International Trends of Application of Seismic Isolation System

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Contents

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Appendix: Data Sheets of Applications

-Response Controlled Buildings and Devices

China

Eight seismically isolated and one response controlled buildings

Italy

Nine seismically isolated and three response controlled buildings

Japan

Nine seismically isolated and one response controlled buildings

USA

Eight seismically isolated and four response controlled buildings

Italy from Mauro Dolce, Massimo Forni and Alessandro Martelli

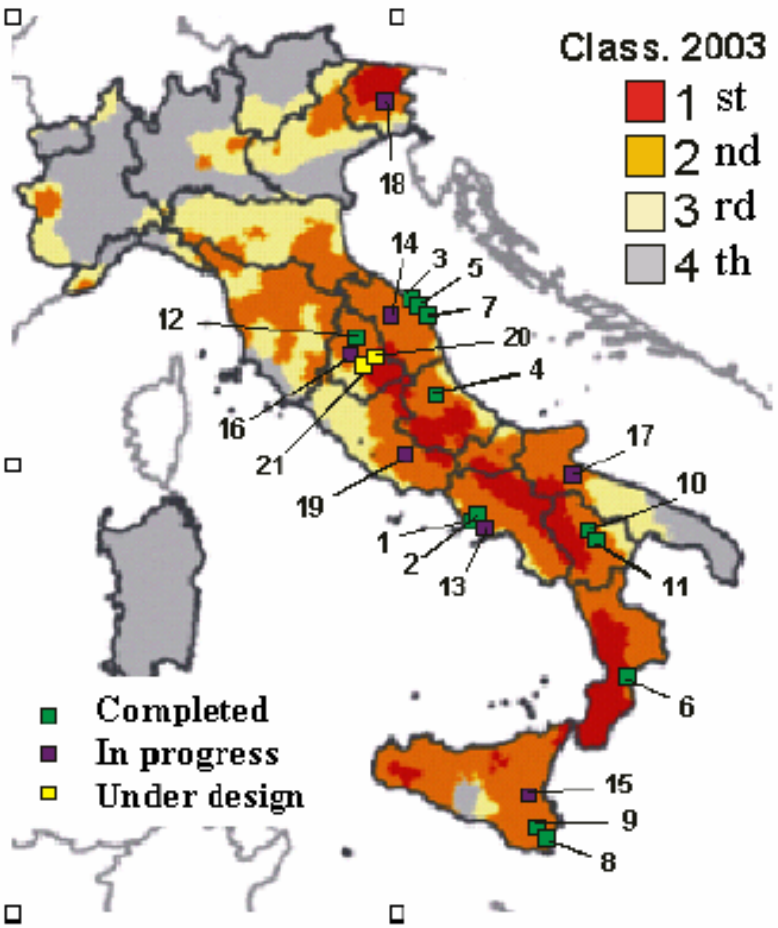


Figure 5.2.1 Location of the Italian seismically isolated buildings of Table 5.2.1 and seismic classification according to Ordinance 3274 of May 8, 2003.

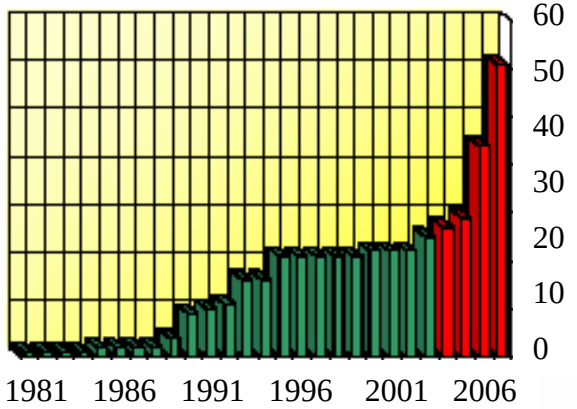


Figure 5.2.2a Building applications of seismic isolation in Italy.

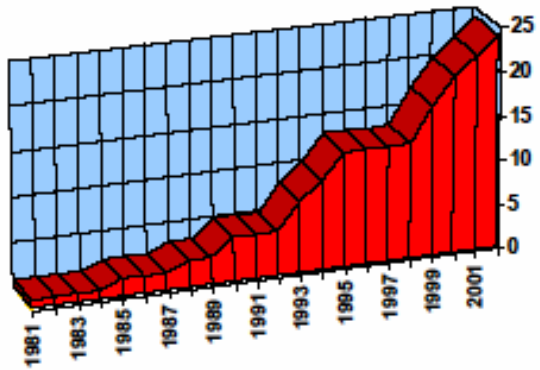


Figure 5.2.2b Building applications of energy dissipation, shape memory alloy devices and shock transmitters in Italy.

