



# Great East Japan Earthquake, JR East Mitigation Successes, and Lessons for California High-Speed Rail

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MTI Project 1225

April 2015

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High speed rail operators must mitigate the risk of seismic damage that exists at tectonic plate boundaries throughout the world. Japan's high-speed rail operator, JR East, has developed a three-pronged approach that has prevented loss of life on any JR East train through 13 significant earthquakes, including the Great East Japan Earthquake of 2011. In fact, More than 15,000 people died when the Great East Japan Earthquake struck on March 11, 2011. Although more than two dozen Shinkansen trains were operating at the time, no trains derailed and no lives were lost among the passengers or crew, thanks to a seismic early warning system that automatically slowed the trains from 171 mph to 43.5 mph.

**A seismic early warning system automatically slowed trains from 171 mph to 43.5 mph.**

- They've developed a program that detects arriving earthquakes using P-wave alarm technology and automatically cuts power to the trains and applies the brake. The system also give audible warning to operators of standard trains.
- They've studied damage from each earthquake over the past fifty years and continuously work to improve the seismic resistance of the Shinkansen infrastructure, minimizing damage and speeding recovery.
- They also maintain an employee seismic safety program that includes an annual earthquake drill involving the passengers and crew on all of its trains.

## Study Methods

The research team conducted a literature review, interviewed JR East officials and consular staff members, and corresponded with the JR East Safety Laboratory staff to understand the development and implementation of their earthquake safety program, and the seismic early warning system in particular. They also interviewed the creators and users of commercial, site-specific earthquake alarm systems in California.

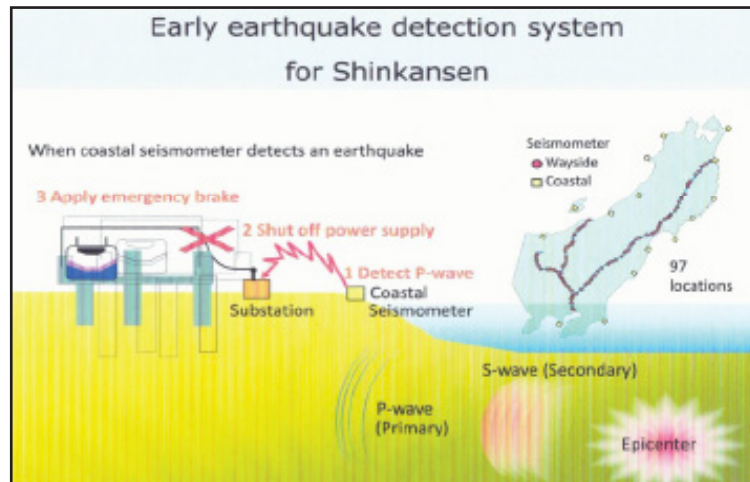
Some of the team studied the various seismic early warning systems used in Japan and conducted real-time development and piloting of California-specific notification systems and algorithms in cooperation with UC Berkeley Seismological Laboratory, CalTech Seismological Laboratory, NASA's Jet Propulsion Laboratory, USGS, the California Geological Survey, and the California Office of Emergency Services. These systems, which are currently installed in critical infrastructure, are used by BART, Caltrans, and a network of researchers, who receive early warning of earthquakes, such as the Napa Earthquake of 2014.

Other team members studied the infrastructure reinforcement systems used by JR East to create seismic resistance in their rail networks. In the Great East Japan Earthquake, materials, designs, and specially constructed derailment protectors each played a role in protecting passengers and rolling stock and facilitating rapid recovery of rail service.

## Findings

JR East's three-pronged approach to seismic safety has proven effective over fifty years of seismic activity, preventing loss of life and limiting property damage. The company studies each earthquake and its damage patterns to learn how to continuously improve seismic resistance for both their Shinkansen and standard train lines.

Existing early warning systems in California have been useful in automatically opening fire station doors and warning bus drivers of impending shaking. They have also assisted Caltrans engineers in setting priorities for bridge inspections following significant shaking. Researchers are developing a system that may soon warn the public.



Source: Hiraoka, 2011. Hiraoka, Shigenori. "The Effects of the Recent Earthquake and Tsunami on Rail and Bus Operations in Japan." Presentation to the APTA Public Education Embassy Roundtable, June 24, 2011.

## Policy Recommendations

The researchers recommend using lessons learned by JR East to inform decisions made by the system in development by the California High-Speed Rail Authority.

- A seismic early warning system is a critical link in system operational safety, especially if it can incorporate power shut-off and automated brake application.
- California's High Speed Rail system should be built with seismic resilience as a design parameter for infrastructure.
- Earthquake safety and response training for rail system staff and passengers is essential to increase the likelihood of survival of passengers and crew in an earthquake.

## About the Authors

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## To Learn More

For more details about the study, download the full report at [transweb.sjsu.edu/project/1225.html](https://transweb.sjsu.edu/project/1225.html)

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