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1995 Kobe earthquake.

Built for strength Protection from earthquake damage

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Since the 1995 Hanshin-Awaji earthquake in Japan, over 2000 base-isolated buildings and bridges have been constructed or are under construction in the country with protection from earthquake damage. During the earthquake in Kobe, for example, two seismically isolated buildings located about 40 km from the epicentre proved the effectiveness of seismic isolation in saving lives and preventing damage to structures and their contents. The recent destructive earthquakes in India, Indonesia, Taiwan and Turkey have once again highlighted the urgent need for seismic-protection isolators and their contribution in saving human lives and preventing structural damage.

Elastomeric isolators, the leading devices of seismic isolation systems, consist of multi-layered thin rubber sheets and steel plates, which are firmly bonded to each other. The thin steel plate reinforcement provides high com-

pressive stiffness to support the heavy weight of structures, while the rubber layers provide a large horizontal deformation, thereby softening the transmission of loads.

Efficacy of seismic isolation stimulates standards growth

Elastomeric isolators were developed in the United Kingdom for the application of bridge bearings in the 1950s and began to be used in buildings and bridges in the 1980s, mainly in the USA and Japan in areas of high seismic activity. The emergence of uniform standards for the design of isolation systems were developed in Japan and the USA, where there was a noted rise in their usage in 1990.

In the USA, the Uniform Building Code developed by the International Conference of Building Officials provides the qualification requirements for prototype testing and production isolators, while the American Association of State Highway and Transportation Officials has developed a *Guide Specifications for Seismic Isolation Design*.

In Europe, the European Committee for Standardization (CEN) has developed its own standards for testing and product specifications of elastomeric bearings for structures, and in Japan, several guidelines and specifications have been developed and updated in the last decade, especially after the 1995 Kobe earthquake.¹⁾

1) In Japan, the document, *Recommendation for the Design of Base Isolated Buildings* (1989, 1993, and 2001 edition), published by the Architectural Institute of Japan, provides much data for base-isolated buildings, isolators, materials, and analysis. The Japan Society of Seismic Isolation developed standards that emphasize testing methods and requirements for the application of isolation devices. A new code for the design of base-isolated buildings, specifying that all isolators are to be approved in advance by government, was created in 2000. For bridges, *Manual for Menshin Design of Highway Bridges* (1992) was published by Ministry of Construction.

About the author



Nobuo Murota is a Senior Engineer of Bridgestone Corporation Japan, Department of Seismic Isolation Engineering. He received a

BSc degree in Mechanical Engineering from Kyoto University, and a MS and PhD in Civil Engineering at the University of California. Mr. Murota's area of specialization is the research and development of seismic isolation systems. He is also responsible for design, engineering support, and testing of seismic isolators for base isolation projects worldwide.



Measures for seismic protection

As the efficacy of seismic isolation became widely accepted in many other countries, ISO technical committee ISO/TC 45, *Rubber and rubber products*, subcommittee SC 4, *Products (other than hoses)*, working group WG 9, *Elastomeric isolators*, began work on an International Standard for the design and quality control of isolators in areas of high seismic activity which culminated in the development of ISO 22762.

Published in 2005, ISO 22762 parts 1-3 deal with elastomeric seismic isolators used to provide buildings or bridges with protection from earthquake damage, and has become widely consulted in recent years as one of the measures used for seismic protection of structures. It is expected to make a useful contribution to the practical design of elastomeric isolators by designers, engineers, and manufacturers.

The suite of standards is meant to serve as a basis for writing project specifications, product development, manufacturing, and quality control of elastomeric isolators used by structural engineers, manufacturers, designers, and owners, while harmonizing the essentials of existing standards in each country.

ISO 22762 was developed over five years, with a balanced viewpoint representing manufacturers and structural engineers from Canada, China, India, Malaysia, Thailand, United Kingdom, the USA, and Japan (Chair), including isolator manufacturers as well as scientists from the rubber chemistry, and the structural engineering field. Throughout the development of ISO 22762, the working group members participated in discussions lead by Japan, the USA, and the United Kingdom, who have experience in establishing standards or guidelines for isolators.

Finally, I would like to express my greatest appreciation to all of the members, who contributed constructively to discussions during meetings and cooperated with each other for the completion of ISO 22762. Members of the Japan Manufacturer Association (JRMA) are also appreciated for their hard work in preparing the draft manuscripts. ■