Foreword

The Past Thirty Years and the Future of Seismic Isolation Structures

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Thirty years have passed since I began working on seismically isolated structures, first hearing of the concept in the mid-1980s as a young engineer, soon after graduating from university. One of the senior engineers in our group brought up seismic isolation as novel developing technology that might be worth investigating. I began daily visits to the office of Professor Hideyuki Tada at Fukuoka University, who was starting to research seismic isolation systems, and we worked together on the development of a new looped steel-bar damper (Photos 1 and 2). Soon after, I designed my first seismically isolated building under guidance from Dr. Shoichi Yamaguchi, the first steel-frame building in Japan to use modern rubber isolators. It took many all-nighters to complete the structural drawings and calculations needed for design approval, but now I look back on it as a fond memory. Also around that time, I participated in the compilation of the first Design Recommendations for Seismically Isolated Buildings issued by the Architectural Institute of Japan (1989).[1] At that time, some senior professors were still wary of seismic isolation in building structures, considering it a technique of dubious value. I recall that it was difficult to become an established member of academic circles and gain acceptance with this technology. That seems incredible today, where thousands of seismic isolation structures have been constructed in Japan, and even the Prime Minister's Office and major governmental buildings now incorporate seismic isolation.

Photo 1: Looped steel-bar damper for seismic isolation

Photo 2: Development of the looped steel-bar damper (1990)

In these thirty years, the JSSI has made enormous contributions to the spread of seismic isolation in Japan, which is now widely used and accepted. In Europe and the United States, not only academic research bodies, but also industry groups have worked to develop standards, quality control procedures and technical guidance, devoting a great deal of effort to ensuring neutrality and reliability. JSSI also provides training and qualification for engineers who supervise the construction of seismically isolated buildings, and these activities are essential to promoting quality in both design and construction. For dissemination of best practices when using special devices such as seismic isolation bearings and dampers, and construction methods of such structures, technical contribution from manufacturers and contractors is essential.

Meanwhile, it is not easy to validate the performance and reliability of seismic isolators during the manufacturing process. Seismic isolators are special devices whose performance is difficult to discern from monitoring the prototype testing, not only for the average structural engineer, but also for specialists in some cases. On multiple occasions over the year problems have occurred due to defects in the seismic isolators, attributed variously to inadequate quality control, design mistakes or simply due to previously unknown properties. As seismically isolated structures become more widespread, incorporated even in small residential buildings, the Association will need to work on developing quality control guidelines and promote the use of such guidelines in the Association and beyond. One possible example for consideration would be a voluntary peer checking system, in which manufacturers periodically provide products to each other for testing.

Development of this type of quality control system by JSSI would also be important in suppressing inferior products, sourced either domestically or imported from abroad. Currently, manufacturers who respond dishonestly to scandals incur penalties such as revocation of their certification, but it is conceivable that such companies could disappear while leaving their devices in place in hundreds of buildings that were constructed before the situation was discovered. It is possible that some companies could even take advantage of this, recovering their company's name and certification while continuing to engage in the same business. Similar situations have already occurred in products such as wind power generation systems, where imported wind turbines built to foreign standards proved inadequate for Japan’s typhoon conditions after the supplier has gone out of business. Quality control systems established on the premise that all the manufacturers would stand behind their products to the end will need to change in the future to address this need. Instead of dealing with problems after they occur, it is important to take steps to prevent such problems through construction supervision. In places such as the United States and Taiwan, some universities and affiliated research institutes are equipped with testing rigs that can test seismic isolators at full scale, with design level deformation, speed and duration, and systems are in place to enable regular third-party testing. This kind of neutral testing facility is also required in Japan, which has been a leader in seismic isolation practice.

Next, I would like to consider the response to internationalization. At present, more buildings in Japan are equipped with seismic isolation structures than any other country in the world. Although China is catching up in terms of numbers, Japan is internationally recognized as providing the highest level of quality and technical expertise, along with the United States. Therefore, there is a need to share Japanese and American technologies with other earthquake prone countries where seismic isolation is less established, such as Turkey, Indonesia, Philippines and others. However, there is less familiarity with Japanese technologies, in part due to the design and construction supervision standards not being available in English. In addition, Japanese seismic isolators are often not priced competitively, even if the quality is high. These factors have limited the spread of Japanese seismic devices. In Turkey, a recent law requires all new hospitals to be built with seismic isolation, despite Turkey current having no design standards for seismic isolation structures, local manufacturers or testing organizations. We were invited to Istanbul in 2013 along with the President of JSSI Professor Akira Wada and Professor Mineo Takayama, and there was strong demand for technology transfer, as well as for Japanese seismic isolator manufacturers to export to Turkey. To promote understanding of Japanese products and their high quality, the construction supervision and quality management standards established by JSSI should be translated into English and quickly made available in countries where seismic isolation is still in an early developing stage. Although some domestic companies may prefer not to expand globally, the situation in near future will require taking an aggressive stance in order to compete with foreign seismic isolation suppliers and to prevent the similar fate of structural steel and building glass industries. Expansion abroad is urgently needed to ensure the survival of Japanese-style seismic isolation systems, which have been refined over the past 30 years.