Italy from Mauro Dolce, Massimo Forni and Alessandro Martelli

Marche Regional Centre of Telecom-Italia at Ancona, the first large application of base SI in Italy (the second Italian application of base SI) constructed in 1992 with HDRB and a fail-safe system

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Isolated residential building at Squillace, the first Italian application of seismic isolation to apartment buildings

The SI system is formed by LDRBs and some HDRBs, the isolators were installed at top of the basement columns.

A vertical and horizontal fail-safe system is present at the isolators level.

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Training building for volunteers

Medical centre

Navy isolated apartment building

Isolated buildings owned by the Italian Navy during 1992-1995 using HDRB, which did not need for any approval by the Ministry of Construction

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Applications during 1994 to 1998

Campus of the University of Basilicata at Potenza in 1995

Fire protection of HDRB

Another application is the New Library of University of Naples in 1996

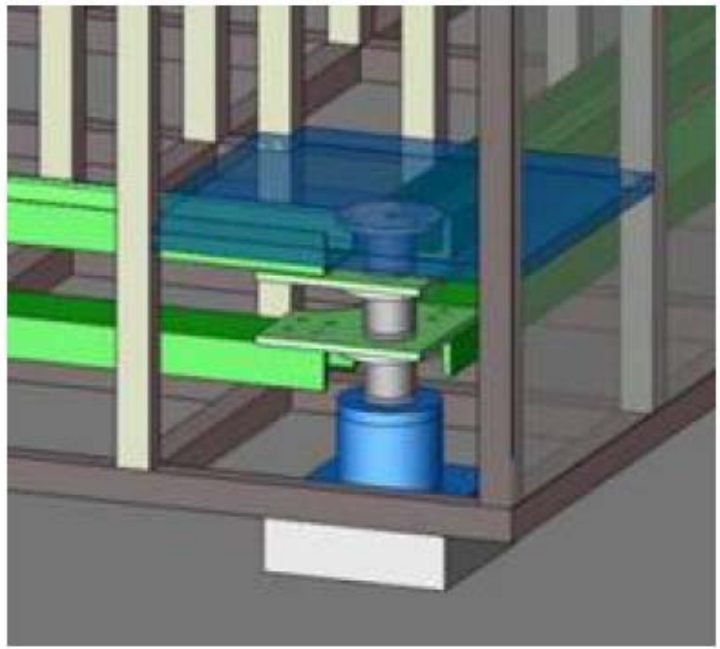
Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Applications during 1999 to May 2003

The seismically isolated housea at Rapolla, near Potenza in 2000, with two different SI systems, namely consisting in HDBRs only and a combination of sliding devices (SDs) and HDRBs, the second systems behaved in an excellent way.

Italy from Mauro Dolce, Massimo Forni and Alessandro Martelli



As a consequence of the damages caused by the 1997-98 earthquakes, application of the SVPC techniques restarted for the seismic rehabilitation of cultural heritage,

Bronzes of Riace and one of its supporting HDRBs (above); Germanicus Emperor and sketch of the three-stage HDRB system

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Applications after May 2003

Applications to new residential buildings at Città di Castello using the new Italian seismic code

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Recent applications to strategic and public buildings

New isolated section of the Gervasutta Hospital using HDRBs

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Recent applications of seismic isolation to existing buildings

Damage of the 1997 Marche and Umbria earthquake

New underground floor after HDRB insertion

Italy

from Mauro Dolce, Massimo Forni and Alessandro Martelli

Recent applications to cultural heritage

The Satyr of Mazara del Vallo, protected by hree-stage HDRB system

Scylla and Neptune, protected by a SD/SMAD SI system

Korea from Dong Guen Lee

Seismic isolation was introduced in Korea when the Pyung-taek LNG terminal storage tanks were built in the 1980s. In the 1990s, a second LNG terminal was constructed in Inchon.

