead plug

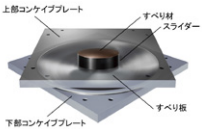
Sliding/rolling bearing



Sliding bearing with elastomer


Rigid sliding bearing


Linear motion rolling bearing


Spherical sliding bearing

Seismic isolation devices Damper

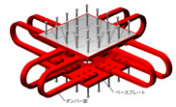
Damper is suppressing shaking and deformation during an earthquake. (Damper type : Fluid type, hysteresis type)

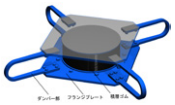
Damper


Oil damper


Rotary damping tube


Lead damper


Steel damper


Laminated rubber bearing with steel damper

Base plate for Isolator

Base plate Flexible joints Expansion joints

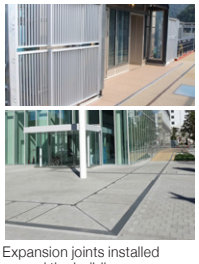
Base plate


It is an embedded hardware that connects the seismic isolation device and the building

Flexible joints


Flexible joints (flexible tubes)

Expansion joints


Expansion joints installed around the building

In relation to seismic isolation Trace device Vehicle VR

Trace device


Trace device installed on the seismic isolation layer

Vehicle


Earthquake simulation vehicle

Related Information ▶
https://www.jssi.or.jp/generalseismic_isolation

VR

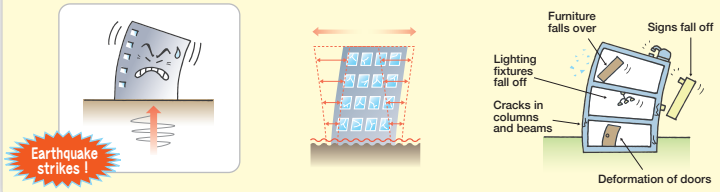
Related Information ▶
https://www.takenaka.co.jp/solution/purpose/medical/sekou/02/index.html

Effect of vibration control structure

Conventional and vibration control buildings during an earthquake

Conventional buildings

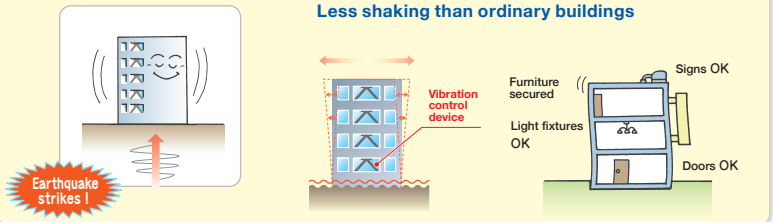
The tremors of an earthquake are transmitted directly to the building, when an earthquake hits, it shakes violently.



Buildings shake violently, furniture falls over, and people's lives are threatened.

Vibration control buildings

Less shaking than ordinary buildings



When an earthquake occurs, the vibration control device absorbs energy of the shaking of the earthquake, the shaking transmitted to the building is reduced, and furniture is less likely to topple over, but it is desirable to fix.

Vibration control buildings are structures that are equipped with vibration control devices to reduce the shaking of the building during an earthquake. In conventional buildings, the energy of an earthquake motion is transmitted to the building as it is in the higher the floor, the greater the shaking. A vibration control device absorbs part of the seismic energy in a vibration control building, which reduces the shaking of the building.

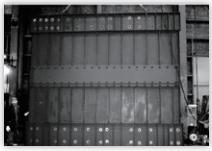
Related Information
https://www.jssi.or.jp/vibration_control-2

Installation of vibration control device

Vibration control s are installed in braces, walls and studs.

Brace type

Wall type



Stud type

About the vibration control device

Vibration control device converts the deformation of metals, the resistance of liquids and soft materials, and the resistance caused by friction into thermal energy, reducing the shaking of buildings during earthquakes.

Related Information
https://www.jssi.or.jp/vibrationcontrol_maker

Part of the vibration control device

Vibration control device using
Metal

As the metal deforms, it absorbs and dissipates seismic energy by converting it into heat energy, reducing the shaking of the building.

