Study on the relationship between seismometer site environment and earthquake early warning seismic parameter estimation accuracy

*Katsutomo Niwa[1], Naoyasu Iwata[1], Shunroku Yamamoto[1]

1. Railway Technical Research Institute

When earthquakes that threaten the safety of railway facilities and running trains occur, earthquake early warning systems aim to stop the trains as soon as possible. The seismometers installed for these systems automatically detect the P-wave arrival, then using information from the initial few seconds of the P-wave estimate seismic parameters such as epicentral distance, epicentral back-azimuth and magnitude, in order to quickly issue an alarm if necessary.

In this research, in order to improve the accuracy of the seismic parameters estimation, we examined the influence of the seismometers installation environment on the accuracy. We defined as characteristics representing the site environment: the ambient noise level of the observation site, determined from 2 seconds of the waveform recorded before P-wave arrival; and the hardness of the subsurface ground, indicated by the average S-wave velocity from the depth of 30m to the surface, henceforth referred to as AVS30.

Firstly, we calculated the RMS pf the 2 seconds of data before the P-wave arrival as the noise level, and checked the relationship between the noise level and the estimation error of the seismic parameters. When the noise level is small, the error of the P-wave detection time tends to become small. When the noise level is large, the automatic P-wave detection time tends to be earlier than would be chosen manually. The epicentral distance tends to be underestimated as the noise level is larger. The estimation error of the epicentral back-azimuth tends to decrease the estimation error as the noise level decreases. However, the magnitude based on the calculated displacement is hardly affected by the noise level, because the magnitude is determined by the maximum value of the observed amplitude.

Following this, we checked the relationship between AVS30 and the estimation error of the seismic parameters. The AVS30 is calculated from the K-NET PS logging result according to a method proposed by Shi and Midorikawa (1999). Since the variation of AVS30 showed little correlation with the estimation error, it can be thought that P-wave detection is hardly affected by the hardness of the subsurface ground. Though the epicentral distance tends to be underestimated as AVS30 gets smaller, this is only to a small extent. The epicentral back-azimuth tends to be smaller as the AVS30 is larger. The magnitude estimation is not correlated with the AVS30.

According to the results outlined above, the accuracy of the seismic parameters estimation will be improved in a quiet environment where the ambient vibration is small, and the subsurface ground is relatively hard. When we select the installation site of seismometers for earthquake early warning, we should therefore give priority to site environments with these characteristics.

Keywords: Earthquake early warning, Seismic parameters estimation, Seismometers installation environment, Noise level, Averaged S-wave velocity

