

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.



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.



WEST JAPAN POSTAL COMPUTER CENTER, SANDA, KOBE PREFECTURE, JAPAN

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



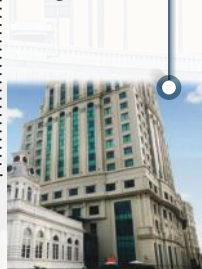
USC UNIVERSITY HOSPITAL, CALIFORNIA, UNITED STATES

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.



9-STOREY BUILDING APARTMENT, SHANTOU, CHINA

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.



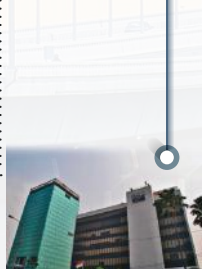
4-STOREY APARTMENT BLOCK, JAVA, INDONESIA

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



RETROFIT OF 5-STOREY UNREINFORCED MASONRY APARTMENT BLOCK, VANADZOR, ARMENIA

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



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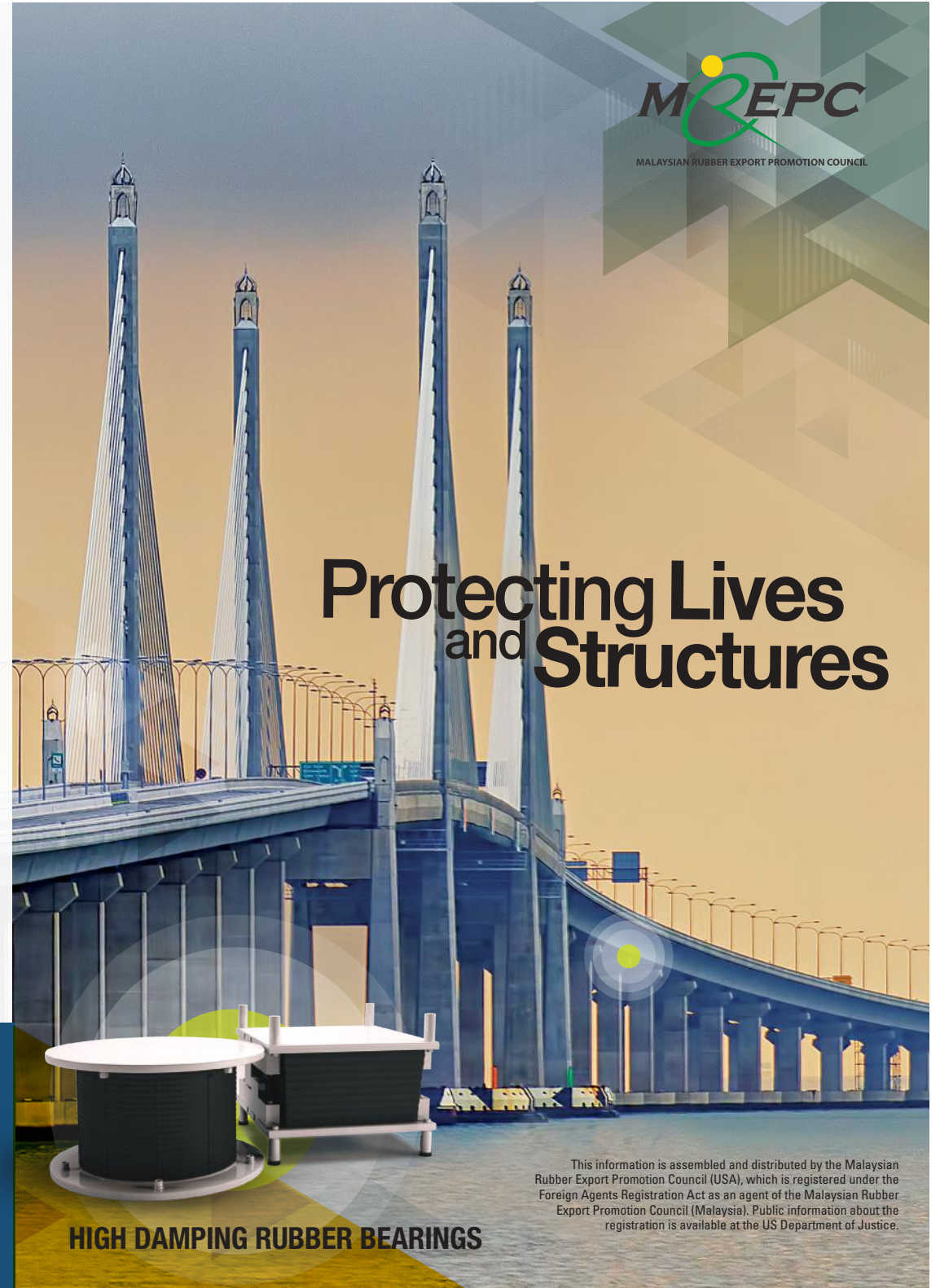
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Protecting Lives and Structures

HIGH DAMPING RUBBER BEARINGS

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RUBBER SEISMIC BEARINGS PRINCIPLE

RUBBER BEARINGS work on the principle of base isolation and limit the energy transferred from the ground to the structure in the event of an earthquake. The rubber and steel laminated bearing is designed to support the weight of the structure and to provide post-yield elasticity.

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.



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

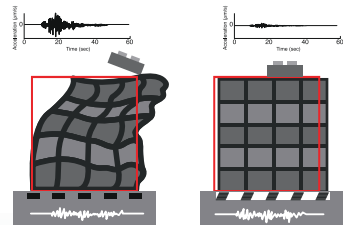
High damping rubber bearings (HDNR) are one of the most widely used means of seismic isolation in structures and have proven effective in numerous earthquakes worldwide.

The system has been researched over the past decades and offers the structural engineer a straight-forward simulation of device response due to simple bilinear modelling. 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.

APPLICATION

HIGH DAMPING NATURAL RUBBER BEARINGS PROTECT STRUCTURES AND CONTENTS FROM SEISMIC ACTIVITY



Acceleration Time (sec)

Left: Conventionally-designed structure Right: Structure on HDNR bearings

The high damping natural rubber (HDNR) bearings consist of alternate layers of elastomeric material and vulcanized reinforcement steel plates. As the reinforcement steel plates are fully embedded in the elastomeric material they are sealed and thus protected against corrosion.

The devices are manufactured with the rubber vulcanised to the top and bottom connection plates. The bearings can also be supplied with additional anchor plates, allowing easier replacement of the device in case of maintenance needs. HDNR are made from natural rubber (NR) providing a high resistance against mechanical wear. 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.



WORLD'S LARGEST STRUCTURE ON SEISMIC BEARINGS: SECOND PENANG BRIDGE MALAYSIA

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.

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

BRIDGE CHARACTERISTICS

