State of the Art Technology:
Base Isolation, Damping Systems
and Buckling Restrained Braces
-Protection of Nonstructural Elements and Building Contents

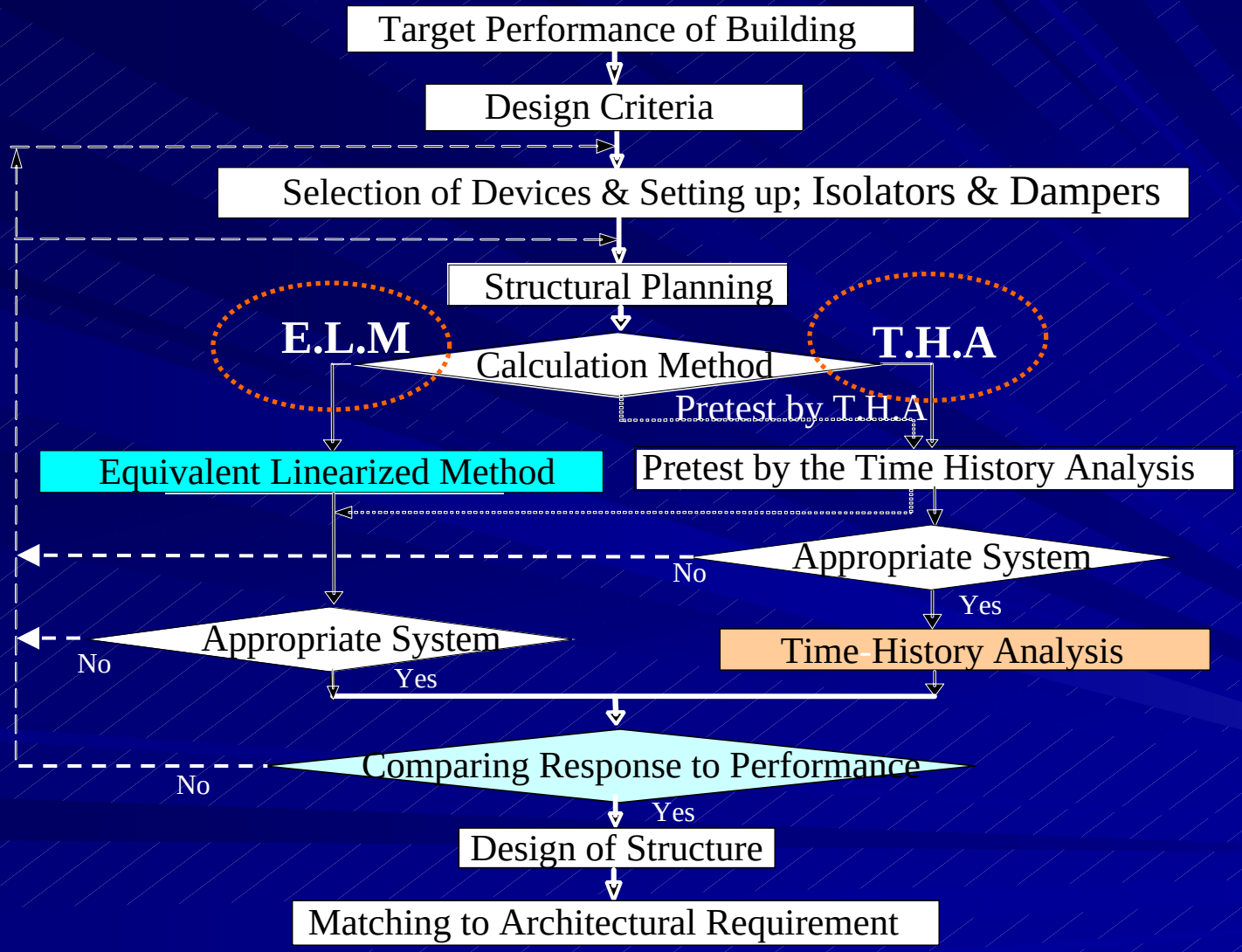
PROGRESS OF SEISMIC ISOLATION IN JAPAN

Kani, N.
The Japan Society of Seismic Isolation
April 17 2006

Recent Trends in SI Buildings in Japan

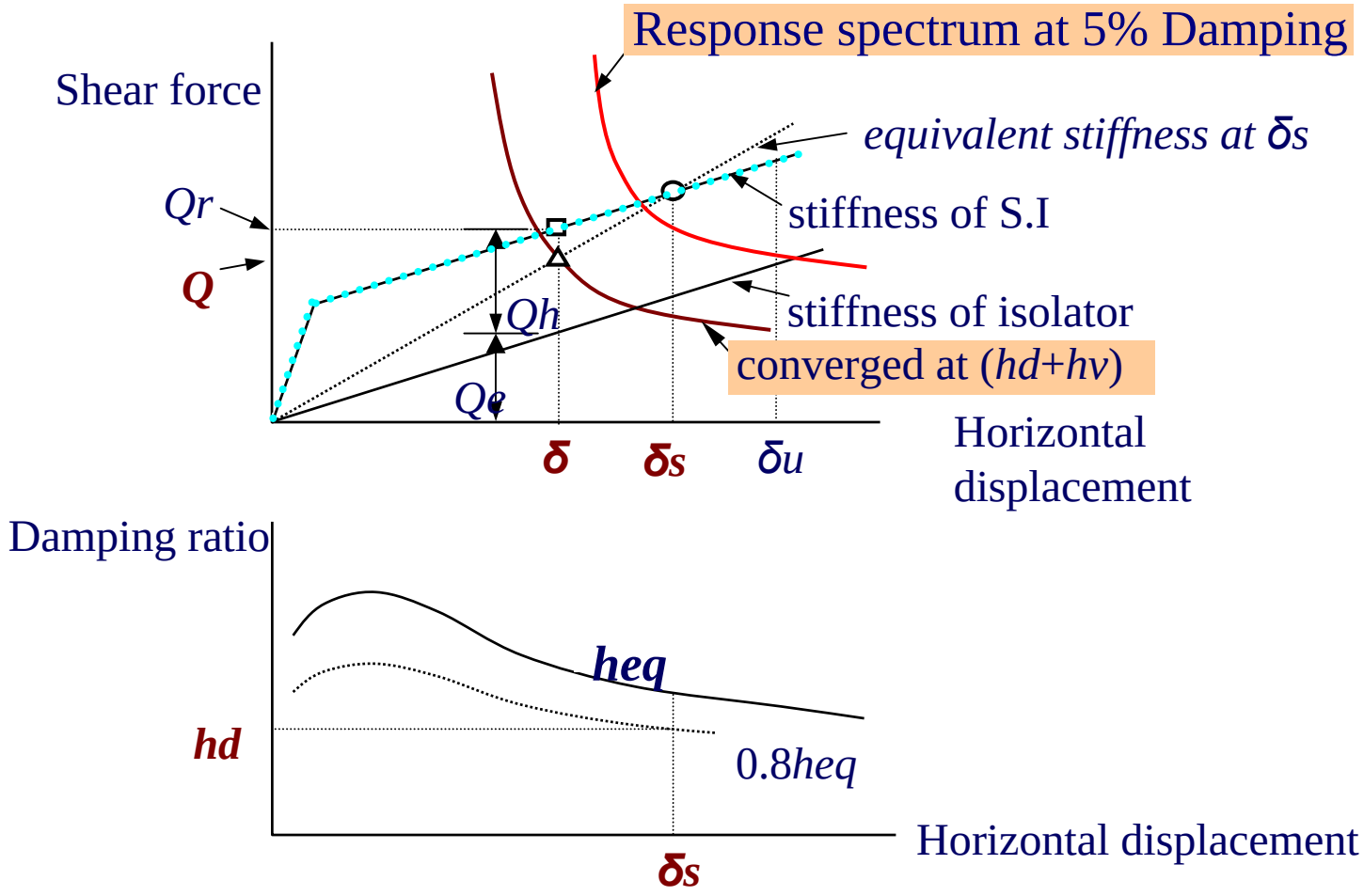
Update No. of SI Buildings	:	1,500
Condominiums:		40%
Retrofit	:	50
Detached House	:	3,000

Flow of Structural Calculation for SI Bldg.



E.L.M.

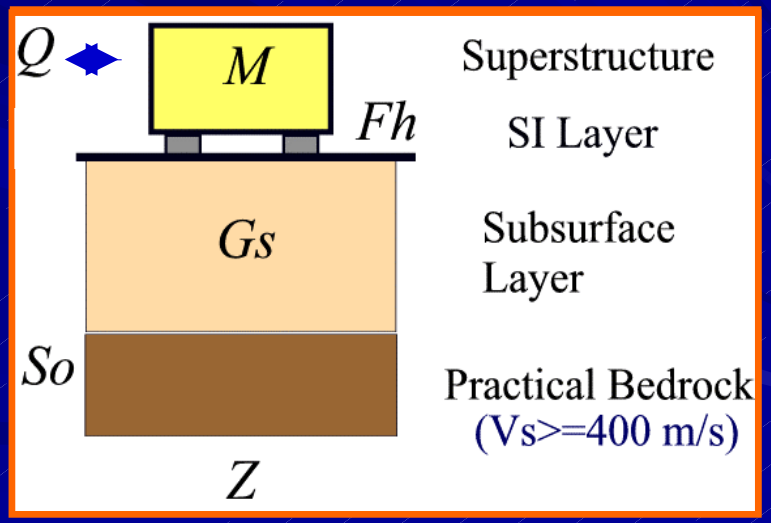
Calculation of Shear Force & Displacement



Shear Force & Displacement by E.L.M.

$$Q = \gamma \cdot So \cdot M \cdot Fh \cdot Z \cdot Gs / Ts$$

γ : Factor on dispersion, aging & temperature (1.0 to 1.3)
So: Standard Spectrum Value on the practical bedrock
M: Mass of SI bldg.
Fh: Reduction rate due to damping (0.4 to 1.0)
Z: Zone factor (1.0 to 0.7)
Gs: Amplification factor
of earthquake motion by
surface geology (1.0 to 1.5)
Ts: Design equivalent period



Shear Force & Displacement by E.L.M.

$$\delta r = 1.1 \alpha \cdot \delta$$

δ： Response displacement of gravity

α： Factor on dispersion, aging & temperature
(1.0 to 1.2)

1.1： Factor for accidental eccentricity

Two Calculation Methods for SI Bldg.