Figure 5.4.1 Inchon LNG terminal

Figure 5.4.2 LNG storage tank

Figure 5.4.3 LRB array

Figure 5.4.4 LRB on pedestal

Figure 5.4.5 LRB under test

Figure 5.4.6 LRB chilled to -28°C

Korea from Dong Guen Lee

Figure 5.4.7 Unison R&D center

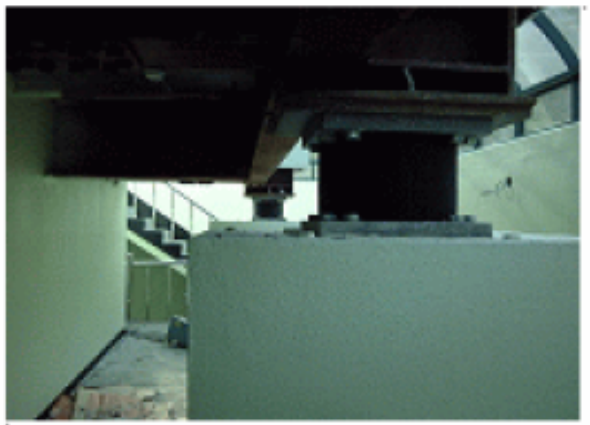


Figure 5.4.8 LRB on a pedestal

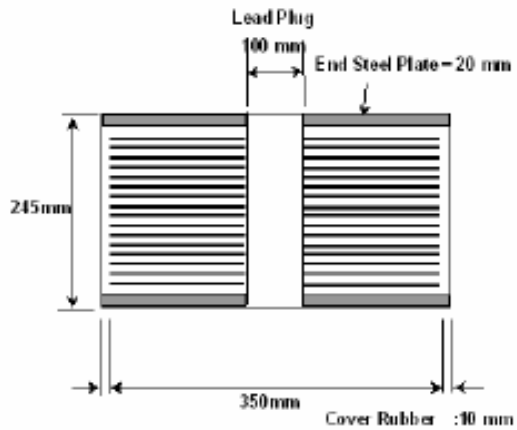


Figure 5.4.9 Section on a LRB

Currently, there are only two seismically isolated buildings in Korea, with a third to be built soon.

The Unison Research and Development Center building, constructed in 1997, was the first seismically-isolated building.

Korea from Dong Guen Lee

Figure 5.4.10 Traum Haus III

Figure 5.4.11 Front elevation

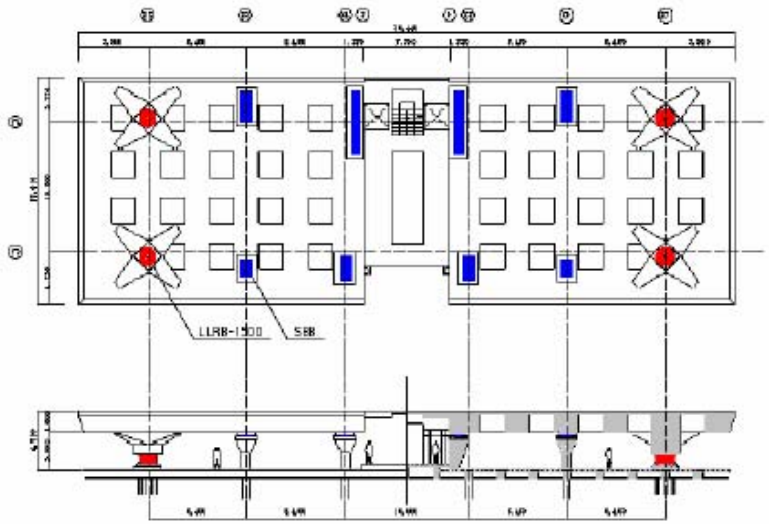


Figure 5.4.12 Location of LRB's and SBB's

The second was Traum Hous III, a 12-story apartment building in Seoul

Figure 5.4.13 LRB located on a base

Figure 5.4.14 Load collector on a LRB

Korea from Dong Guen Lee

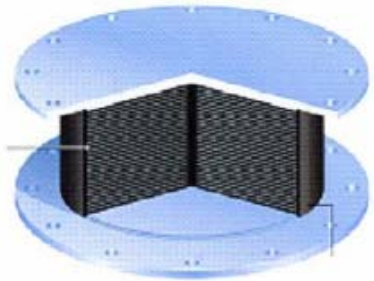
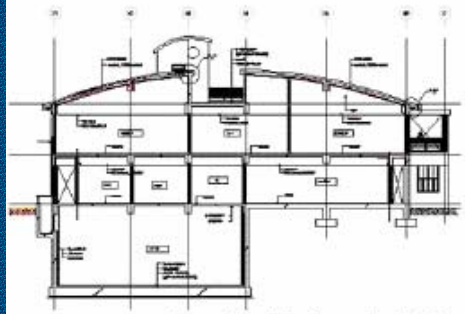
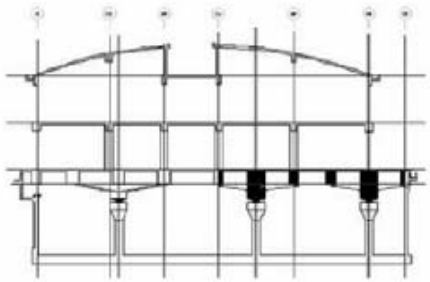


