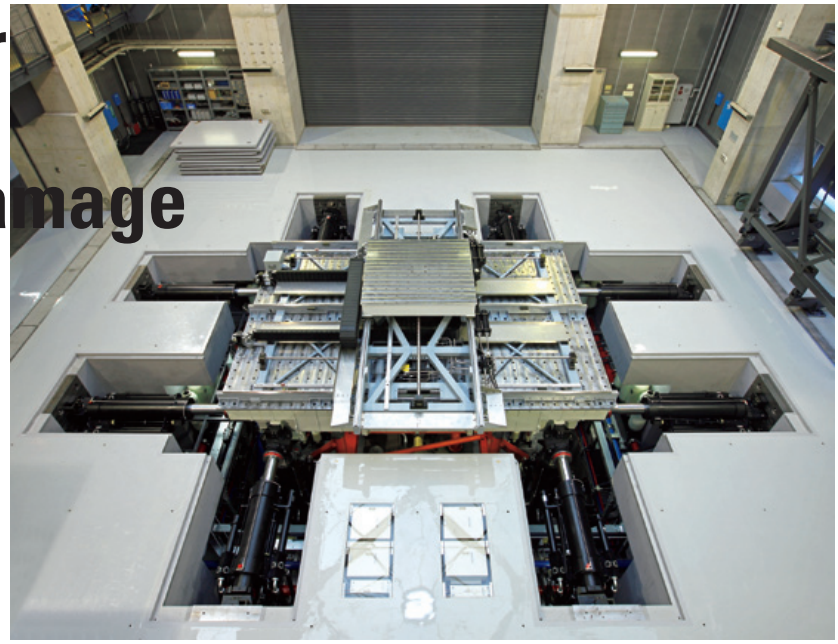
Technology for Minimizing Earthquake Damage

CASE 02



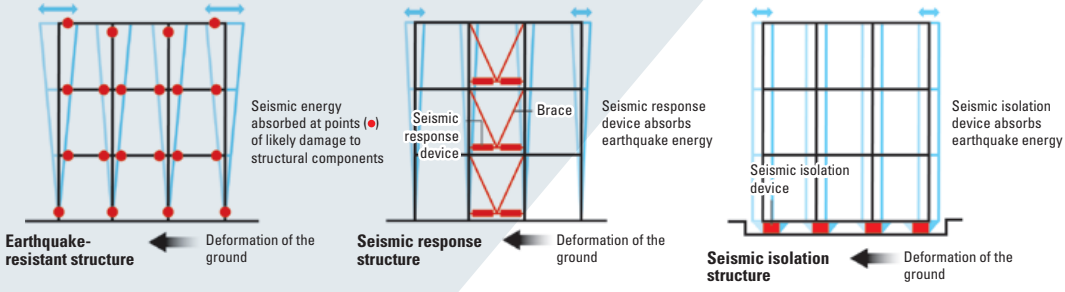
Seismic response structures dampen earthquake tremors while seismic isolation structures transform tremors into gentle movements. Kajima's various anti-earthquake technologies protect buildings and structures and help increase earthquake readiness.

Super-High-Rise Earthquake-Resistant Design Technology at Kajima

Completion of the Kasumigaseki Building, Japan's first skyscraper, in 1968 marked the starting point for Kajima's progress with earthquake-resistance technology. The development of a seismic resistance system for skyscrapers more than 40 years ago, built around a sophisticated computerized seismic response analysis system and streamlined construction methods using large H-beams and deck plates, forms the basis for our super-high-rise building designs even today. In the years since, Kajima, with its extensive track record in skyscraper construction, has built a reputation as Japan's leading name in the field. Today, we have developed various seismic response and seismic isolation technologies to further improve the safety and comfort of buildings and structures.

"Seismic response structure" refers to a variety of mechanisms to reduce the impact of earthquake tremors by placing devices in a building that absorb seismic energy. "Seismic isolation structure," on the other hand, is a term for devices that structurally isolate a building from the ground in order to reduce swaying. The minimal structural damage to buildings resulting from the Great East Japan Earthquake demonstrated the progress that has been made in Japan with respect to earthquake resistance. However, ceilings and other non-structural building components, as well as building equipment, were severely damaged. Kajima is moving ahead with research and development to meet the need for more comprehensive seismic protection methods that cover building structures along with secondary materials and equipment.