ELM using Response Spectra
Notification 2009 by MLIT

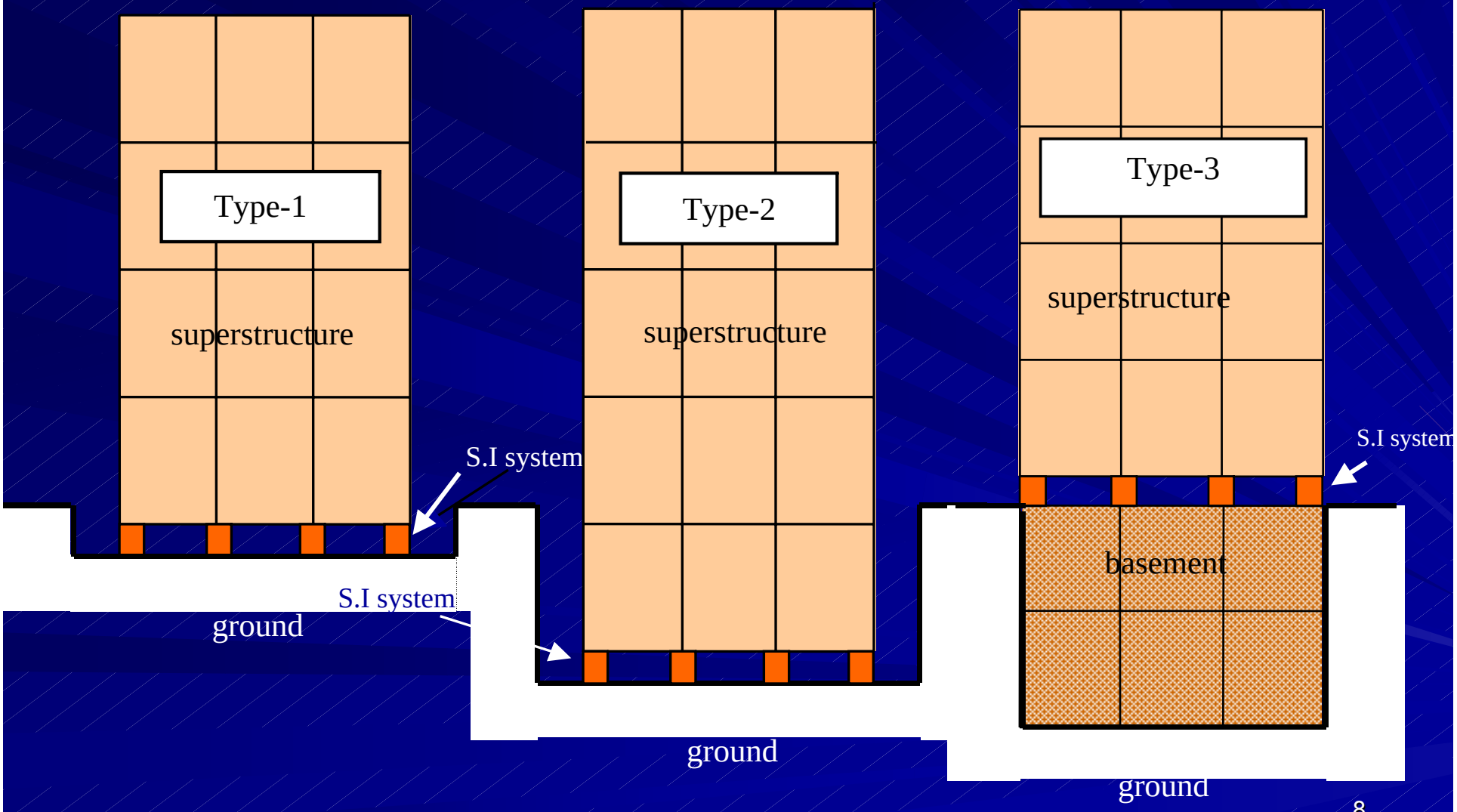
Notification is issued in Oct. 2000.
Approval by “Building Official” is requested.

THA
Notification 1461 by MLIT

Time History Analysis Method is used since 1983.
Performance evaluation by the authority,
and approval by Ministry of Land, Infrastructure and Transportation are requested.