Vibration control device using
Liquid

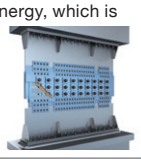
The oil injected into the device or the sticky or sticky viscous material resists flow, converts seismic energy into heat energy, absorbs and dissipates it, and reduces the shaking of the building.

Vibration control device using
Soft materials

By installing a soft material such as rubber in the damping device, the soft material deforms greatly during an earthquake, converting the seismic energy into heat energy and absorbing and dissipating it, reducing the shaking of the building.

Vibration control device using
Friction

Frictional materials such as metals and sliding materials are tightened, and the frictional force generated when moving converts seismic energy into heat energy, which is absorbed and dissipated, thereby reducing the shaking of the building.



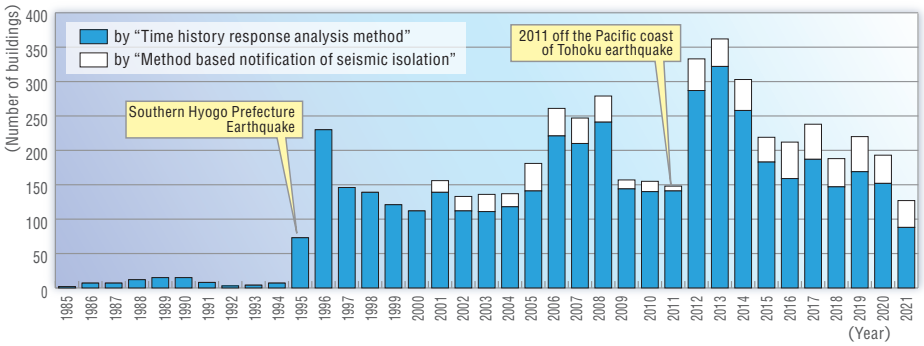
3 Achievements for seismically isolated and vibration

Achievements for seismically isolated buildings

(Results of data accumulation by the Japan Society of Seismic Isolation)

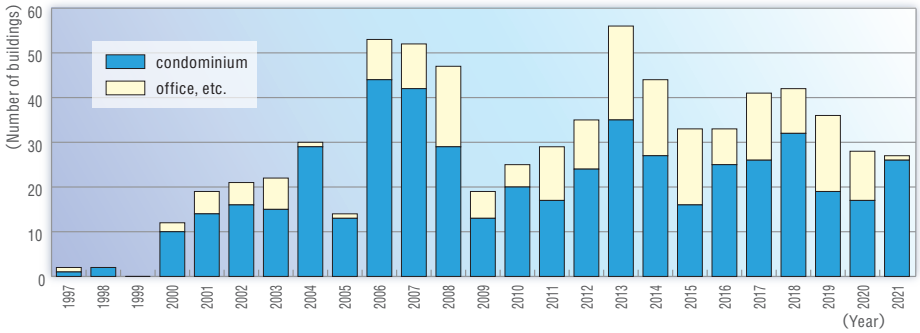
Transition in the number of buildings planned for seismic isolation

The first was built in 1983. Triggered by the 1995 Southern Hyogo Prefecture Earthquake, it spread rapidly.
Currently, the number of buildings is about 150/year. 5286 buildings by 2021



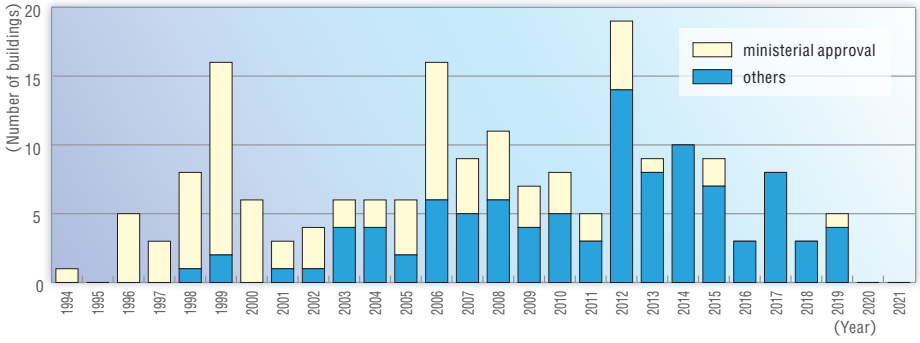
Transition for seismically isolated super high rise buildings

