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P and S wave identification filter for the on-site seismic alarm

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1. Introduction

S wave average amplitude is about 5 times larger than that of P wave. Onsite warning system measures P wave amplitude or real-time shaking intensity and estimates that of S wave. In a case when an onsite warning system is not able to discriminate S wave arrivals and estimates S wave amplitude using observed S wave data instead of P wave, estimated S wave amplitude becomes five times larger in average than the observed value. Damaging earthquakes except for those in the subduction zones occur in areas within about 30km and their (S-P) times are less than 3 or 4 seconds. Therefore, it is important to develop a technique to discriminate S wave arrival within a short time from S wave onset. The present study propose a filter which makes possible to identify S wave arrival within a short time from its onset.

2. P and S wave identification filter

It is well known that 1) The amplitude of the vertical component is large at P wave arrival and horizontal component at S wave arrival, 2) The dominant frequency of the S wave is longer than that of P wave. We propose the following filters for identifying the P and S waves.

$$F(t) = \{bZ(t) - NS(t) - EW(t)\} - c\{V(t) - rA(t)\} \quad (1)$$

Where, Z (t), NS (t) and EW (t): running means of absolute value of vertical, NS and EW components, V (t) and A(t); running mean of the absolute value of the three component seismograms and their derivative by time, b, c , and r are constants. b, c and they are put to be 2.0, 0.3 and 0.0. In a case P wave onset is measured, b and r are re-defined using about one second of data after P wave arrival so that the first and the second terms in (1) become 0.

The first term of Equation (1) corresponds to the amplitude variation of the vertical and horizontal components. If the vertical component becomes dominant at P wave arrival, it becomes positive and becomes negative if the horizontal component dominants at S wave arrival. The second term corresponds to the change in the dominant frequency. The value becomes negative by the low frequency S wave arrival.

3. Result

We used waveform data with seismic intensity larger than 5 lower recorded by K-NET, NIED to examine the effectiveness of the present P and S wave discrimination filter. The plot of the outputs of the filter together with observed waveforms shows that filter outputs for almost all seismograms become negative at S wave arrivals and their absolute values are several times larger than amplitudes of P wave or P wave coda. We conclude that the present filter is effective for the development of accurate on-site alarm system. We also concluded that this filter is effective for the automatic P and S wave arrival time picking in periods just after a large earthquake when the aftershock activity is extremely high and difficult to distinguish between P and S wave.

Keywords: Onsite Alrm, P and S wave identification filter, H/V change, frequency change, intensity estimation, Automatic hypocenter location