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The Kobe Earthquake:
Applying Lessons Learned, 10 Years after the Disaster

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Applying Lessons Learned, 10 Years after the Disaster

This year is the 10th anniversary of the Great Hanshin-Awaji Earthquake, which struck Kobe and the surrounding area on January 17, 1995. The powerful inland earthquake had a magnitude of 7.3 on the Richter scale, took 6,433 lives, and totally or partially destroyed more than 250,000 buildings.

In October 2004, the Niigata Chuetsu Earthquake, which measured 6.8 on the Richter scale, claimed 40 lives, damaged or destroyed 100,000 buildings, and forced 100,000 local residents to live in temporary evacuation shelters. Then, on December 26, a massive quake off the coast of Sumatra, Indonesia unleashed giant tsunamis that caused unprecedented death and destruction along thousands of kilometers of shoreline in the Indian Ocean basin.

These recent disasters were a terrifying reminder of the importance of disaster preparation. In this feature article, we introduce what we have learned following the series of major earthquakes and what kind of technologies have been developed over the past 10 years to prevent damage.

The Violent Force of the Great Hanshin-Awaji Earthquake

One of the harsh lessons learned from this earthquake was that nearly 90% of the victims died from being crushed or asphyxiated due to the collapse of structurally fragile old buildings. Enormous damage and injury occurred even when buildings did not collapse, owing to the disruption of lifelines and the falling down of interior fixtures or equipment such as computers. The earthquake resulted in the loss of internal functions at hospitals engaged in emergency treatment and at schools and other public facilities that serve as evacuation areas, seriously hindering disaster-relief efforts. Although finding a way to prevent the collapse of buildings is the highest-priority task to contain damage from future quakes, at the same time it is essential to devise systems to keep buildings from swaying.

The Kobe Red Cross Hospital and Hyogo Emergency Medical Center Complex

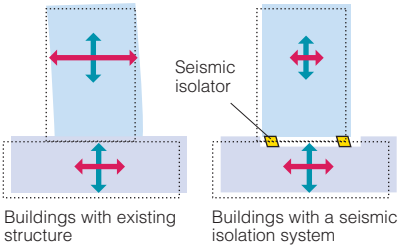
Design and supervision: Hyogo Prefecture, Yamashita Sekkei Inc.
Construction: Kajima Kansai Branch

Buildings That Do Not Collapse, and Systems to Prevent Swaying

Japan is among the countries with the most frequent occurrence of earthquakes in the world. If small quakes with a magnitude of about 1 on the Richter scale were included, more than 1,000 earthquakes occur in Japan each year. That is why Japan is a world leader in earthquake engineering technical research, and in this regard Kajima's Technical Research Institute plays a key role.

Kajima has developed and commercialized a wide array of earthquake protection construction methods to meet seismic reinforcement requirements for new buildings and existing structures. We also developed a series of technologies to prevent building sway during a quake to minimize damage. These construction methods include a vibration damping system that uses oil dampers to control the slight vibrations caused by wind-induced swaying to severe shaking from major earthquakes, a seismic isolation system utilizing multi rubber-bearing and other devices, and earthquake-proofing and seismic isolation reinforcement methods to retrofit structures even as the occupants continue to work or live in them. Kajima has deployed these construction methods at more than 160 buildings in the past 10 years. They offer proven high cost-effectiveness, and their use is expected to increase in the coming years.

Basic concept of the seismic isolation mechanism



When vibrations are transmitted, the building is deformed. The higher the structure, the greater the shaking. The seismic isolation system absorbs earthquake shock and prevents building deformation.

A Hospital Incorporating Lessons Learned from the Earthquake

One of the latest examples in adopting the latest design concept and technology is the Kobe Red Cross Hospital opened in August 2003 in HAT Kobe, the new city center in eastern Kobe. Along with the jointly established Hyogo Emergency Medical Center, the hospital is expected by many to become a core facility for community healthcare, as well as emergency and disaster medicine.

