

**4-storey Apartment Block,
Java, Indonesia**

Indonesia's first building installed with HDNR bearings was a four-storey apartment block constructed in 1994 under UNIDO/MRB project.



**Retrofit of 5-storey
Unreinforced Masonry
Apartment Block, Vanadzor,
Armenia**

This is a 1995 UNIDO/MRB Project. 30 HDNR bearings fabricated in Malaysia were installed. People continued living in the apartment while the bearings were being installed at the basement.



**LNG Tank Project, Shantou,
China**

Three liquefied natural gas (LNG) tanks were constructed installed with HDNR bearings designed by MRB and fabricated in Malaysia in 2005.



**Parand Township Project,
Parand, Iran**

The 5 blocks of 12-storey apartment buildings under the Parand project were installed with HDNR bearings in 2007.



**CTC Headquarters, Ain
Defla, Algeria**

The National Technical Control of Construction Centre (CTC) headquarters was the first isolated building in the Algerian Republic. Completed in 2007, the pilot project showed the economic effectiveness of the seismic isolation technique for reinforced concrete frame buildings designed according to the Eurocode 8.

**Aston Hotel, Medan,
Indonesia**

12-storey Aston Hotel in Medan was the 2nd Indonesian building on HDNR bearings. The building was completed in 2010 and sits on 25 bearings.



**MPOB 3-storey office
block in Lahad Datu,
Sabah, Malaysia**

Completed in 2011, the building sits on 28 natural rubber bearings designed and fabricated in Malaysia.



**Gudang Garam Tower,
Jakarta, Indonesia**

Completed in 2013, the 26-storey Gudang Garam Tower was the first building in Jakarta isolated on 40 seismic rubber bearings.

Malaysian Rubber Seismic Bearings



Protecting lives and structures

Malaysian Rubber Export Promotion Council (MREPC)

HEAD OFFICE
Unit No 36-02
Level 36, Q Sentral
2A Jalan Stesen Sentral 2,
KL Sentral, 50470
Kuala Lumpur, Malaysia.
Tel : +60 3 2782 2100
Fax : +60 3 2782 2199
Email : mpd@mrepc.com

USA OFFICE
3516, International Court
N.W Washington DC
20008 USA.
Tel : +1 202 572 9771/9721
Fax : +1 202 572 9787
Email : esahsyip@mrepc.com

CHINA OFFICE (SHANGHAI)
Unit 1708, Hong Kong Plaza,
283 Huaihai Road Central,
Huangpu District,
Shanghai 200021,
P.R. China.
Tel : +86 21 3376 7001
Fax : +86 21 3376 7002
Email : shanghai@mrepc.com

CHINA OFFICE (GUANGZHOU)
Room 505, Block A,
China Shine Plaza,
No.9 Linhe Xi Road, Tianhe,
Guangzhou, 510610,
P.R. China.
Tel : +86 20 2205 7707
Fax : +86 20 2205 7706
Email : guangzhou@mrepc.com

INDIA OFFICE
907, Tulsiani Chambers
Nariman Point
Mumbai-400 021
Maharashtra, India.
Tel : +91 22 6221 6725
Fax : +91 22 6223 2359
Email : mumbai@mrepc.com
EUROPE OFFICE
Email : europe@mrepc.com



Malaysian Rubber Export Promotion Council

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RUBBER SEISMIC BEARINGS



Foothills Community Law and Justice Center, San Bernardino, California, United States

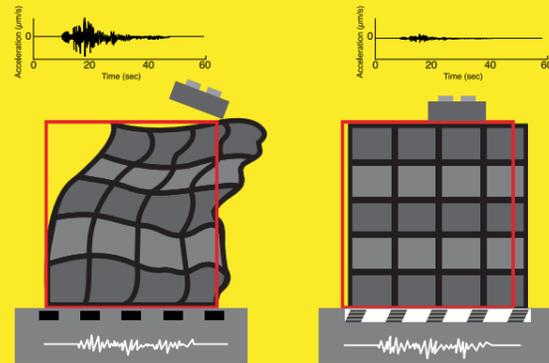
Rubber bearings are increasingly being used for base isolation of buildings, bridges and other structures in areas with high seismic activity. With this technology, the building or structure is isolated from the horizontal components of the earthquake ground motion by interposing elastomeric bearings with low horizontal stiffness between the structure and the foundation. In an earthquake, the superstructure responds as a rigid body, with the deformation occurring in the bearings.

