Disaster-Proof Shinkansen to Offer the Very Ultimate in Safety

Although the Shinkansen utilizes the most advanced technologies, it is still susceptible to Mother Nature and needs to monitor changes in it constantly. Our efforts to develop a Shinkansen system that can withstand both natural disasters and abnormal weather conditions are never-ending.

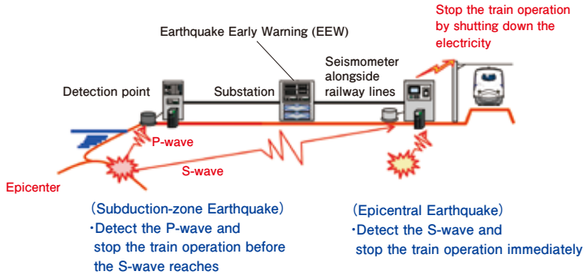
Protecting the Shinkansen from Earthquake Disasters

A host of systems to cope with earthquakes have been developed over many years since the Shinkansen commenced operation. In preparation for the threat of a major earthquake that could happen at any time, we continue to implement measures to improve seismic resistance.

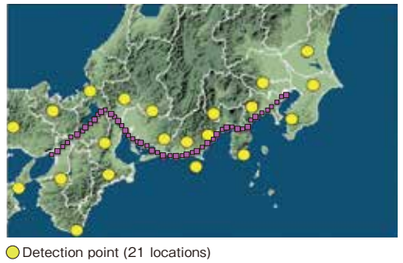
Mitigate Seismic Disasters—Early Earthquake Detection System

The Japanese archipelago is an earthquake-prone region. Twenty-seven trains were operated on the Tohoku Shinkansen at the time of the Great East Japan Earthquake (Magnitude of 9.0) on March 11, 2011. Fortunately, a potential catastrophe was avoided and no passengers were injured during this earthquake. This was thanks to our early earthquake detection system that instantly detects tremors and shuts off the supply of electricity to the trains, which in turn causes the emergency brakes to activate automatically and bring all trains to a stop. The Shinkansen system employs an earthquake rapid alarm system. By installing seismometers along the rail lines, coast lines, inland areas, and other locations and detecting the preliminary waves (P-wave) of an earthquake that arrive earlier than the secondary waves (S-wave), an alert can be issued early thereby allowing time for trains to be slowed down by the time that the S-wave arrives at the tracks. In addition to such systems, emergency earthquake warnings sent out by the Japan Meteorological Agency and other earthquake information is used to bring trains to a halt as quickly as possible when an earthquake occurs.

Train Control System During an Earthquake



Location of Detection Points and Location of Seismometers Alongside Railway Lines
(Eg. : Tokaido Shinkansen)



Detection point (21 locations)
Seismometer alongside railway lines (50 locations)

Fighting Large-Scale Earthquakes—Reinforcement of Structures

The anti-quake reinforcement of Shinkansen structures has been underway since the Great Hanshin-Awaji Earthquake with a focus on elevated track columns prone to failure by shearing. To date, about 17,600 columns on the Tokaido Shinkansen have been reinforced. A damper brace construction method that controls the ampli cation of the tremors on elevated tracks by installing X-shape bracings and strengthening the columns has also been employed. On the Sanyo Shinkansen, similar measures to strengthen elevated track columns prone to failure by shear, measures to prevent bridge collapse and tunnel reinforcement work have been completed.

Accelerated by the Sanriku-Minami Earthquake in 2003 and the Niigata-Chuetsu Earthquake in 2004, the seismic reinforcement work on the Tohoku, Joetsu, and Nagano Shinkansen was completed in 2007 with the reinforcement of 18,500 elevated track columns prone to failure by shear. As a result of these enhancements, while the Great East Japan Earthquake did result in the damage of some columns of elevated structures, there was no shear failure where seismic strengthening work had been carried out. Furthermore, there was no falling or collapse of elevated tracks.

We will take all possible precautions, including strengthening of the columns of elevated bridge columns prone to bending, to further strengthen structures that may incur damage due to strong seismic movement in preparation for the Tokai, Tonankai, and Nankai earthquakes that are predicted to occur.

Seismic Reinforcement of Train Station Buildings

Seimic reinforcement work has been underway at station buildings and in some tunnels. The Great East Japan Earthquake caused some ceilings in train station buildings to fall, but there were no fatal accidents involving customers at train stations.

Preventing Derailment and Rolling Stock Deviation during Earthquakes

The Shinkansen ensures passenger safety through measures that prevent derailment during an earthquake. And, deviation prevention measures have been implemented to prevent train cars from deviating off the track and colliding with incoming trains or structures in the event that a train does derail.

[Derailment Prevention]

"Derailment prevention guards" are installed sequentially to prevent derailment of trains when an earthquake occurs. The guards are installed parallel to the inner side of the rails to prevent derailment during an earthquake as much as possible. If the tracks move laterally due to an earthquake, the wheels on one side of the train will collide with the rails forcing the wheels on the other side to bounce up from the shock of the impact. The train derails when the tracks then move in the opposite direction under such conditions. Since the wheels opposite the wheels that have bounced up are still riding on the rail, the derailment prevention guards can signi cantly decrease the risk of derailment by stopping these wheels from moving any further in the lateral direction.

[Deviation Prevention]

There are two main types of deviation prevention measures. One is the placement of deviation prevention guards on the tracks. When the rolling stock derails due to an earthquake, the wheels make contact with the guards. This prevents major deviations and reduces damage. The other is measures for rolling stock bogies. The Tohoku, Joetsu, and Nagano Shinkansen have had backwards L-shaped "rolling stock guides" installed on bogies. If the rolling stock derails, the guides prevent the lateral movement of the wheels beyond a certain point. The Tokaido, Sanyo and Kyushu Shinkansen have had "deviation prevention stoppers" installed on the central area of bogies.

Preparations for Other Natural Disasters

[Wind and Rain Countermeasures]

When it is raining, the control center constantly monitors data obtained from rain gauges installed along the lines. Speed restrictions are enforced if the rain level exceeds a predetermined threshold. Anemometers are installed in locations where wind is concentrated and sections where windblasts are anticipated to occur, such as mountain ravines and bridges. If wind speeds exceed a certain level an alarm instantly noti es the control center of the Shinkansen and stations, then operation restrictions, including operation suspensions, are enforced. Sprayed concrete is applied to cut sections to prevent the collapse of slopes during heavy rainfall and further increase the Shinkansen's ability to withstand disasters.

[Snow Countermeasures]

The 70 km-section around Sekigahara on the border between Gifu and Shiga Prefectures and Niigata Prefecture are both areas which have heavy snowfall thereby making the Shinkansen operation challenging. Speed restrictions are imposed in snow-covered sections and the surrounding areas. Sprinklers are installed to wet snow in order to prevent it from getting kicked up by the trains. Visibility during blizzards is monitored using video cameras mounted above the ground so conditions can be checked in real time. Snow is removed using Russell snowplows, vehicles mounted with rotating brushes, snow blowers, and through manual labor at night.

[Restoring Train Service]

The average delay time of less than one minute per train is realized by the measures that are taken to minimize the impact of natural disasters on train operations. Routine training is provided on predetermined codes of conduct, such as reporting conditions from the eld, unifying communication channels and assembling in theeld, and communicating problems quickly in order to quickly restore train service in the event of a disaster or other abnormal situations. In the event that operation restrictions are imposed, train operation will resume after promptly con rming the safety of the area where restrictions are applied.