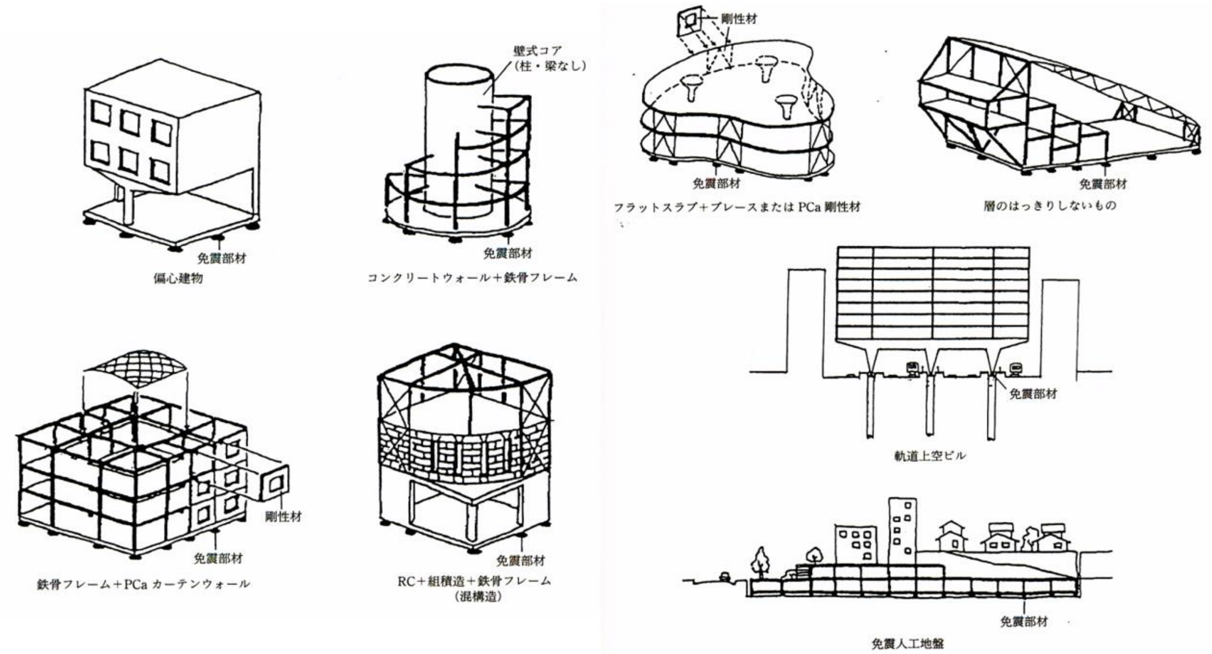
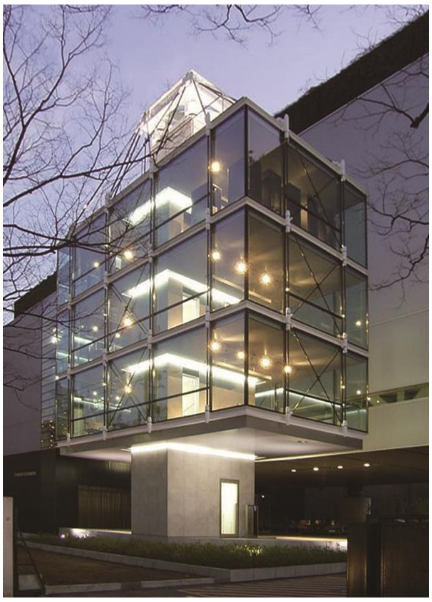


Figure 1: Possible future seismic isolated systems (1995)

Last, I would like to present some future dreams. Figure 1 depicts "possible future seismic isolated systems" that were recorded in Introduction to Seismic Isolation Structures,[2] published by JSSI in 1995 (20 years ago). I remember working on these drawings in a hotel in New York while on a business trip, racking my brains and my imagination. During the past 20 years, a variety of structural designs using seismic isolation technologies have been conceived and realized. For example, a structural form that would have been inconceivable at that time is depicted in Photo 3.[3] Meanwhile, seismic isolation systems using exterior curtain walls to provide the superstructure stiffness have not come into general use yet. As structural forms have diversified, the boundaries between seismic isolation structures and structures with energy-dissipating devices have begun to blur.[4] Some groups refer to these structures collectively as "response controlled structures." Many unknown possibilities still exist for seismic isolation structures (and response controlled structures), and the JSSI ought to enhance its support systems in order to promote greater freedom in design while maintaining reliability. I hope to do whatever I can to contribute to that goal.



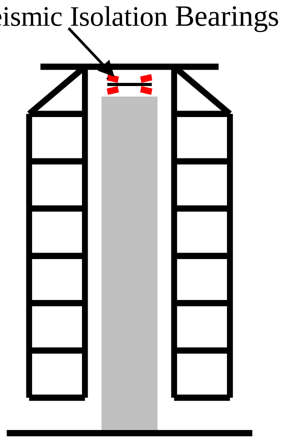


Photo 3: Core-suspended seismic isolation structure
(Shimizu Corporation Safety & Security Center, 2006)

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3. Y.Nakamura, M.Saruta, A.Wada, T.Takeuchi, S.Hikone, T.Takahashi: Development of the core-suspended isolation system, Earthquake Engng. Struct. Dyn. (2010), DOI:10.1002/eqe.1036
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