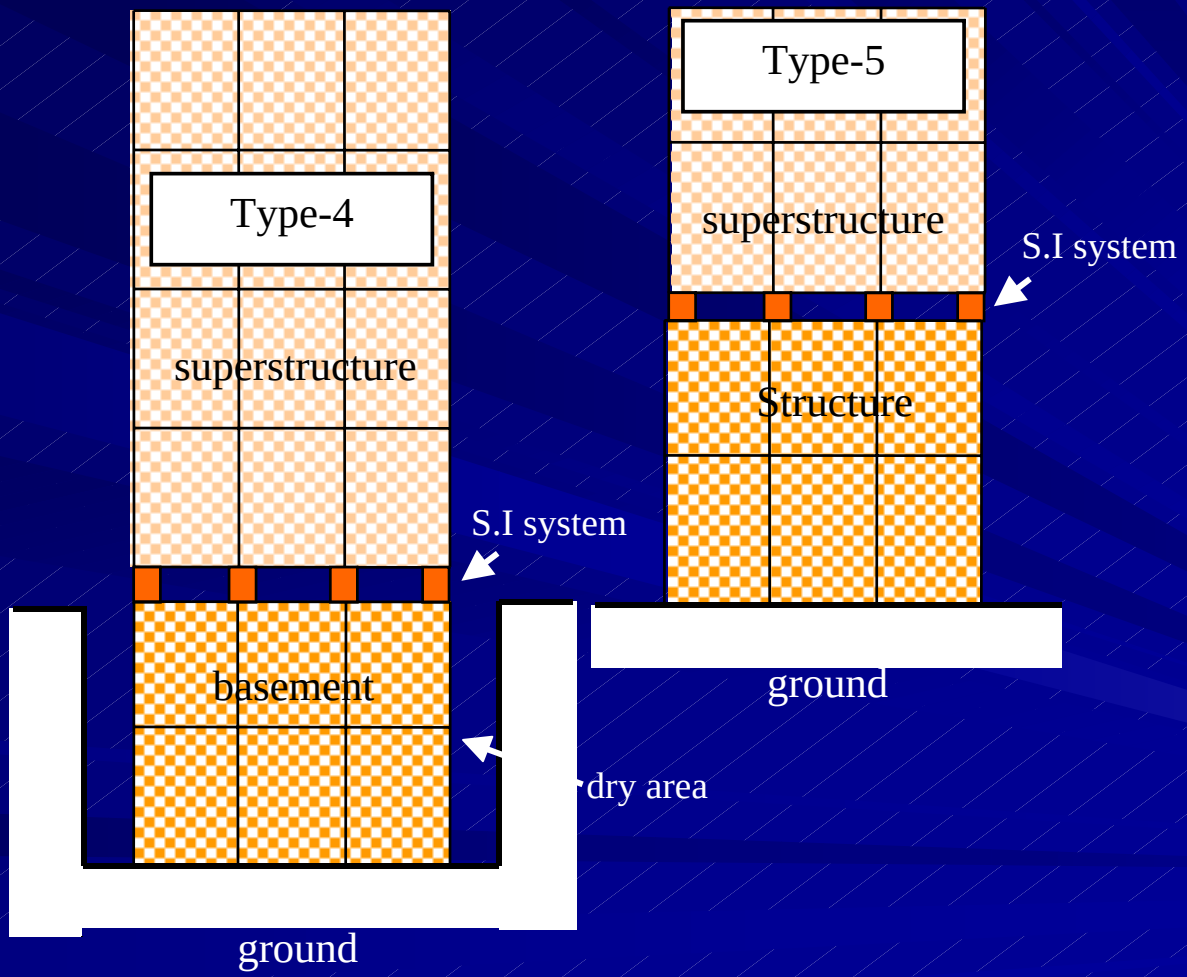
Location of Seismic Isolation Layer

(Base isolation: 90%)



Location of Seismic Isolation Layer

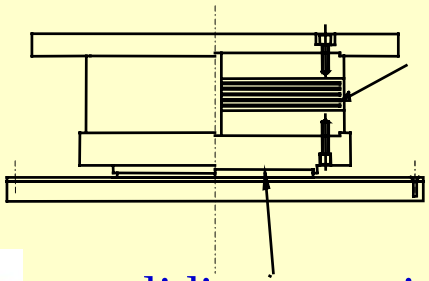
(Within the building isolation: 10%)



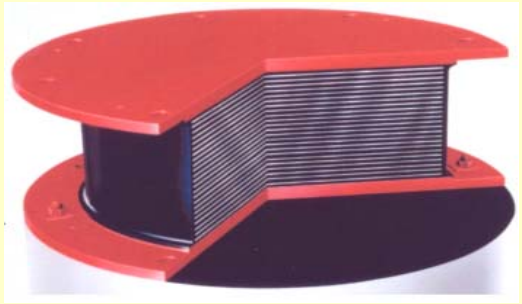
Isolators

- Elastomeric Isolator
  - Natural Rubber Bearing
  - Lead plug Rubber Bearing
  - High Damping Rubber Bearing
- Slider
- Rotating Ball Bearing