In 1997, the first super high-rise seismic isolation building was constructed.
It is mainly used as condominium, but in recent years the number of offices has also increased.
The highest building with seismic isolation is over 200m.
A total of 722 buildings by 2021



Transition in the number of buildings retrofitted for seismic isolation

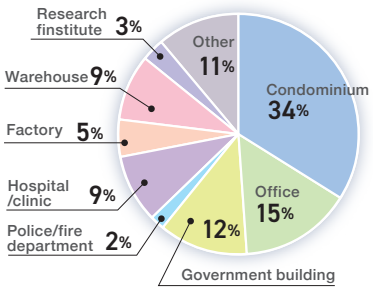
The first was built in 1994, ministerial approval may or may not be obtained.
Slightly declining in recent years.
A total of 186 buildings by 2021



Usage ratio for seismic isolation buildings

(2017~2021)

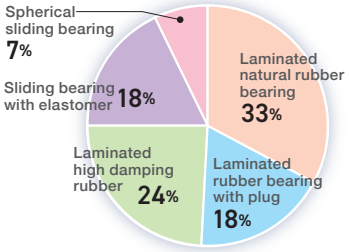
The most common use is condominium, next, many offices and hospitals adopt seismic isolation structures.
Recently, the number of large-scale facilities such as warehouses and factories is increasing.



Usage ratio for isolators

(2017~2021)

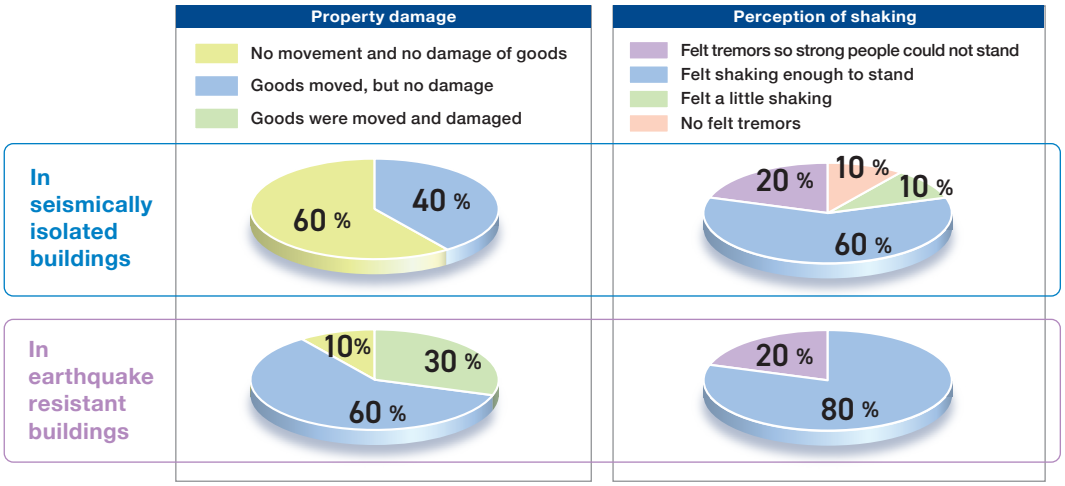
Laminated natural rubber bearing is the most common, followed by laminated rubber bearing with plug and laminated high-damping rubber.
Sliding bearings with elastomer are used in combination with other bearings.
Recently, the use of spherical sliding bearings has been increasing.



control buildings

Questionnaire of persons who experienced tremors in seismically isolated buildings

Questionnaire survey of those who experienced the 2011 off the Pacific coast of Tohoku Earthquake

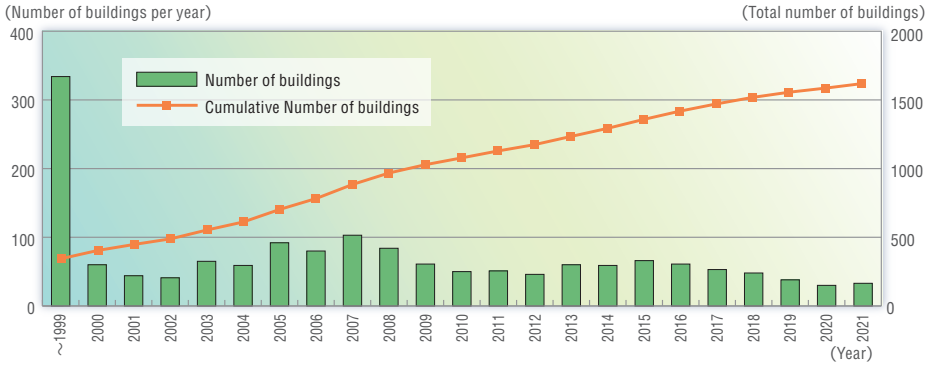


Achievements for vibration control buildings

(Results of data accumulation by the Japan Society of Seismic Isolation)