The most commonly-used seismic rubber bearings are High Damping Natural Rubber (HDNR) bearings. They are simple, cost effective and maintenance-free. This type of rubber bearing was developed by the Malaysian Rubber Board (MRB) in the late 70s as part of a joint R&D effort with the University of California, Berkeley, to

evaluate the use of seismic rubber bearings for structures. The project culminated in the construction in 1985 of the first base-isolated building in the US - the five-storey Law and Justice Center building in San Bernardino, California.

HIGH DAMPING NATURAL RUBBER BEARINGS

Protect Structures and Contents from Seismic Activity



Conventionally-designed structure

Structure on HDNR bearings

The **HDNR** bearings effectively protect structures from earthquake damage and protect occupants and contents inside the buildings by significantly reducing higher mode response in structures. Now more than 30,000 structures all over the world use this system and other base isolation techniques.

HDNR bearings are made by bonding sheets of vulcanized rubber to thin steel reinforcing plates. They are flexible horizontally and capable of isolating low to medium rise buildings and other structures from the destructive effects of earthquakes. The exact maximum height of a building suitable for isolation depends on its location and characteristics.

Advantages of HDNR bearings

- Rubber-steel laminated bearings based on natural rubber have been in service since 1950s; hence their ageing behaviour is known and predictable. A large body of field data on performance of rubber in the bearings are available for evaluation and comparison.
- Rubber bearings have no moving parts and are therefore maintenance free, remain unaffected by time and are resistant to environmental degradation.
- HDNR bearings are able to sustain some tensile loads without damage; therefore can be used if tensile stresses are present as may happen when vertical seismic excitations are significant.
- The behaviour of the elastomeric isolation system can normally be approximated by linear models; this allows for analysis by most of the commercially available Finite Element software and for a safe engineering judgement-based assessment of the calculated results.
- HDNR bearings could cope with displacement inputs larger than the design displacements, thus providing a "safety" factor with respect to beyond design earthquake.

SECOND PENANG BRIDGE, MALAYSIA

World's Largest Structure on Seismic Bearings



The Second Penang Bridge, Malaysia – Completed in 2013, it is the world's largest structure on seismic bearings.

The Second Penang Bridge is the longest bridge in Southeast Asia. More than 2,000 units of HDNR bearings were installed on this cable-stayed bridge connecting Batu Maung in Penang to Batu Kawan on the mainland.

BRIDGE CHARACTERISTICS

Overall Length	24km
Length Over Water	16.7km
Main Bridge (type)	Cable-stayed bridge with beam & slab deck
Approach Bridge (type)	Box Girder
Main Navigation Span Ship Protection	Steel box buffer system

OTHER STRUCTURES WITH RUBBER BEARINGS



West Japan Postal Computer Center, Sanda, Kobe Prefecture, Japan

Built in 1986, this 6-storey building exhibited excellence performance during the Kobe earthquake. In 2002, it was the largest base-isolated building in the world.

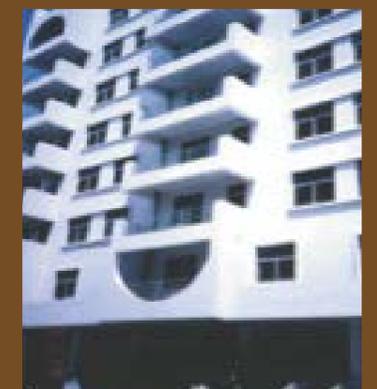
USC University Hospital, California, United States

The University of Southern California (USC) University Hospital was completed in 1991 at a construction cost of US\$50 million.

The seven-storey high building sits on 149 rubber anti-seismic bearings. The cost of the bearings was only 1.5% of the total construction cost.



9-storey Building Apartment, Shantou, China



This is a 1994 UNIDO/MRB project. The apartment was the first building in China installed with HDNR bearings designed and fabricated in Malaysia.