Figure 5.4.15 NRB

Figure 5.4.16 A 1/3 scale model on a shaking table



(a) original design w/o isolation



(b) revised design with isolation

Figure 5.4.17 Revision of design by introduction of seismic isolation

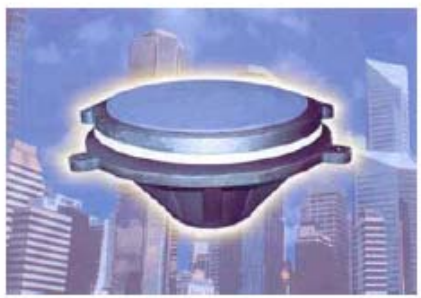


Figure 5.4.18 Sliding bearing

The third is the Yechon Community Center building, a two-story RC frame with one-level basement in a small village in Seosan City, Chung-Chong-Nam-Do Province.

New Zealand from John X. Zhao

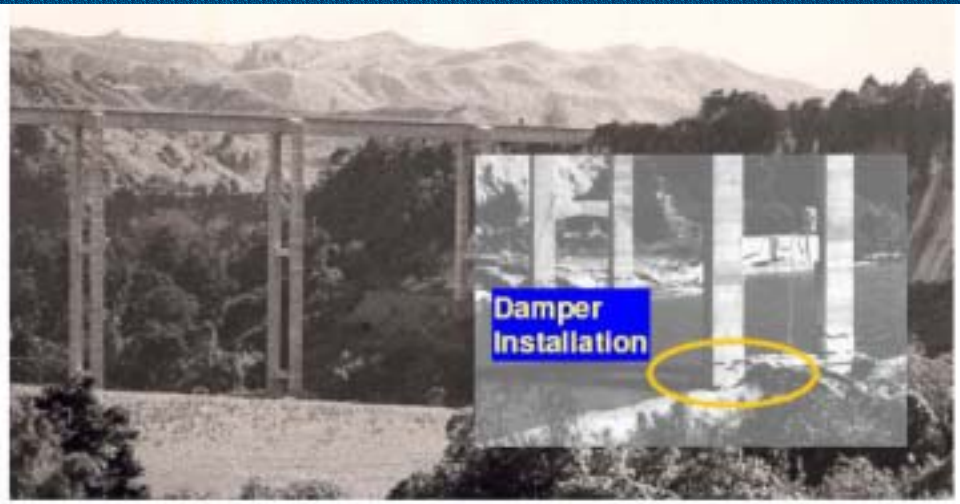


Figure 5.5.7 South Rangitikei viaduct under construction. The foot of each leg of all piers are designed to "step" (supplied by Jim Cousins)

The first seismically isolated structure in New Zealand was the Motu Bridge in the North Island completed in 1974.

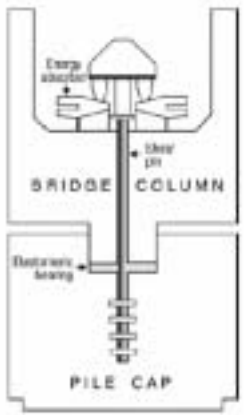


Figure 5.5.8 Details of guide and damper systems

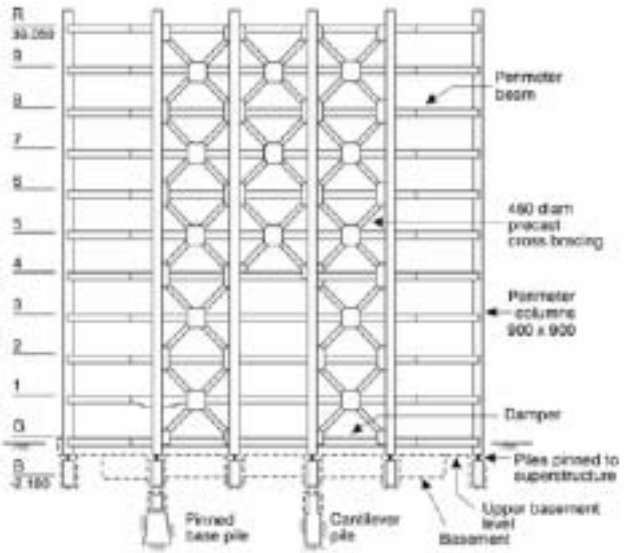
Figure 5.5.9 Steel dampers similar to this were used in the South Rangitikei viaduct (supplied by Robinson Seismic Ltd.)