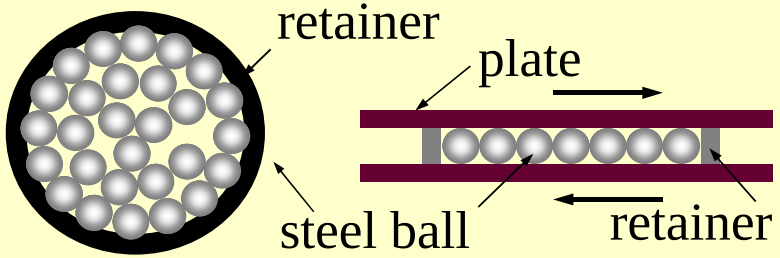
Slider with Elastomer



Elastomeric Isolator

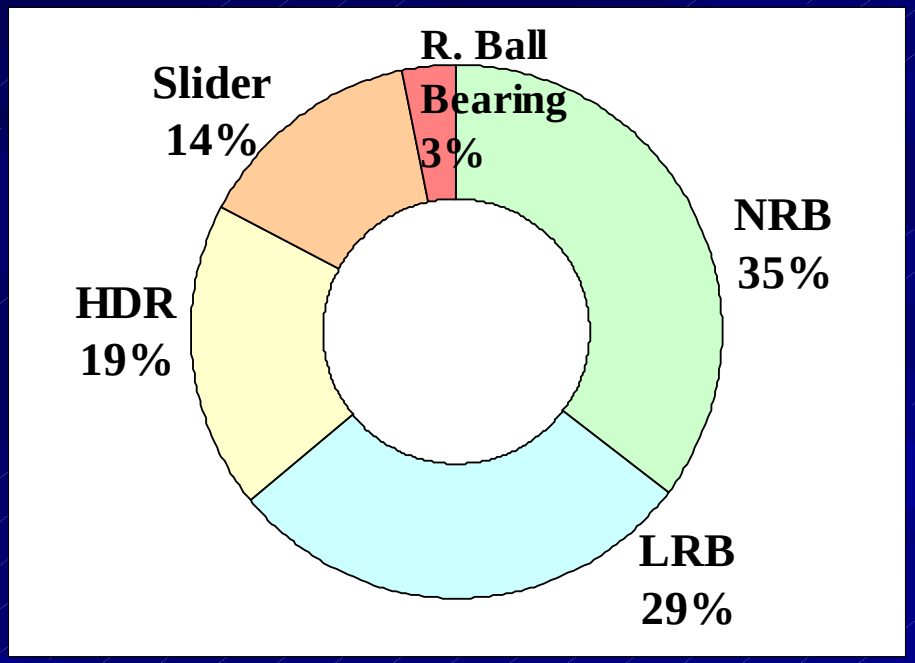


Rotating Ball Bearing

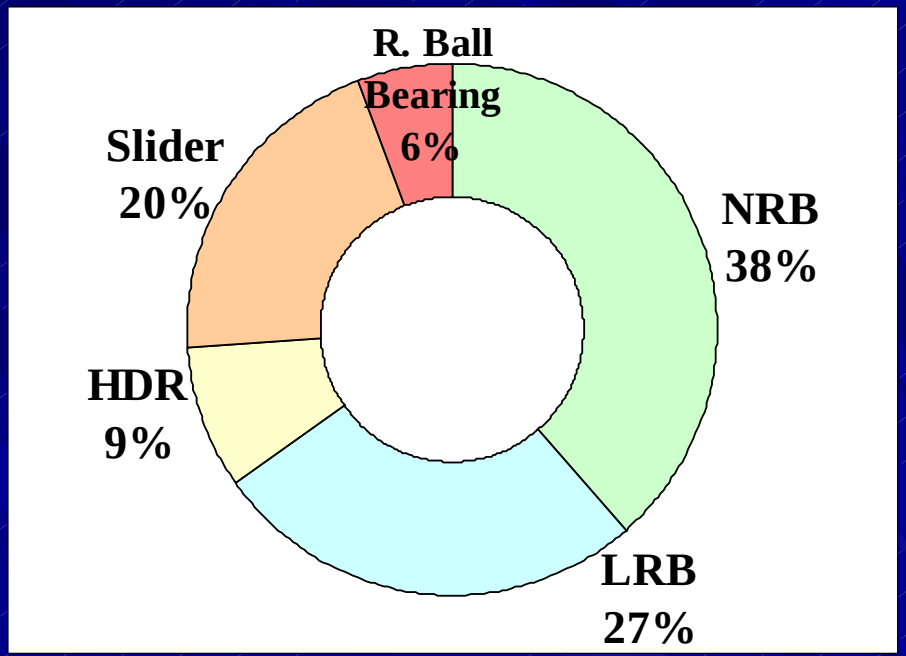


Usage Ratio of Isolators

(1983 ~ 2002)



(2000 ~ 2002)

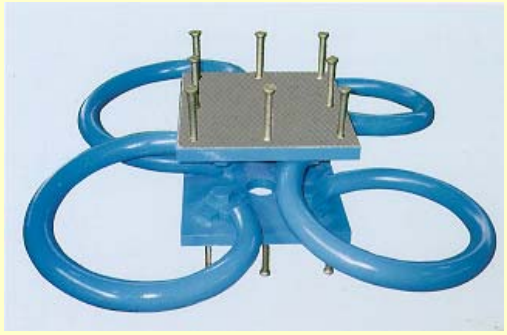


NRB: Natural Rubber Bearing
LRB: Lead Rubber Bearing
HDR: High Damping Rubber Bearing
RBB: Rotating Ball Bearing

Dampers

- Elastoplastic Damper
  - Steel Damper
  - Lead Damper
- Fluid Damper
  - Oil Damper
  - Viscous Damper
- Friction Damper

Steel Damper

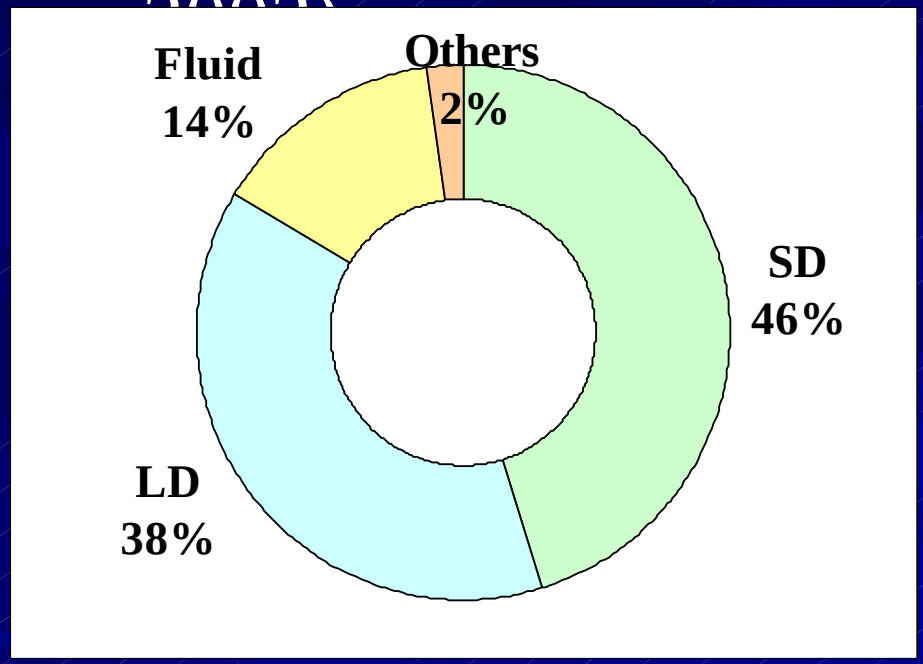


Lead Damper

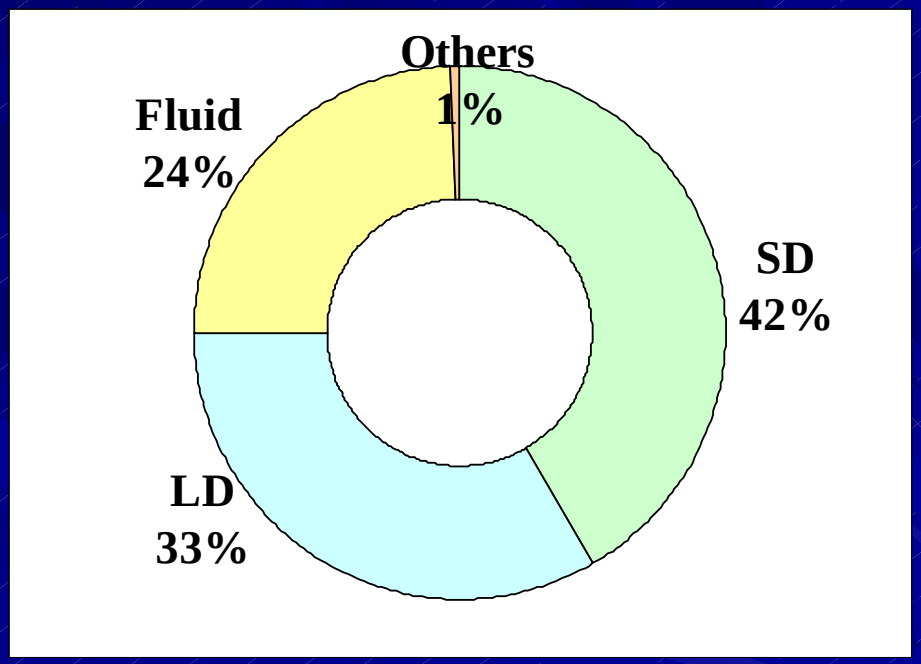
Oil Damper

Usage Ratio of Dampers

(1983 ~ 2002)



(2000 ~ 2003)



SD: Steel Damper
LD: Lead Damper
Fluid: Viscous Damper or Oil Damper

Device Qualification

Standard for SI Devices

Notification 1446 by MLIT

Performance evaluation by the authority,
and approval by Ministry of Land Infrastructure
and Transportation are requested.