The hospital-medical center complex is the outcome of the fusion of plans conceived by the Red Cross and Hyogo Prefecture in the aftermath of the Great Hanshin-Awaji Earthquake. The Red Cross considered it an urgent priority to establish a hospital to offer sophisticated routine medical care suited to the needs of the times, while serving as a facility capable of providing adequate emergency medical care on a prefectural scale in an emergency. For its part, Hyogo Prefecture envisioned a center to perform the critical disaster-response functions of supplying medical care, gathering information and issuing directives, transporting patients, and stockpiling medication during large-scale disasters.

The new Red Cross facility is a general hospital with 19 medical departments, a pathological examination department, and 310 beds (the Emergency Medical Center has 30 beds). The hospital building has a seismic isolation structure that can withstand an earthquake with a magnitude of 7.0 on the Richter scale. The seismic isolation mechanism, which involves attaching 112 high-damping rubber-bearing seismic isolation devices between the base of the superstructure columns and the foundation to suppress transmission of ground motion to the building, reduces horizontal shaking to one-third to one-fifth during a quake. The hospital's corridors and laboratories are equipped with medical gas supply systems and other medical infrastructure, so that the number of

beds can be increased to up to 600 in an emergency.

Kajima's Vibration Control/Seismic Isolation Technology Are Confirmed in an Earthquake

The Niigata Chuetsu Earthquake struck on October 23, 2004 on the Sea of Japan side of the island of Honshu. Immediately afterward, Kajima established an earthquake countermeasures headquarters on the scene and offered full cooperation and support for the restoration of railways, roads, and buildings. As the extent of the damage became known, the general administration building of Hokuriku Gakuen, located in the city of Nagaoka, Niigata Prefecture near the quake's epicenter, became a focus of attention. Kajima completed the building's construction in 1997, employing a seismic isolation construction method that demonstrated superb seismic isolation performance during a quake in the area that registered a magnitude of 6.0. Not only the building itself, but also the internal fixtures and fittings came through the quake unscathed; it is said that even flower vases on shelves inside the building did not topple over.

Meanwhile, in the city of Niigata, situated 70 kilometers (43 miles) from the epicenter, a building erected by Kajima in 2003 demonstrated robust earthquake resistance to match its design specifications. Standing 140.5 meters (460 feet) high, the 31-story Niigata Bandaijima Building is the highest building in the region adjoining the Sea of Japan. It is equipped with Kajima-developed oil damper vibration control devices (HiDAX + HiDAM). Although an intensity of 4.0 was recorded in Niigata City, guests at the Hotel Nikko Niigata reported feeling nearly no shaking.

Kajima will analyze vibration data gathered from the two buildings with the aim of developing seismic isolation and vibration control technologies that offer even greater accuracy. The durability of these buildings in a catastrophic earthquake has attracted the attention of municipal government offices, schools, hospitals, and other facilities that serve as disaster-prevention facilities, and Kajima considers it important to rapidly disseminate information on the buildings' performance.

Providing Means Preventing

Many examples of escaping collapse or damage by implementing appropriate earthquake protection measures or structural reinforcement were found at the time of the Great Hanshin-Awaji Earthquake and the Los Angeles Earthquake of 1994 (with a magnitude of 6.7). The words of a high-ranking Los Angeles municipal official at the time of the quake there are telling: "We should not spare cost in preparing for future disasters. In view of the loss of life and the blow to the local economy, at the end of the day this isn't economy in expenditures." The same can be said of households and smaller communities. People who live on the earthquake-prone archipelago of Japan must be prepared for the worst. Consequently, Kajima is continuing its quest to provide safety and security by developing ever more effective earthquake protection technology.

We at Kajima offer our heartfelt prayers for those who lost their lives in the Great Sumatra Earthquake and Indian Ocean Tsunami, and we wish fervently for a speedy recovery for many victims who are now living in difficult circumstances. To help those affected by the natural disaster, we have donated a total of ¥10 million to Sri Lanka, Indonesia, and Thailand for construction of temporary housing and immediate relief aid.