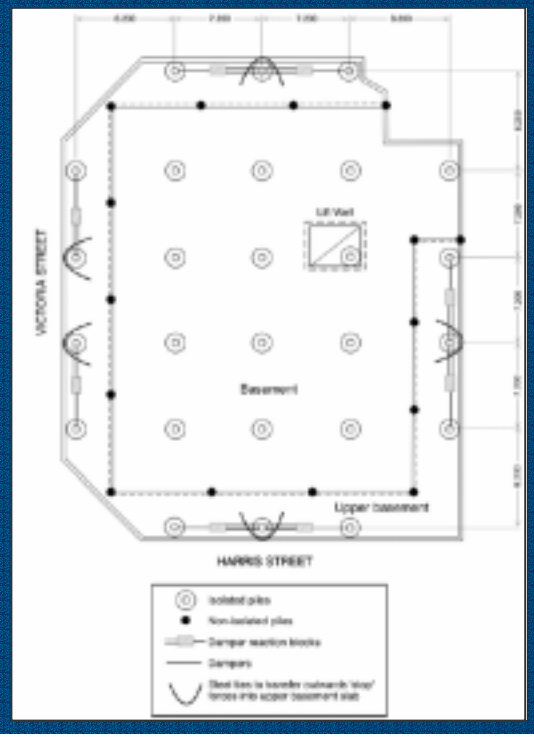
Rocking Seismic Isolation System

The isolation mechanism is provided by stepping action of each of the two feet of the piers. Steel dampers are used for energy dissipation.

New Zealand from John X. Zhao

Figure 5.5.10 Wellington Central Police Station (supplied by Robinson Seismic Ltd.)





Sleeved Pile Seismic Isolation System

The Wellington Central Police Station with 24 lead extrusion dampers that connected the pile caps to the ground along the perimeter.

USA from Ian Aiken and Andrew Whitaker

Construction of the first seismically-isolated building in the USA was completed in 1985, and by mid-2005 there were approximately 80 seismically-isolated buildings in the USA

The first building in the USA is the Foothill Communities Law & Justice Center, in Rancho Cucamonga, California, was completed in 1985,with 98 high-damping rubber bearings located below the basement level

USA from Ian Aiken and Andrew Whitaker

The second building application in the USA was the City and County Building, in Salt Lake City, Utah, completed in 1989 with 208 lead-rubber and 239 natural rubber bearings.

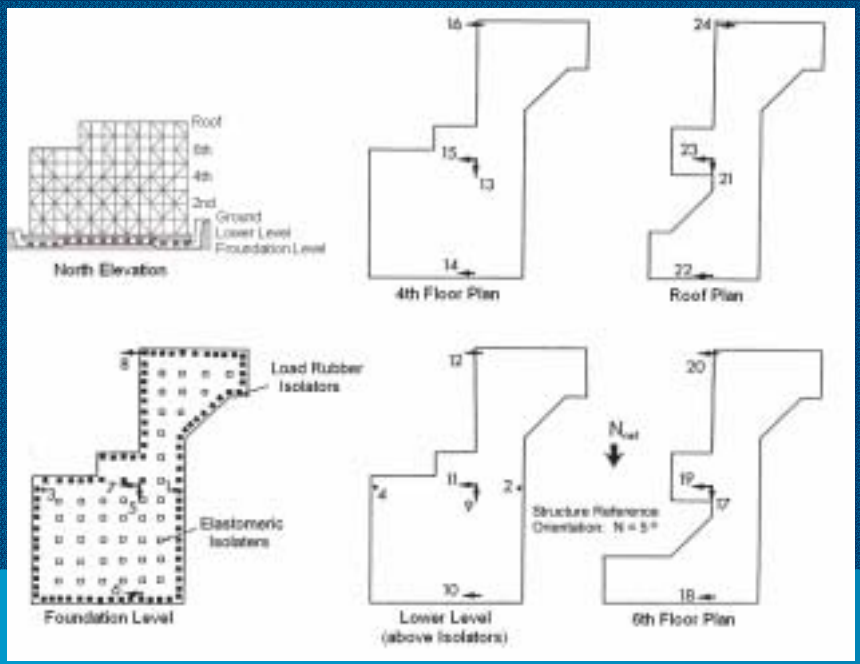
This project was the first in the world to use isolation for retrofit, completed in 1989.

