Earthquake Countermeasures of the Shinkansen

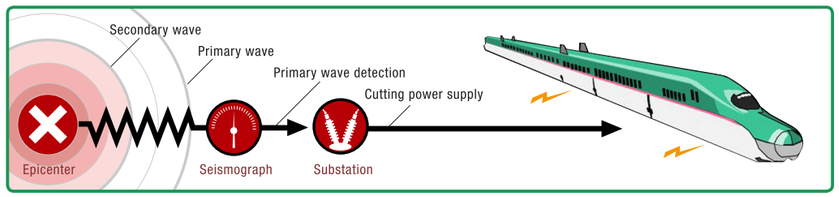
The year 2014 marked the fiftieth anniversary of the Shinkansen, Japan's high-speed rail. Its record of zero injuries and fatalities throughout numerous major earthquakes is due to the ceaseless efforts of everyone involved in its operation and development.

Since it began service, the Shinkansen has been equipped with an early earthquake detection system. When the first slight tremors from seismic waves are detected, electrical power is shut down, and the emergency brakes are applied, thereby reducing the speed of the train to a considerable degree before the strong tremors hit. The system is constantly upgraded, and it currently takes only about two seconds for the system to activate the device after primary seismic waves are detected.

Sophisticated earthquake countermeasures have been implemented in ground facilities as well. During the Great Hanshin-Awaji Earthquake in January 1995, elevated rails of the Shinkansen collapsed, causing massive damage. In light of this bitter experience, the railway companies retrofitted the elevated rail bridges against earthquakes, performing work such as reinforcing the bridge piers with steel plates. Since then, no bridge piers have been seriously damaged in major earthquakes.

During the magnitude 6.8 Chuetsu Earthquake in October 2004, a train in service derailed. Fortunately, the cars did not come off the tracks completely and did not overturn because the rail became caught between the wheels and the equipment under the cars, causing the train to stop. Having learned from this incident, the railway companies equipped cars and tracks with derailment prevention devices.

These combined measures have proved successful, and during the Great East Japan Earthquake, all twenty-seven trains in service at the time stopped safely the moment the quake hit. Such accumulated countermeasures implemented in both ground facilities and trains, developed based on experience, ensure the safety of high-speed rail service.



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1. The Early Earthquake Detection System demonstrates its extraordinary effectiveness each time an earthquake hits, ensuring the safety of the high-speed rail service. Development is currently under way to improve the system's accuracy and response speed. 2. The pillars of elevated tracks have been seismically reinforced with steel plates. The white areas are the parts that have been reinforced. 3. Several measures are in place to prevent derailment. One such measure is the Derailment Prevention Guards installed inside the rails. Another measure is the installation of protrusions to prevent derailment placed on either side of the cars.

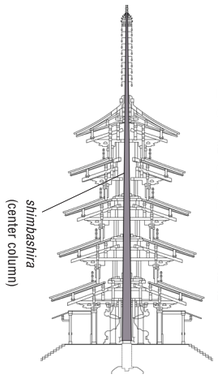
World's Tallest Freestanding Broadcast Tower Fuses Traditional and Leading-Edge Technologies to Ensure Safety

Completed in February 2012, TOKYO SKYTREE® boasts a height of 634 meters (2,080 feet), making it the world's tallest freestanding broadcast tower. In Japan, a country prone to earthquakes, it is crucial that the tower be able to maintain its function as a broadcast tower and transmit information in times of disaster. Therefore it was extremely important that the tower be designed to withstand earthquakes.

One of the technologies to ensure this is the vibration control system developed for this tower. The system consists of two structurally independent parts, a center column, or *shimbashira* (心柱), and the surrounding frame (the main body of the tower), which sway differently when an earthquake hits, thereby counteracting the swaying of each structure, and reducing the overall shaking caused by the quake. A 375-meter (1,230-foot) column rises through the center of the tower. From the ground level for the first 125 meters (410 feet), it is fixed to the steel frame of the tower body, but beyond that it is separated from the frame, connected loosely only by oil dampers. During an earthquake, they move with different resonant frequencies, thus limiting the swaying of the tower.

The system gets its name from the center column used in wooden multistory pagodas—a traditional form of Japanese architecture. Among all the wooden multistory pagodas across Japan that have stood for hundreds of years, including the 31.5-meter (103-foot) five-story pagoda at Horyuji, a classic temple built around A.D. 680, almost none have collapsed in an earthquake. Its structure, in which the center column is structurally independent from the wooden frame of the main body, has remained the same for over 1,300 years, to this day.

Japan's disaster countermeasures have evolved by combining traditional and advanced technologies.



Five-story pagoda and center column:
The center column that rises through the center of the tower connects to the main body only at the peak of the top story. There is a gap between the column and the body from the first through the fourth stories.

Image provided by A&W DESIGN.

Cross-section showing shock-absorbing zone around the center column

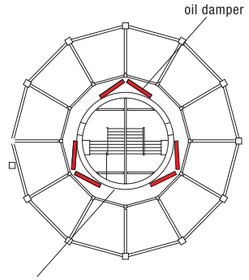


Image provided by Nikken Sekkei LTD.

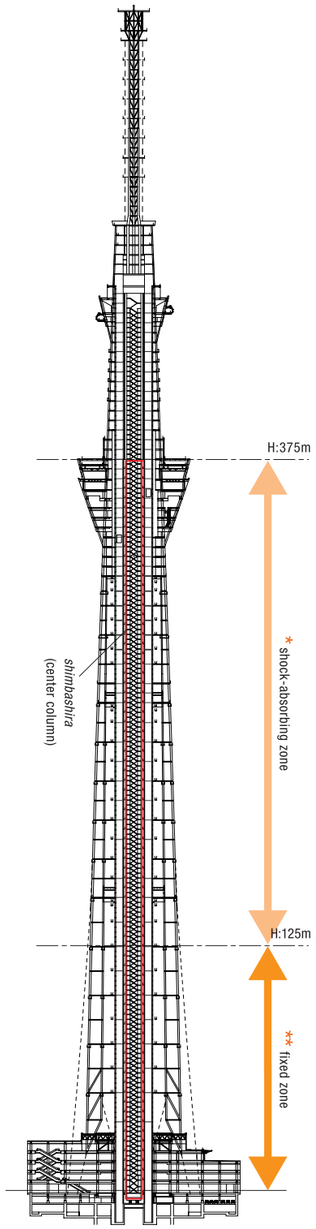


Image provided by Nikken Sekkei LTD.

* : The center column not fixed to the walls steadies the structure through the shock-absorbing function of the oil dampers.

** : The column is fixed to the surrounding steel structure with steel beams.