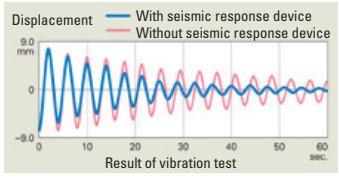
Advances in Earthquake Protection Technologies



Technologies that Shield Structures from Earthquakes – Seismic Response and Seismic Isolation

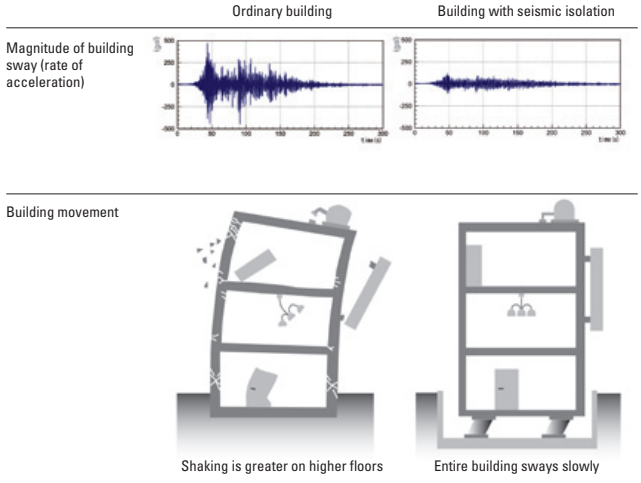
Kajima was the first construction firm in Japan to pursue research and development of technologies for withstanding long-period seismic ground motion, many of which are in use today. In Kajima's seismic response system, special devices, suitable for high-rise and low-rise buildings alike, are installed in a building to absorb the seismic energy to ensure safety against tremors. Also, the system aims to reduce swaying caused by strong winds, thereby eliminating a source of discomfort for occupants. Kajima has developed a diverse selection of these versatile systems for compatibility with various site conditions and provides the best options for every requirement from our clients.

In the field of seismic isolation, we have a long list of accomplishments in both building construction and retrofitting projects, starting with the 1986 completion of our first building with seismic isolation. This employed device combines laminated rubber bearings with dampers to separate the foundation from the building it supports. Structurally isolating the building from ground movement during an earthquake converts tremors into a gentle swaying motion. In addition, seismic isolation is highly effective at protecting building equipment and fixtures from damage and at preventing furniture from falling over. The powerful Great Hanshin Earthquake that struck Japan in 1995 proved the safety of seismic isolation because buildings with this technology suffered almost no damage. Following this disaster, the use of seismic isolation in Japan increased rapidly, particularly at hospitals and apartment buildings.



HiDAX-e is an oil damper developed by Kajima to reduce building vibrations. Requiring no electricity and featuring outstanding durability and simple maintenance, the device has been applied in a large number of super-high-rise buildings.

Comparison of Swaying at Buildings with and without Seismic Isolation (Great East Japan Earthquake)

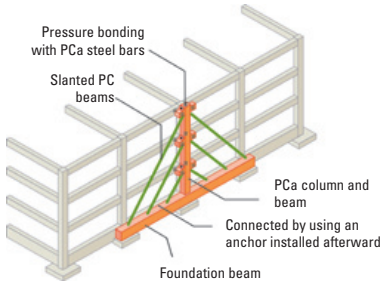


Making Existing Buildings More Resistant to Earthquakes

The Great Hanshin Earthquake and the Great East Japan Earthquake demonstrated that buildings constructed before the new earthquake resistance standards enacted in 1981 were more severely damaged than buildings conforming to these standards. Together with government offices and other buildings in the public interest, buildings constructed before 1981 need an earthquake resistance inspection and subsequent reinforcement or reconstruction depending on the inspection results.

Every building has different requirements concerning measures for upgrading earthquake resistance. Available methods for such measures include seismic resistance, response, and isolation. Kajima uses its many years of experience to perform comprehensive assessments that result in the best proposal for each customer.

Earthquake-resistance renovations at schools and other academic institutions demand particular attention to the time needed for retrofitting and to avoiding negative effects on how the building can be used afterward. For medium- and low-rise buildings, we use the Parallel Frame System, in which precast concrete beams are placed parallel to one another. The effect on rooms is minimal during and after reinforcement work. Vistas, ventilation and sunlight are also largely unchanged. Since installation work can be carried out during summer vacation or on weekends, this method is widely applied for the structural reinforcement of schools, which are extremely difficult to relocate even temporarily.



The Parallel Frame System

East Building of the Yakumo Gakuen Junior and Senior High School (Meguro-ku, Tokyo)