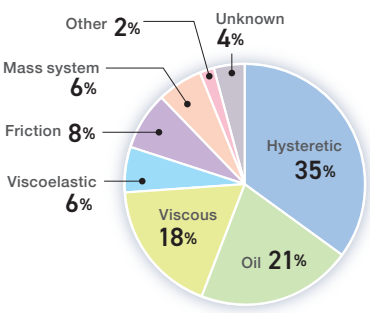
Transition in the number of vibration control buildings

The first was built in 1984, currently, the number of buildings is about 50/year. 1618 buildings by 2021



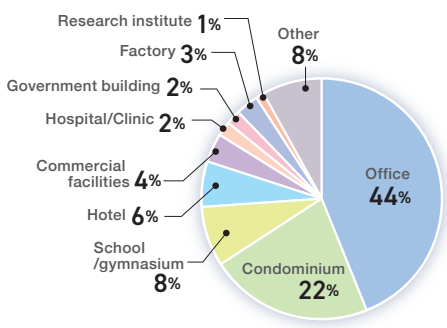
Ratio of vibration control devices

Hysteresis type is the most common, next types are oil dampers and viscous dampers, and in recent years, oil dampers are increasing in number.



Usage ratio of vibration control buildings

High-rise offices are the most common, then, it is often used in super high-rise condominiums.



4 Earthquake observation records for seismically isolated buildings

The 2011 off the Pacific coast of Tohoku Earthquake

Ishinomaki Red Cross Hospital

Seismically isolated structure has demonstrated its functionality as a disaster base

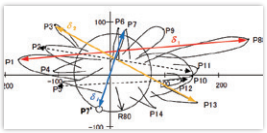
Provided by Ishinomaki Red Cross Hospital

Although the seismic intensity near the construction site was 6-lower, there was no damage to buildings and no important equipment or medical equipment was knocked over. After the earthquake, we quickly resumed medical services and were able to accept many patients as a local disaster base.

Site: Ishinomaki City, MIyagi Prefecture
Building outline: Steel, B1-7F
SI device: LRB, SLD, SD

Indoors after the earthquake. Documents on desks and books on shelves without doors are sliding down, and shelves and furniture are not falling over.

Entrance plaza used for medical treatment after the earthquake



Trajectory of tracer

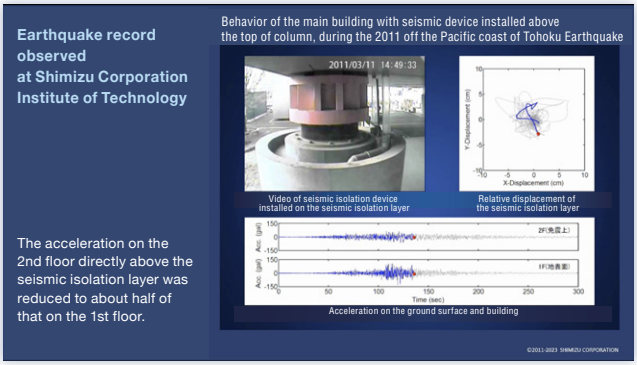
Condition of steel damper after earthquake

Shimizu Corporation Institute of Technology

Photographing the behavior of seismic isolation laminated rubber during an earthquake

Movie provided by Shimizu Corporation Institute of Technology

Site had a seismic intensity of 5 strong, but there was no damage to the building structure, fixtures, or fixtures.
The seismometer recorded a ground acceleration of 132 gal and a building top floor acceleration of 72 gal.
The maximum displacement of the seismic isolation layer was about 8cm.



