

Early Earthquake Warning System in Railways

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1. Introduction

It is important for earthquake disaster prevention of railways to control train operation at an earthquake in order to prevent disaster caused by train running and to insure passenger's safety. In that sense, an imminent prediction of earthquake occurrence is very useful information. However, it is said that there are few earthquakes of which occurrence will be able to be imminently predicted. Under such situation, Urgent Earthquake Detection & Alarm System (UrEDAS) was developed and has been practically used in railways. The system automatically estimates epicenter and magnitude within a few seconds from P-wave arrival and judges influence upon railways and warns trains against running before the main shock arrival. The outline of the early earthquake warning system in railway is as follows.

2. Early earthquake warning system in railways

An automatic train control system in railways at an earthquake was introduced with the opening of Tokaido-Shinkansen. Train control at an earthquake was judged by the maximum amplitude value (the main shock) of acceleration sensors along railways. Later, as Shinkansen network expanding and train speed being up, necessity of issuing alarms before the main shock was examined. It is thought that the accident rate of running train will decrease much if high-speed trains can be decelerated and stopped before the main shock reaches the railway. UrEDAS is an early earthquake warning system developed on the basis of this concept.

UrEDAS roughly estimates epicenter and magnitude from initial part of P-wave at a single seismic station. This estimation can be said, 'Imminent prediction of the earthquake ground motion (the main shock)'. UrEDAS is now in operation at about 80 seismic stations along mainly Shinkansen.

About ten years have passed since UrEDAS was put to practical use. Seismic networks of official organizations including Japan Meteorological Agency(JMA) have been rapidly developed in recent years and a plan of dispatching immediate earthquake information is advanced. NOWCAST earthquake information of JMA is the one. Railway Technical Research Institute is now developing a new early earthquake warning system using NOWCAST earthquake information. We expect that the new system will be widely introduced to many railways in the whole country and contribute to the progress of earthquake disaster prevention in the entire network of railways.

3. Expectation for earthquake prediction research

It seems that a medium-term and a long-term earthquake prediction give valuable information on an earthquake-proof design and a reinforcement plan of existent structures in order to reduce damage of railways caused by earthquake ground motion. On the other hand, it seems that short-term predictions of the time order from a few minutes to a few hours give very important information by which train operation can be safely controlled before the earthquake occurrence. In addition, it seems that train control by imminent prediction of earthquake ground motion like the early earthquake warning mentioned above becomes a realistic measure. In the future, it is expected that safety of train operation at an earthquake can improve extremely if a series of information on short-term prediction and imminent prediction of ground motion is able to be practically dispatched. The research of this field is expected to progress further in the future.