Kajima around the World

From the United States

Five Projects Put a National Rollout on the Fast Track

Few companies illustrate the complexities and opportunities of supply-chain management the way the AmerisourceBergen Corp. (ABC) does. As the largest pharmaceuticals-specific supply chain services company in the United States, ABC provides a contemporary case study of the distribution network. For Industrial Developments International, Inc. (IDI), Kajima and one architectural firm, it serves also as a case study of an aggressive, multiple-project rollout.

Often when companies undergo a consolidation of their distribution network, they implement a rather long-term program, planning new structures one after another. ABC, however, consolidated the timelines as well as its network, introducing five new IDI-developed and Kajima-constructed distribution facilities in five new locations in just two and a half years. Each project has been a full-service venture, including site search, due diligence, design and construction.

IDI submitted its development proposal to ABC in January 2002 and ground was broken in November of the same year in Columbus, Ohio. Other sites that followed included Dallas, Texas; Chicago, Illinois; Kansas City, Missouri; and Bethlehem, Pennsylvania. The latter project is scheduled for completion in July 2005.

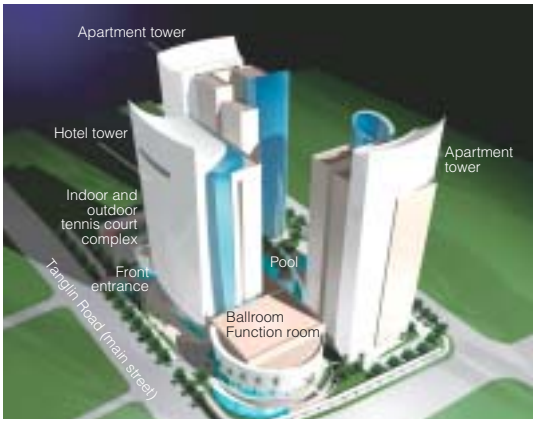
Michael Felton, vice president of corporate development for IDI's National Fee Development group, said the overall project was made more complex by the highly automated and forward-focused nature of the ABC facilities. Fully expandable to 56,000 square meters (600,000 square feet), each building currently has an average footprint of 28,000 square meters (300,000 square feet), not counting its office, parking and truck-court space. In addition, each building is fully air-conditioned and carries a redundant power supply backed by a 2,000-kilowatt generator. Fire protection also is redundant for added protection of the high-value contents.

The buildings were constructed by Kajima Construction Services, Inc. (KCS) offices in Cincinnati, Dallas and Chicago. The architect for all the buildings was Macgregor Associates Architects in Atlanta. IDI offices in Cincinnati, Dallas and Chicago assisted.

Michael Parks, vice president for IDI's National Business Development, oversaw the client-developer relationship, and saw the consistency within the project team as one of the keys to success. "This was an ambitious turnkey effort," he noted. "We achieved continuous process improvement from one location to another because we had fewer change orders with each subsequent building, effectively managing everything from the security required by the client to meeting Federal Drug Administration regulations."

From Singapore

Kajima Bids Successfully for the St. Regis Hotel and Residence Joint Development Project in Singapore



Kajima Overseas Asia Pte. Ltd. (KOA) and Tiong Seng Contractors (Pte) Ltd., a leading general construction company in Singapore, formed a consortium represented by a Kajima subsidiary in Singapore to enter designated competitive bidding for a contract worth about ¥20 billion for construction of the St. Regis Hotel and Residence Joint Development Project, involving the Singaporean industrial conglomerate Hong Leong Group and Japan's Mitsui Fudosan Group. The consortium submitted the successful bid in competition among six companies, including other Japanese contractors.