The 2016 Kumamoto Earthquake

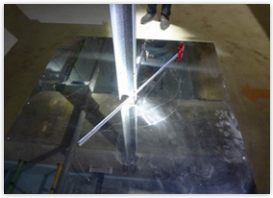
Aso Medical Center

Provided by Takayama Laboratory, Fukuoka University

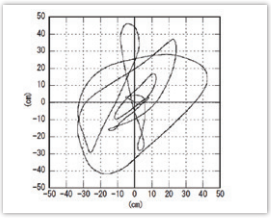
The seismic intensity near the site was 6-weak, but, there was no damage to the building, and no important equipment or medical equipment was knocked over. As a result, medical services were resumed promptly after the earthquake, and it was able to accept patients from the surrounding non-seismic isolation hospitals (13 facilities) that were shut down during the earthquake.
The maximum double amplitude recorded by the tracer on the seismic isolation layer was approximately 90cm (one side amplitude 46cm).

Site: Aso City, Kumamoto Prefecture
Building outline: RC, 4FL
SI device: LRB, LRB with lead plug

Building



Displacement record by tracer



Record of displacement by tracer

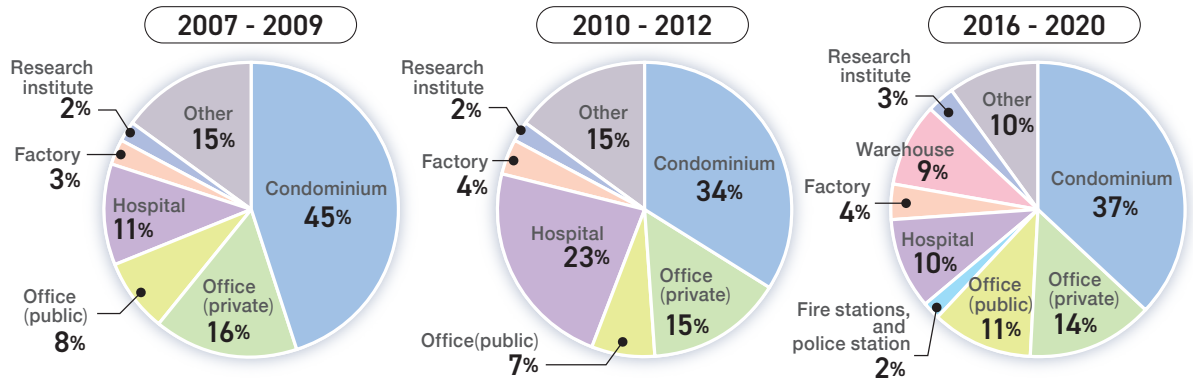
5 Seismic isolation buildings and business continuity / Daily life continuity
Seismic Isolation buildings and earthquake risk

Increase in applications for business continuity

Since the Mid Niigata Prefecture Earthquake 2004, it has become widely known that seismically isolated structures are effective in maintaining functionality even after earthquakes, they have already become the standard for hospitals that serve as disaster prevention bases, and by 2012, we had a track record of 425 hospitals. In addition, application to Public offices, fire departments, and police stations, which are disaster prevention bases, is increasing. Recently, the number of large-scale facilities such as warehouses and factories has been increasing.

Related Information
https://www.jssi.or.jp/society_economy-2

Usage of seismic isolation buildings



Continued operations as a disaster prevention base after the 2011 Great East Japan Earthquake Disaster

The Ishinomaki Red Cross Hospital and the Ishinomaki Koiki Fire Department headquarters are both buildings with seismic isolation structures, and during the 2011 Earthquake, they served their function as disaster bases immediately after the earthquake, and the two worked together. Rescue, transportation, relief, and medical activities were conducted.

