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 using Utsu's formula (1982). 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, the 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*.

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

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.

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

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 2004 Niigata-ken Chuetu and the 2008 Iwate-Miyagi Nairiku earthquake. Totally 1,570 waveforms recorded with seismic intensity over 1 at 124 sites during the 55 earthquakes(Mw≧4.5) were used for determining the coefficients.

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

$$Mp = 1.667(\log Pmax - \log r + 0.0055\,r + 0.338) \qquad (3)$$

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 the seismic intensity showing a linear relation. The relationship of *Pmax* and the seismic intensity *I* was obtained as follows.

$$I = 2.18 \log Pmax + 0.77 \qquad (4)$$

Fig. 3 shows the comparison of observed and the 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.

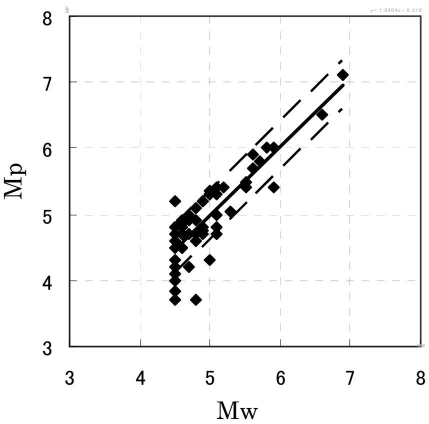

Fig.1 Relationship between Mw and Mp.

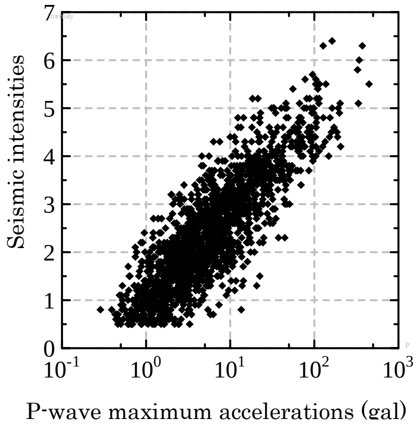

Fig.2 Relationship between P-waves' maximum accelerations and observed seismic intensities.

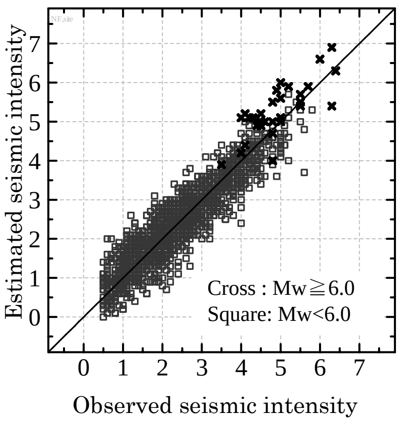

Fig.3 Comparison between the observed and the estimated seismic intensity.