The project involves the construction of a complex comprising a 20-story first-class hotel with 299 elegant guest rooms and two 20-story luxury apartment towers with a total of 255 privately owned residences. The complex will be located in the Tanglin area, a tranquil, prestigious residential district near the Orchard Road area, Singapore's commercial center.

St. Regis Hotel is one of America's most storied hotel brands. The six-star hotel, scheduled to open in 2007, will offer numerous deluxe facilities, including Singapore's largest ballroom, with capacity for 1,000 guests, and an air-conditioned two-story indoor tennis court complex. The luxury residence towers have been dubbed St. Regis Residence and will share some facilities with the hotel. The aim is to create the most exclusive property in Singapore's luxury condominium market.

From Japan

Kajima Open MRI Room Technology Draws a Tremendous Response at RSNA 2004

Kajima exhibited the technology for the world's first open magnetic resonance imaging (MRI) room at the 90th Scientific Assembly and Annual Meeting of the Radiological Society of North America (RSNA 2004), held from November 28 to December 3 at McCormick Place in Chicago. RSNA, a nonprofit organization, aims to promote and develop the highest standards of radiology and related sciences through education and research.

At its booth, Kajima displayed a transparent shielding door for an open MRI room developed by Kajima and NABTESCO Corporation, the first of its kind in the world. The door is made using magnetic shielding sticks developed jointly by Kajima and Nippon Steel Corporation and magnetic shielding glass developed jointly by Kajima and Taiyo Wire Cloth Co., Ltd. Because the shielding door is suitable for use with high magnetic field MRI equipment with field strengths of 1.5 tesla or higher, it is not subject to the limitations on installation location that apply to conventional shielding doors. The glass used in the door incorporates stainless steel wire fabric that provides a

magnetic shielding effect. The use of double panes of the glass makes possible electromagnetic shielding effectiveness of 100 decibels and effective sound insulation. Because the wire fabric has an extremely fine mesh, it offers light transmittance of 60% or higher.

During the five-day exhibition, the Kajima booth drew more than 2,000 visitors, and Kajima received many specific inquiries concerning the breakthrough technology from radiology professionals from around the world. More than 90% of visitors who filled out a questionnaire indicated interest in Kajima's magnetic shielding technology. One visitor commented, "I've been involved in MRI-related work for more than 20 years, and this type of technology for enclosing MRI rooms with glass doors and walls is a first. I definitely want to use it."

Kajima plans to move forward with further product development, including the development of modular panels for magnetic glass doors and wall panels.

The Curtain Is Set to Rise on the 2005 World Exposition, Aichi, Japan

Based on the theme Nature's Wisdom, the 2005 World Exposition, Aichi, Japan opens on March 25. The exposition will be held at two venues on a site covering approximately 173 hectares (430 acres) in a hilly suburban area to the east of the city of Nagoya in central Japan. More than 120 countries and international organizations will participate in the exposition, and countless appealing attractions and events will be held during the 185 days until it closes on September 25. Main exhibits include leading-edge environmental technologies, information technologies, next-generation robots, and a frozen woolly mammoth excavated from the permafrost in Russia. Working robots will share in cleaning, security, and customer service duties. Access to the venue will be provided by the world's first magnetic levitated train in commercial service.

The 2005 World Exposition, Aichi, Japan is the world's first exposition for which site planning and construction was conducted on the basis of environmental impact assessment, and more than 217 evaluation items were considered. The 3R principle (reduce, reuse, recycle) has been rigorously adhered to, including 100% reuse of the concrete fragments from previous facilities demolished on the site and the use of wood obtained from thinning and recycled material.

Kajima has been extensively involved in preparation of the exposition, with responsibility for land development work for the main sites, the construction of three corporate pavilions, preparation of the route infrastructure for the unmanned buses of the Intelligent Multimode Transit System (IMTS), and construction of the Global Loop, Global Commons, and Expo Dome. In pavilion construction, Kajima used temporary materials and otherwise actively engaged in environmentally friendly construction.

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