Related Information (movie)
https://www.youtube.com/watch?v=Pc1ZO7YwcWc

Ishinomaki Red Cross Hospital

provided by Ishinomaki Red Cross Hospital

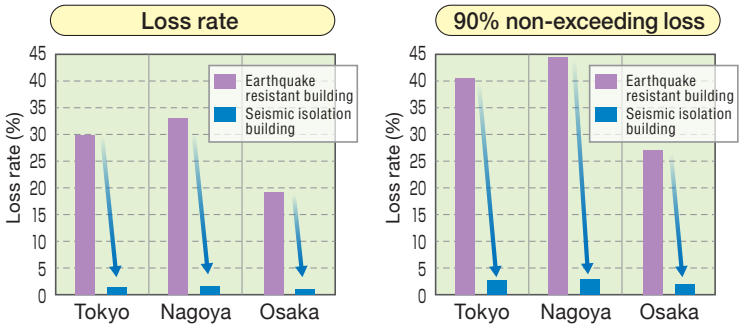
Ishinomaki Fire Department Headquarters

provided by Ishinomaki Fire Department Headquarters

Significant reduction in earthquake risk

The cost-effectiveness of earthquake-resistant buildings can be evaluated using the earthquake risk-reduction effect. With reference to the definition of PML, which is used as an index of earthquake risk, the expected loss value and 90% non-exceeding loss over the next 50 years are evaluated, and earthquake-resistant buildings and seismically isolated buildings are compared.

Comparison of earthquake loss rates over the next 50 years



Conditions to consider

- 10-story steel construction • Office
- National seismic motion prediction map, 2016 edition
- The structure above the seismic isolation layer is the same as an earthquake-resistant building.

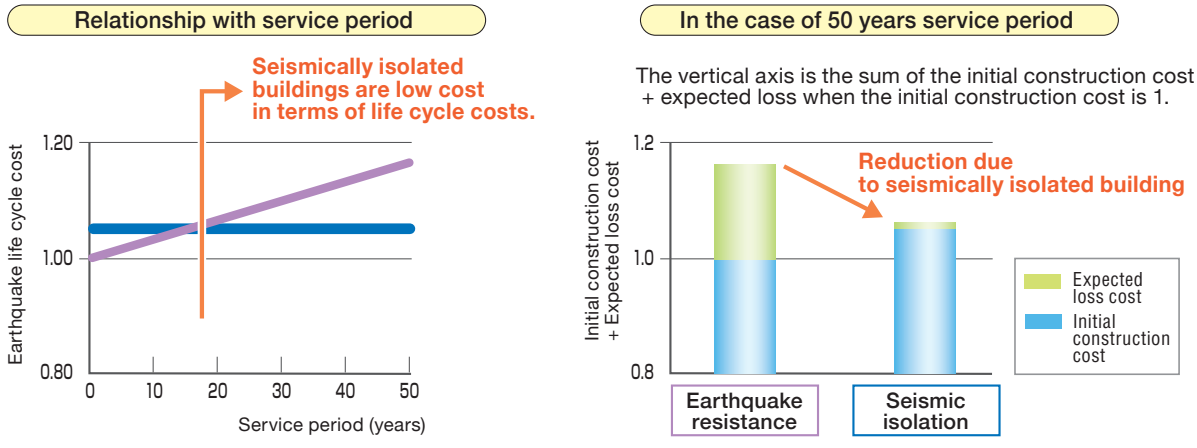
[Loss rate]
Ratio of restoration costs to new construction costs
[Expected loss value]
Average loss
[90% non-exceeding loss]
Loss rate that has a 10% probability of exceeding that value

Furthermore, in addition to reducing physical-losses that occur during earthquakes, reducing opportunity-losses due to business interruptions. From the perspective of business continuity and life continuity, it can be said that it is advantageous to use seismic isolation buildings.

Seismic Isolation Buildings and Seismic Life Cycle Costs

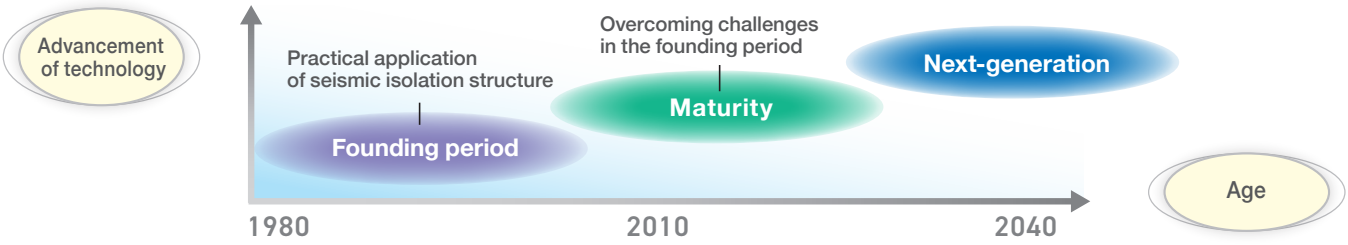
Comparing the life cycle cost, which is the initial construction cost plus the loss expected value during the service period, since the expected loss value of a seismically isolated building is very small, it can be seen that the seismically isolated building becomes more economically advantageous over time.

