USGS
science for a changing world

Earthquake Early Warning: Vital for City Transit

By Donyelle Davis

Although no one can reliably predict earthquakes, today's technology is advanced enough to rapidly detect seismic waves as an earthquake begins, calculate the maximum expected shaking, and send alerts to surrounding areas before damage can occur.

This technology is known as "earthquake early warning" (EEW).

An EEW system called "ShakeAlert" is being developed and tested for the West Coast of the United States. The U.S. Geological Survey (USGS), along with a coalition of State and university partners, is working on this innovative technology.

The San Francisco Bay Area Rapid Transit (BART) system is one of many partners who joined with the USGS to help apply its ShakeAlert EEW system in a way that could save hundreds of lives and allow their critical transportation assets to survive a major earthquake and speed the city's recovery.

One idea already in place is the automatic slowing of BART trains before seismic shaking arrives.

"EEW technology allows BART to add another layer of resiliency by reducing the risk of derailments during an earthquake. There are many components to a derailment, but the two most significant are the magnitude of the earthquake and the speed of the trains," said John McPartland, BART director. "EEW doesn't help with the former, but it does allow us to control the latter."

Timely warnings could provide several seconds—and in favorable cases, up to a minute or two—before the arrival of damaging shaking. Even a few seconds can allow time for protective actions, such as taking cover in safe locations, stopping elevators and opening elevator doors at the nearest floor, or automatically stopping critical processes to mitigate damages or enhance public safety.

"EEW technology allows BART to add another layer of resiliency by reducing the risk of derailments during an earthquake."

Commuters on BART train. Photograph courtesy of BART.

BART train in the San Francisco Bay Area. Photograph courtesy of BART.

BART train at the San Francisco International Airport in 2003. Photograph courtesy of BART.

Early Warning Technology Advances Safety Efforts

BART began using EEW technology in 2012 to improve the resiliency of the San Francisco Bay Area to the effects of a major earthquake. An early test project with the University of California, Berkeley, a ShakeAlert project partner, evolved into BART becoming an early adopter of the USGS ShakeAlert system. In addition to implementing EEW, BART invested more than $1 billion in their Earthquake Safety Program to seismically retrofit much of their infrastructure so it can remain in service after a major earthquake.

"BART is using EEW to slow the trains down before the strong shaking hits the trackway," McPartland said. "Slowing down the trains will reduce the number of derailments, and that will have a direct effect on reducing the number of injuries and deaths."

According to BART, the system already proved successful. In August 2015, a magnitude 4.0 earthquake in Oakland triggered the system, and trains automatically slowed. The magnitude 6.0 Napa earthquake in 2014 gave BART an 8-second warning, which initiated automatic train-stopping protocols, although no trains were running at 3:20 a.m.

Following a major earthquake, the recovery of the 26 cities and 4 counties served by BART can benefit greatly from an operating transit system. According to Tracy Johnson, the BART Seismic Engineering Manager, providing a conduit for transporting emergency responders and supplies to assist in the Bay Area region's recovery would be invaluable, particularly when roads and bridges are expected to be out of service.

"EEW is a game changer with respect to postdisaster recovery," Johnson said. "By using EEW to minimize derailments, lives will be saved, injuries will be reduced, and the impacts to a postdisaster-stressed medical system will be minimized."

The ShakeAlert system is under development with public and private partners, including the California Governor's Office of Emergency Services; the California Geological Survey; the Gordon and Betty Moore Foundation; the California Institute of Technology; the University of California, Berkeley; the University of Washington; the University of Oregon; the University of Nevada, Reno; and Central Washington University.

"EEW is a game changer with respect to postdisaster recovery," Johnson said. "By using EEW to minimize derailments, lives will be saved, injuries will be reduced, and the impacts to a postdisaster-stressed medical system will be minimized."

Students conduct the "drop, cover and hold on" safety procedure. Photograph credit: Jessica Fitzpatrick, USGS

Contact:
For more information about USGS science on earthquake early warning:

David Applegate
Associate Director
Natural Hazards Mission Area
Email: applegate@usgs.gov
Phone: 703–648–6600