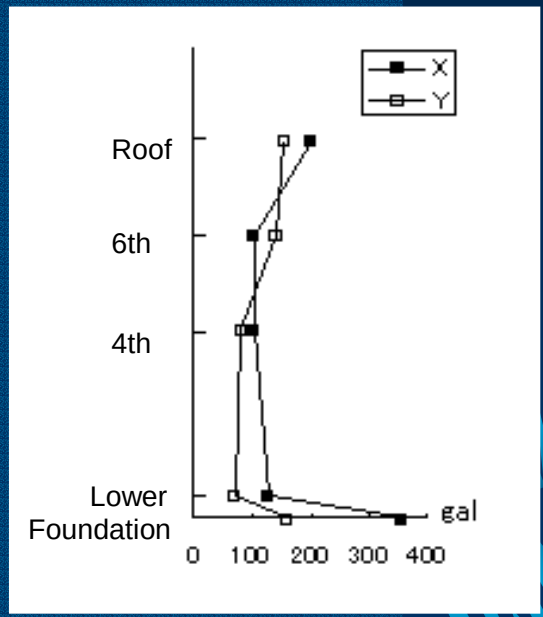
USA from Ian Aiken and Andrew Whitaker

The USA Court of Appeals building, in San Francisco, another example of a large historic building retrofit, was the first large building to utilize the friction pendulum isolation system, using a total of 256 isolators, completed in 1994.

USA from Ian Aiken and Andrew Whitaker

The USC University Hospital in Los Angeles, completed in 1991, was the first hospital in the world to use seismic isolation with 68 lead-rubber isolators and 81 natural-rubber isolators.





The 1994 Northridge earthquake

USA from Ian Aiken and Andrew Whitaker

Application to emergency operation centers

The Tsukamoto Public Safety Building in Berkeley, California, completed in 2000, with 25 lead-rubber isolators.

Application to computer centers and high-tech facilities

The headquarters building for Pixar Animation Studios, in Emeryville, California, completed in 2000, with 216 high-damping rubber and sliding isolators.

Macedonia from Garevski A. Mihai and James M. Kelly

Primary School Pestalozzi" in Skopje, the first structure in the world base isolated by means of rubber bearings constructed in 1969