Comparison of earthquake life cycle costs (initial construction costs + expected losses) in Tokyo



6 Construction of next generation seismic isolation structure system and new system

Next-generation seismic isolation system



Buildings that control nothing fade away, and controlling the response of buildings is taken for granted.
What the next generation needs:

High-performance seismic isolation system that can respond to increasing seismic motion and high performance requirements

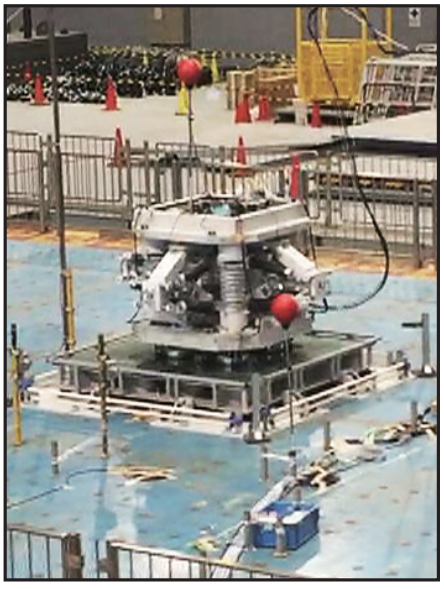
- **Floating construction method**
  A system that levitates during an earthquake using a response control device and an electric levitation device
- **Variable stiffness device + variable damping device**
  The period and damping performance are changed by the response control device and the electric variable device.

Simple seismic isolation system that is extremely primitive and applicable in any country

Sliding seismic isolation using low-cost sliding materials, the building is set on the sliding layer that spreads over the foundation. Earthquake energy is absorbed by the sliding material and stops when the shaking ends

New system

Dynamic levitation device on the floor



Movie provided by National Research Institute for Earth Science and Disaster Resilience

Floating method

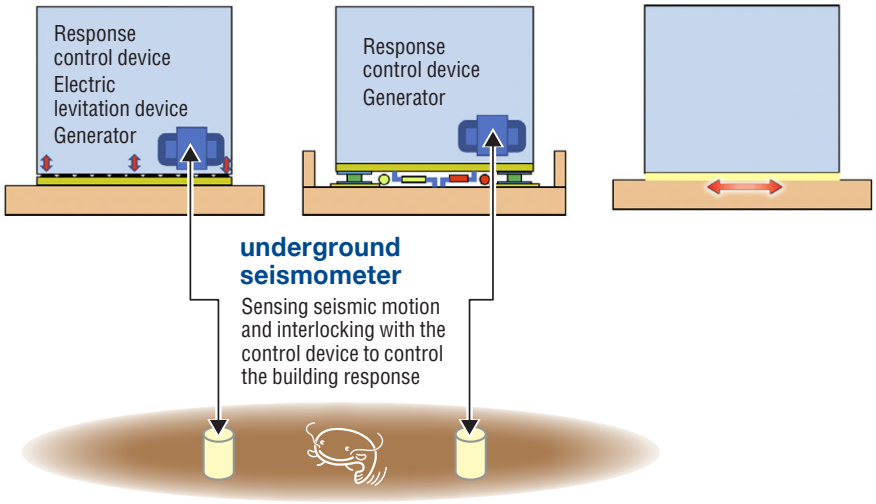
Floating during an earthquake with a response control device and an electric levitation device

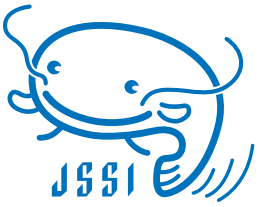
Variable stiffness device + variable damping device

Change period and damping factor by response control device and electric variable device

Simple seismic isolation system

Use a sliding type and a cheap material for the sliding material





Japanese fairy tale:
Earthquake due to moving by catfish

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