Standard for SI Devices

1. Feature
   (shape, size, materials)
2. Basic performance value & measurement
   (stiffness, stress, equivalent damping, etc.)
3. Ultimate Strength & deformation value & measurement
   (compressive, tensile, shear strain, etc.)
4. Dependency, dispersion & measurement
   (Vertical Stress, Temperature, Cycle, Velocity, etc.)
5. Inspection at completion

Retrofit with SI

(Not Occupied)

Building	Usage	Story	Area	Constructed	Isolation Layer
Yugawara Training Center East	Office	7/0	3153	1964	F
Yugawara Training Center	Office	14/2	12505	1964	6
Hakone Town Office	Office	4/0	3528	1969	F
East Japan Construction Security	Office	10/1	14773	1972	2
Microtech Headquater	Office	5/1	1151	1994	1
Meiko Construction Office	Office	4/0	1109		1
Japan Industial Club	Office	5/0	8612	1920	F
Foreign Affairs Headquater	Office	8/1	55892	1960	F
Osaka Central Public Hall	Hall	3/1	9970	1918	F
Risshokoseikai Main Hall	Hall	8/0	26971	1964	F
Kaitokaku	Hall	3/0	3386	1908	F
Jounior High School B Bkdg,, Tokyo Kasei University	School	4/1	4273	1967	B1
First test Lab., Kansai University	Laboratory	4/0	1271	1973	F
National Museium	Museium	3/1	4354	1959	F
Chiba Province Museium	Museium	5/0	2416	1967	F
Old Kobe Concession	Others	2/0	346	1880	F
Sawanotsuru Oishigura	Others	2/0	977	1840	F
Daigokuden, Heijo Palace	Others	1/0	1700	-	F
Clock Turret, Kyoto University	Others	2/1	5312	1925	F
Bushogonenkai Temple	Temple	1/0	907	1953	F
Rikkyo University Church	Church	1/0	505	1920	F
Kudankita Dormitory	Dormitory	11/1	3296	1967	F

Location; F: on the Footing, B1: on the Basement, No.: on No. Floor

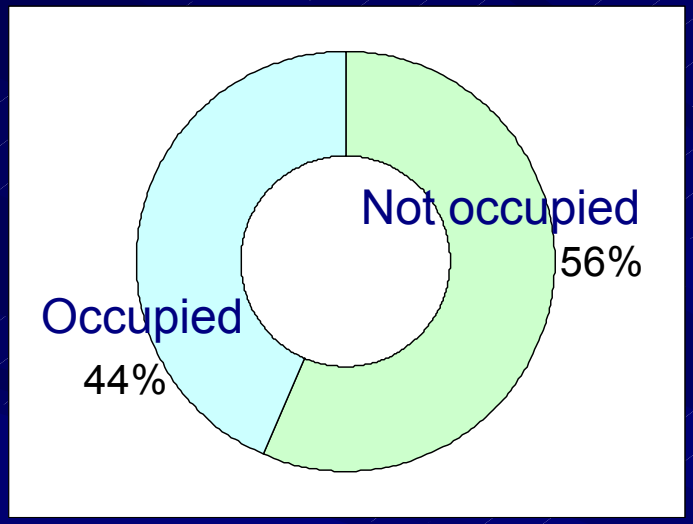
Retrofit with SI

(Occupied or Sliding)

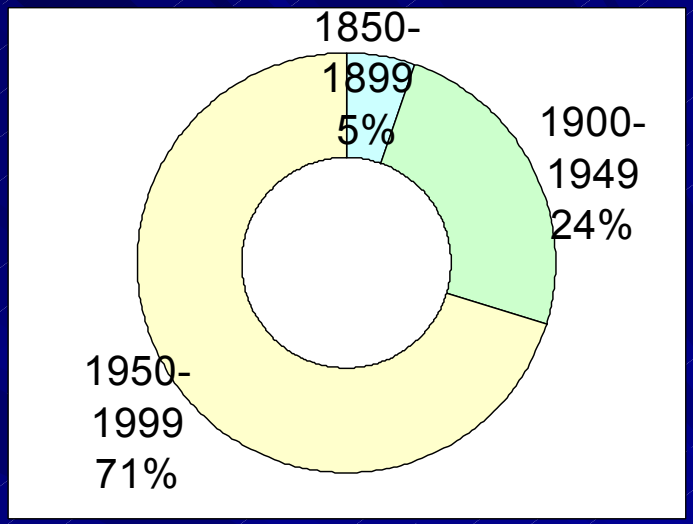
Building	Usage	Story	Area	Constructed	Isolation Layer
Toshima City Office	Office	4/1	13057	1961	F
Tekken Construction Office	Office	11/1	8304	1979	B1
Kudan Post Office	Office	10/0	7696	1967	2
Murakami City Office	Office	5/0	6900	1974	1
Shinjuku Station West	Office	8/2	20291	1964	3
Central Office 3rd Bldg.	Office	11/2	69973	1966	F
Yamanashi Prefectural Office	Office	8/1	10035	1963	B1
Mie Prefectural Office	Office	8/1	23128	1964	F
Atsugi City Office	Office	5/1		1971	F
New Prime Minister's House	Office	2/0		1929	F (SLD)
Children's Library	Library	3/1	1971	1906	F
Chubu University 9th Bldg.	School	5/0	1964	1966	F (SLD)
Nihon University Funabashi 3rd Bldg.	School	4/0	3061	1965	B1
Gate, Kagoshima Old office	Others	3/0	935	1925	F (SLD)
Honganji Temple Annex	Temple	1/1	1173	1929	F
Terrace House Minaminagasaki -4	Condominium	5/0	1686	1962	1
Terrace House Minaminagasaki -3	Condominium	5/0	1514	1962	1