Photo 3.1. Part of the isolated building

Macedonia from Garevski A. Mihai and James M. Kelly

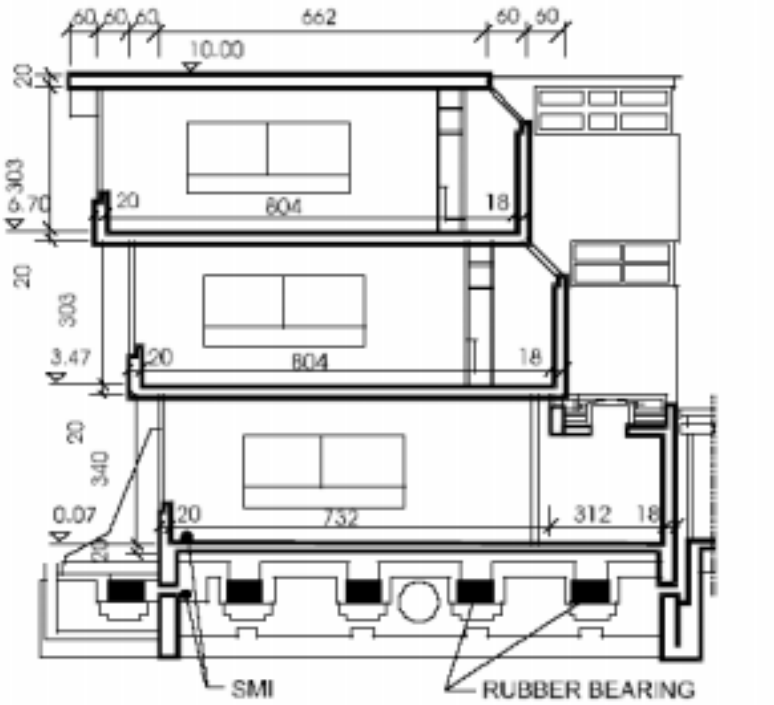


Fig. 3.2. Cross-section of the structure

Fig. 3.4. Seismic gap with a width of 20cm

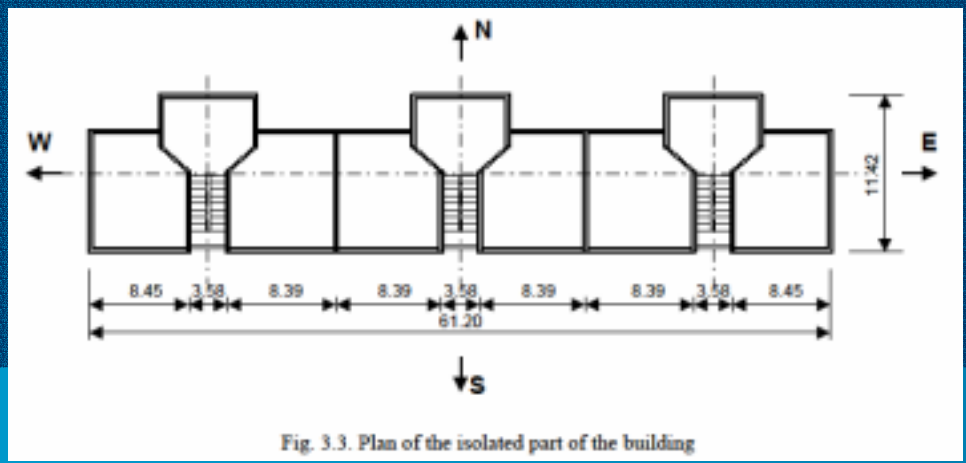


Fig. 3.3. Plan of the isolated part of the building

Figure 3.5. Rubber bearings placed between the strip foundation and the building

Macedonia from Garevski A. Mihai and James M. Kelly

Fig. 5.4. The bearing after two months from the date of its extraction

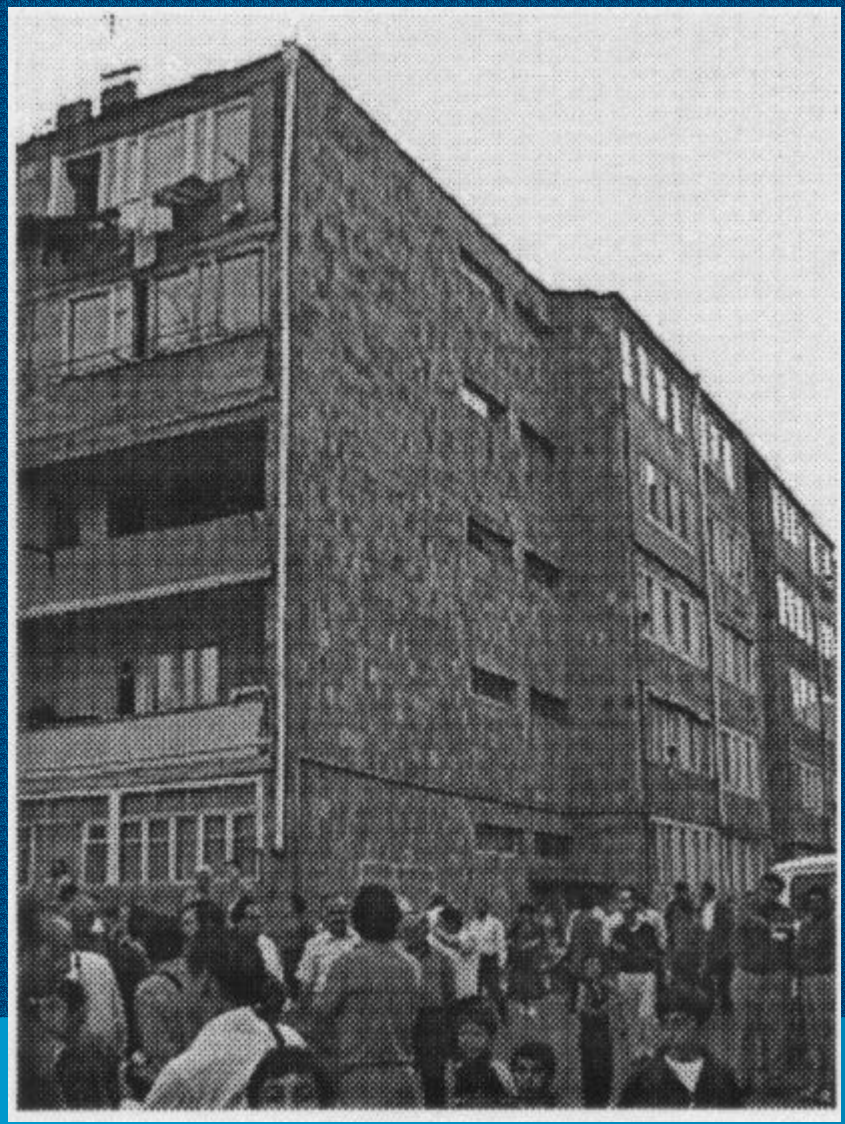
Fig. 5.23.c. Occurrence of the first cracks between the layers of the bearing

