

Improvement of the single-station EEW algorithms for railways

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The present earthquake early warning system for railways adopts a single-station approach which has functions of a S-wave warning that is issued by threshold excess of acceleration and a P-wave warning that is issued by analyzing the P-wave initial phase, in order to control trains as rapid as possible during earthquakes. To improve accuracy and rapidity of the P-wave warning, here we proposed upgraded P-wave warning using the new algorithms developed recently.

Major upgraded points are as follows, 1) P-wave detection, 2) epicentral distance estimation, 3) back-azimuth estimation, 4) magnitude estimation and 5) noise discrimination. For improving P-wave detection, we re-determined the STA/LTA parameters so as to be able to detect seismic motions growing very slow, and we also introduced the level trigger logic which simply monitors threshold excess to make the trigger performance more reliable. For enhancing the performance of estimating epicentral distance and back-azimuth, we introduced the C- Δ method (Yamamoto et al., 2012) and the variable time window method (Noda et al., 2012) which improve the accuracy of estimation by 12% and 28% respectively. Further we re-defined the relation between the coefficient C and epicentral distance. For upgrading magnitude estimation, we introduced acceleration magnitude which is directly determined from observed acceleration. Since it is confirmed that the peak amplitude of seismic motions averagely appears faster in acceleration than in displacement, faster estimation can be possible by using acceleration for magnitude estimation. To improve the noise discrimination performance, we developed the new algorithm using frequency information of the input signal (Iwata et al., 2014).

Improvement of the P-wave warning is expected by using those upgraded algorithms. A prototype seismometer has been developed and tested in the field to evaluate its performance.

Keywords: Earthquake Early Warning, P-wave, Single-station method