RAILWAY MONITORING

Earthquake warning system for Harbin - Dalian high-speed railway in China.

Background

China has one of the world's longest and fastest high-speed railway networks, with trains reaching speeds of between 250 and 350 km/h. China is also a high risk region for earthquakes, so when an earthquake event occurs near a railway, there is significant potential for a major accident or derailment. A railway earthquake warning system can cause high-speed trains in the region of the earthquake to reduce their speed or come to a stop, thereby reducing the potential for personal injury and damage.

Early Warning Concept

The concept of the high-speed railway earthquake warning system is that the propagation speed of electromagnetic waves is much greater than that of seismic wave velocity. So when a P wave is detected following a seismic event, the alarm can be raised and reach the train before the main motion of the seismic wave is felt.

Project

The Harbin - Dalian high-speed Railway is the world's first high-speed railway operating at high latitudes and low temperatures in winter. The high-tech line has been designed so that trains can operate even in icy and snowy conditions. The line runs for over 900 km from Harbin City to the coastal city of Dalian, passing through the three northeastern provinces, the three provincial capital cities and six prefecture-level cities and their jurisdiction counties.

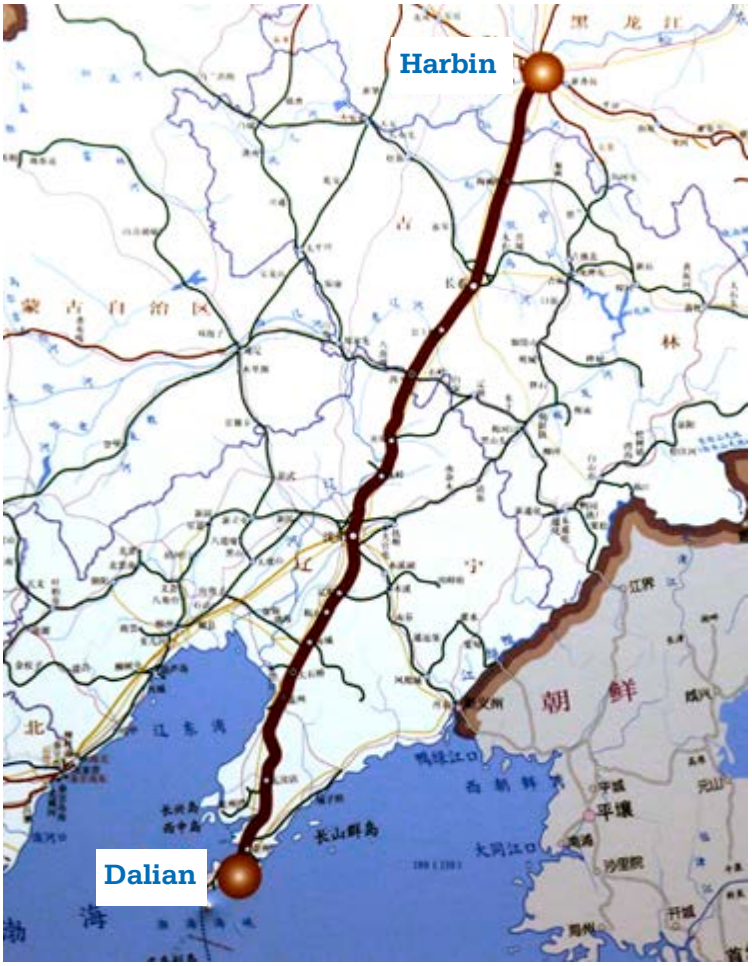

Figure 1 Map showing the route of the Harbin-Dalian railway

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The Solution

The railway earthquake warning system consists of 23 stations approximately 25 km apart. The stations are designed to detect the P waves of local or very strong earthquakes that may impact the railway line whilst ignoring the vibrations emitted during the normal operation of the high speed trains.

Figure 2 Example location of seismic station on Harbin-Dalian railway

Strong motion network

Each station is equipped with a Güralp 5TC accelerometer which has a large dynamic range and output sensitivity of up to 4g.

Figure 3 Guralp 5TC Accelerometer

Rapid and reliable digitisation

Each 5TC accelerometer is paired with a Güralp CD24R6EAM digitiser delivering 24-bit, high-performance, low-latency digitisation of less than 100 milliseconds. The waveform data is then transmitted to the data center.

The system is designed with an additional dual back-up CD24R6EAM digitiser at each station to ensure stable operation. The network has been operating since 2012.

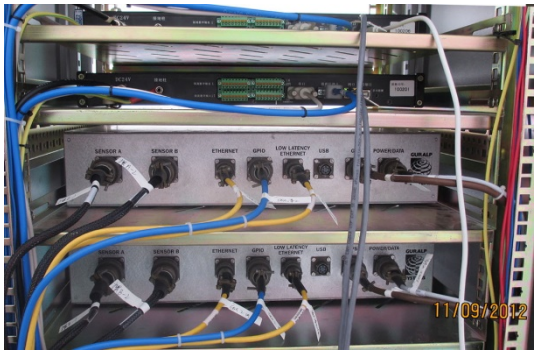

Figure 4 Digitiser setup with dual back-up CD24R6EAM

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