Location; F: on the Footing, B1: on the Basement, No.: on No. Floor

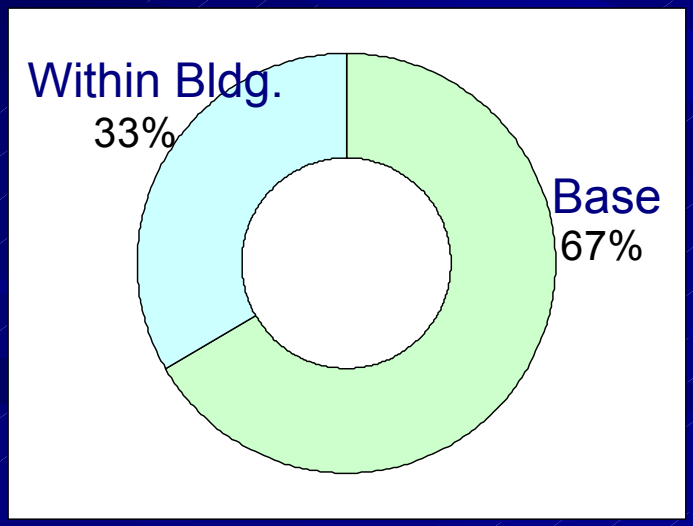
Retrofit with SI



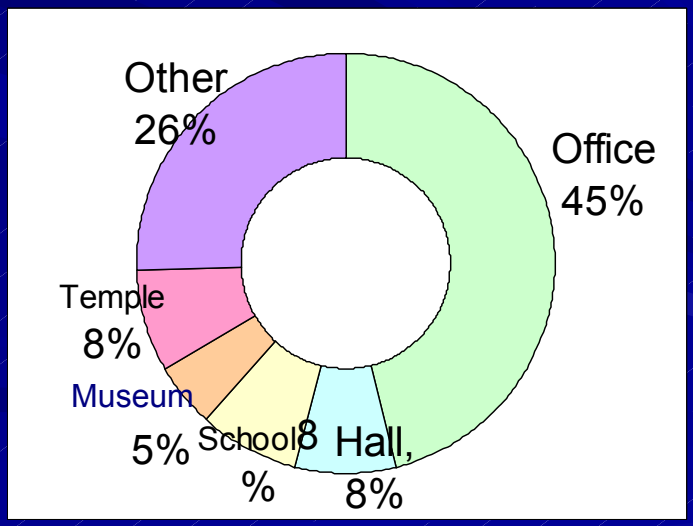
Retrofiting situation



Completion time frame



Location of isolation layer



Usage

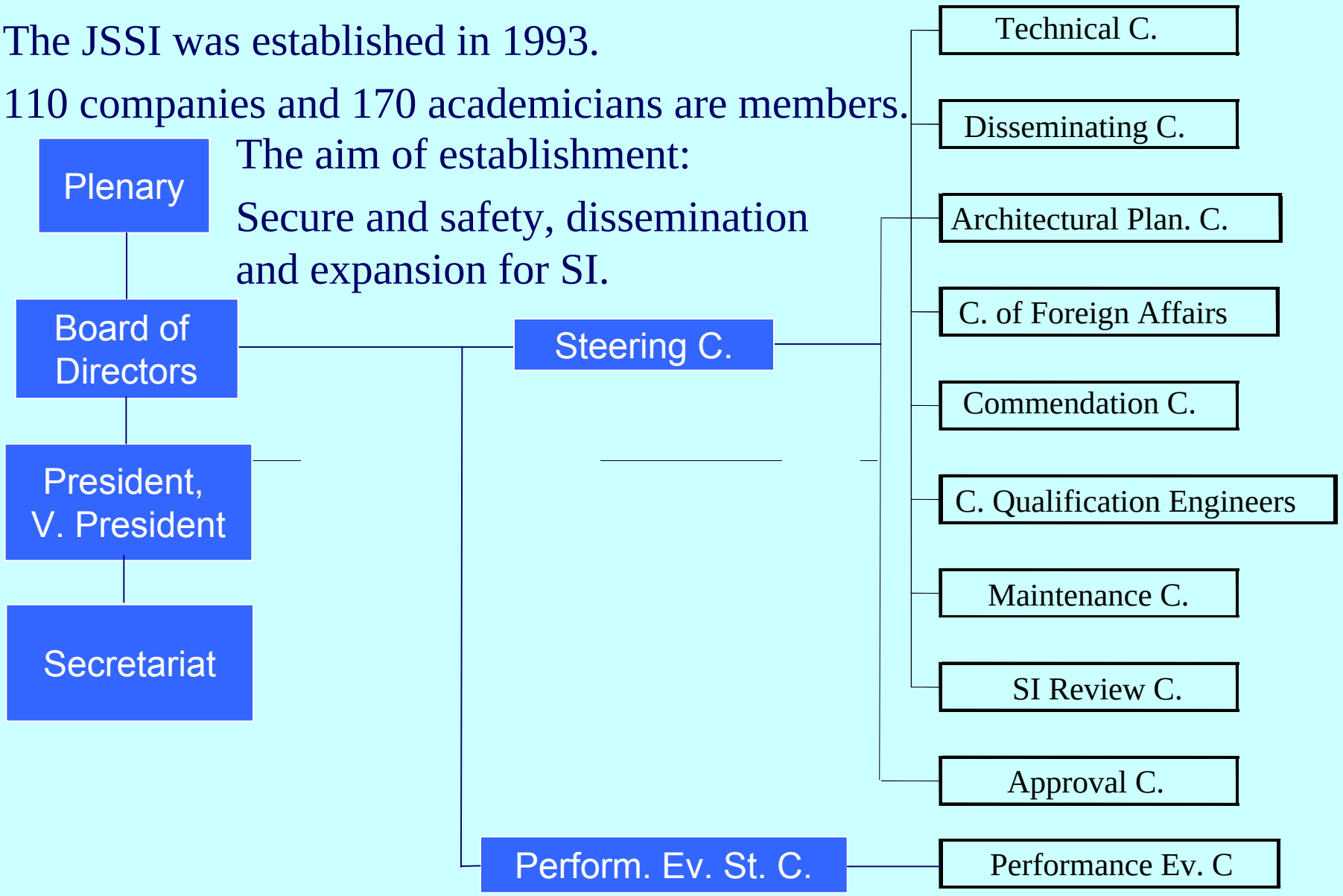
Organization of JSSI

The JSSI was established in 1993.

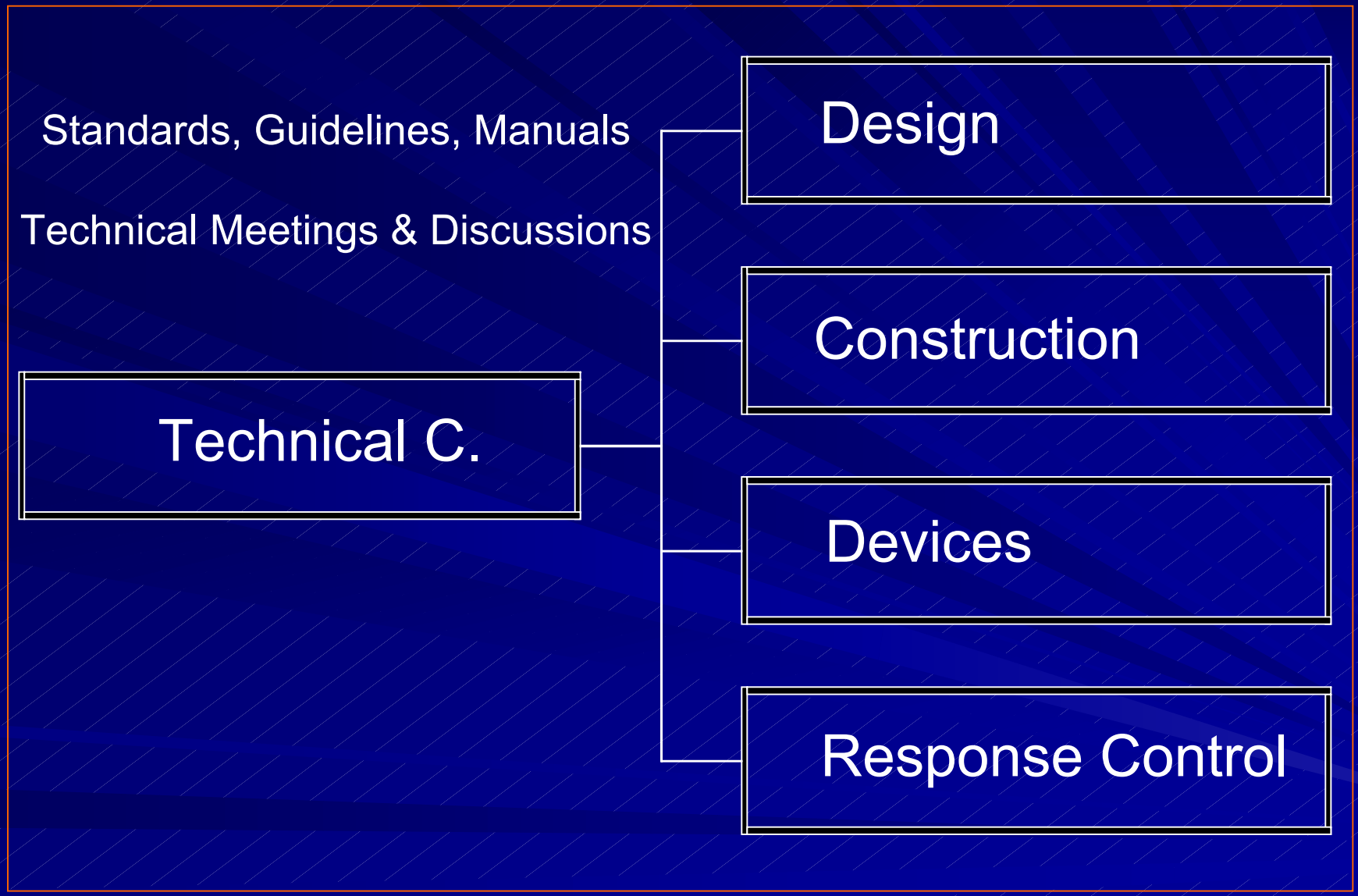
110 companies and 170 academicians are members.

The aim of establishment:

Secure and safety, dissemination and expansion for SI.



Technical Committee



Disseminating Committee

Seminars, Technical Tours,

Publishing Magazines, Books

Exhibitions, Forums

For the Development of SI Structures in Future

- High Performance Devices
  1. the elastomeric isolator with softer stiffness & with good durability,
  2. more stable isolators for large vertical loads with large deformations,
  3. much smaller dispersion and much lower dependency on devices
  4. more efficient dampers
- Performance Evaluation of SI & Merging Business Continuity

- Next System

  Hybrid System, etc.

Orienting a direction to control the behavior of structures by using response control devices with a stable computer system.

For Advance on Seismic Isolation

- More dissemination, explanation and expansion of public relations must be conducted.
- Acquirement on Dynamics for Structural Engineers

Thank you for your attention