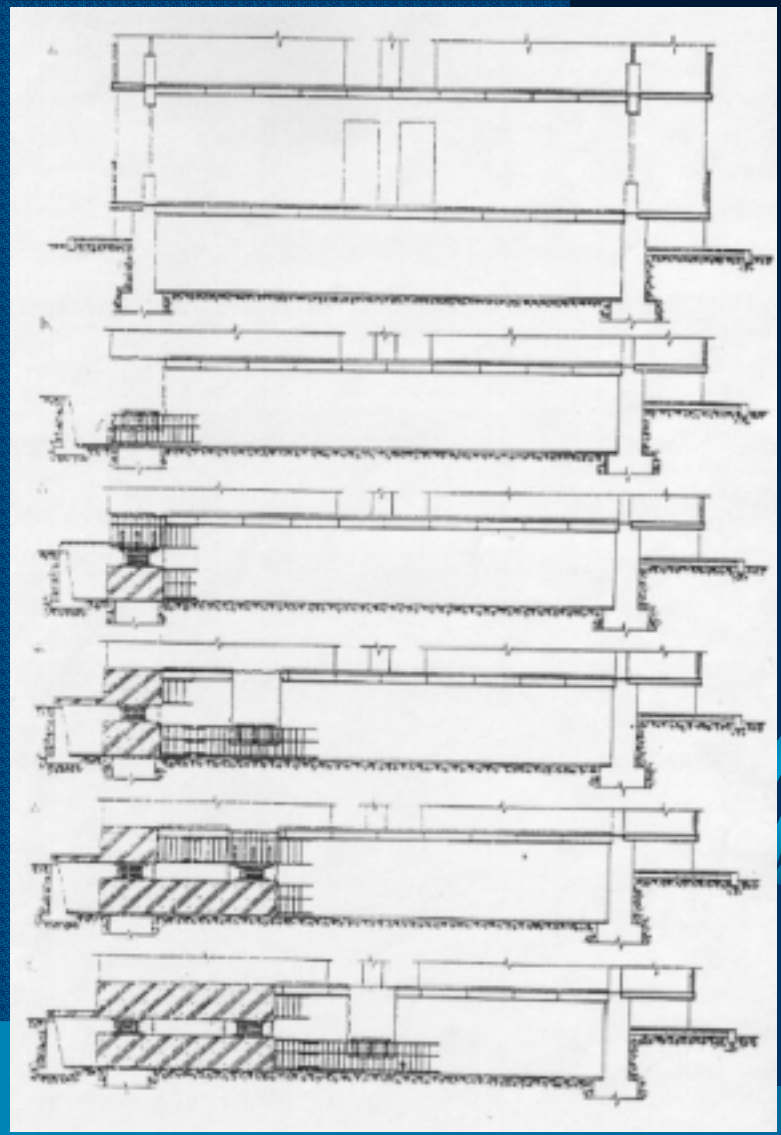
Fig. 5.5. Bearing Placed on a Press, prior to testing

Fig. 5.23.d. Propagation of cracks between the layers of the bearing

Armenia from Michael G. Melkumian, NSSR

Seismic retrofit of R/C residential building





Armenia from Michael G. Melkumian, NSSR

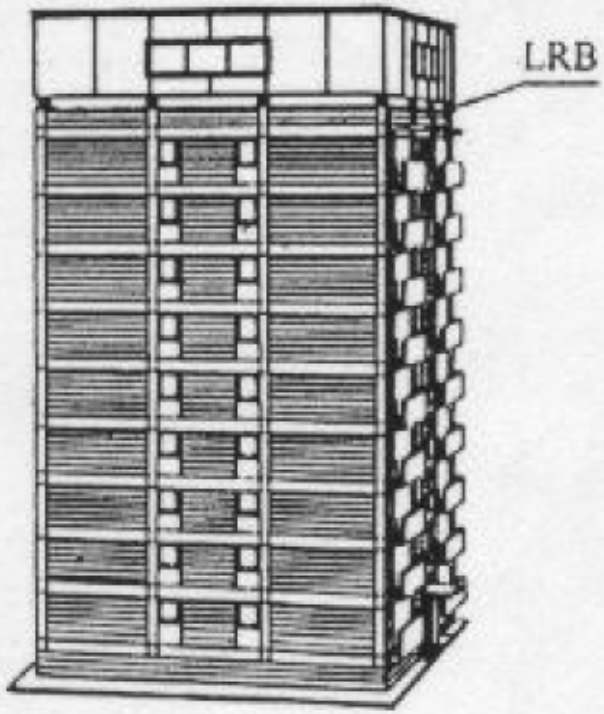


Figure 1. R/C 9-story full-scale frame building with the additional isolated upper floor in Vanadzor

R/C 9-story building with additional isolated upper floor

写真 2　既存高層住宅の塔屋免震化

New working commission CIB/W114

- *CIB/TG44 (2000-2006.11)*

  "Performance Evaluation of Buildings with Response Control Devices"

- *CIB/W114 (2006.11-)*

  "Earthquake Engineering and Buildings"

The first three years activities of the CIB/W114 put focus on buildings with response control devices such as rubber bearings, viscous (oil) dampers, etc.

CIB/W114 Network

http://www.cibw114.net