Improvement of Earthquake Early Warning- Intensity Estimation from Initial Part of P-wave -

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Seismic intensity in the Earthquake Early Warning (EEW) system is determined as follows. First, Mj is estimated using amplitudes of displacement doubly-integrated from to acceleration records of P-waves and then converted to Mw. Second, peak ground velocity (PGV) at a target site is calculated with the empirical relationship of PGV attenuation (Si and Midorikawa, 1999) which is given as a function of Mw and the source distance. Finally, seismic intensity I is derived using the empirical relationship I vs. PGV (Midorikawa et al., 1997). In the above method, many empirical equations are needed to calculate the seismic intensity. In a new idea we propose, the seismic intensity can be calculated by using only two empirical equations.

In this paper, we propose a conception of P-wave's Magnitude (Mp). Mp is defined as a function of the maximum acceleration Pmax in initial parts of the P-waves and the source distance r.

$\log Pmax = a\,Mp - \log r - b\,r - c$ (1)

Here, the constant b is a coefficient of internal attenuation and c is the site effect. On the other hand, seismic intensity I is estimated by using the following equation.

$I = m \log Pmax + n$ (2)

At first, we estimate the coefficients using strong motion records at the sites where seismic intensity over 4 were recorded during 19 crustal earthquakes including the mainshocks and their aftershocks of the 2000 Tottori-ken-Seibu earthquake, the 2004 Niigata-ken Chuetu and the 2008 Iwate-Miyagi Nairiku earthquake. Totally 1293 waveforms recorded with seismic intensity over 1 at 121 sites during the 65 earthquakes were used for determining the coefficients.

The Mp derived tentatively from the data is given as follows.

$Mp = 2.08(\log Pmax + \log r + 0.029\,r - c)$ (3)

Fig.1 shows the relationship between Mw and Mp derived from equation (3). The correlation seems to be fairly well as far as less than Mw 7 is concerned. Fig.2 shows the relationship between the P waves' maximum-accelerations and the observed seismic intensities. It seems to be useful to estimate seismic intensity showing a linear relation. The relationship of Pmax and seismic intensity I was obtained as follows.

$I = 2.18 \log Pmax + 0.78$ (4)

Fig. 3 shows the comparison of observed and estimated seismic intensity by using the P wave magnitude Mp. The agreement between them is well especially in high intensity range over 4. We conclude that the method presented in this paper is very successful and credible to improve the technique of EEW.

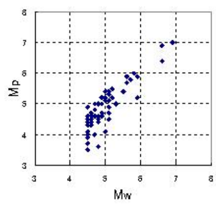

Fig.1 Relationship between Mw and Mp

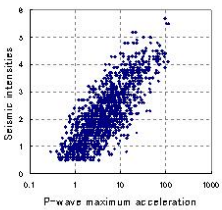

Fig.2 Relationship between P-waves' maximum accelerations and observed seismic intensities

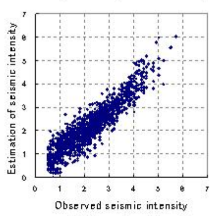

Fig.3 Comparison of observed and estimated seismic intensity