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improvement of the stochastic simulation method by introduction of the scattering effects in a simple way

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1. Introduction

The stochastic simulation method is a practical tool to compute high-frequency strong motions and is used widely. However, this method is not still free from several shortcomings. One of them is that the method cannot fully incorporate the effect of scatterings due to randomly inhomogeneous propagating media into computation. As a result, computed motions are underestimated except for zones very close to a fault. Thus, we will propose a simple practical improvement to introduce the effect of scattering into the stochastic simulation method.

2. Modeling of envelope of acceleration waveforms

We, at first, make a model of the envelope of acceleration waveform. Specifically, assuming the functional form of the envelope as $t^b*\exp(-ct)$, coefficients a and b are estimated from KiK-net borehole recordings of for 25 earthquake ranging from Mw4 to Mw5.5 occurred in western Japan. Estimated values of coefficient b are distributed so widely probably due to strong contamination of P code. This dissuades us from making a regression formula for coefficient b as a function of the focal depth, the magnitude, and the focal distance. Thus, we inherit the method to determine coefficent b as in the conventional stochastic simulation method. Specifically, given a width of the envelope of accelaration waveform, Tw, then the value of coefficient b is about 1.25 on the two condition that a peak of the envelope generates at 0.2Tw, and that a value of the envelope at width Tw is 0.05 times the peak value.

On the contrary, estimated values of coefficient c are concentrated within a certain range and decreases with increasing focal distances. This indicated that coefficient b is properly estimated. We make a regression formula not for coefficient b but for width Tw, since Tw is related to the source parameters such as the seismic moment and the stress drop through the corner frequency. Coefficient c is converted to width Tw using the relation Tw=b/(0.2c). Through the statistical analysis, we found that width Tw is linearly dependent on the focal distance and is little on magnitude and focal depth. Thus, the regression formula for Tw is specified as

Tw=2/fc+0.34(r-15)-0.0012d

, where fc is the corner frequency, r is the focal distance, and d is the focal depth. Coefficent c is again obtained from equation c=b/(0.2Tw).

3. Application to Kobe earthquake

We apply this new technique to Kobe earthquake and generate acceleration motions at 10 sites within Osaka basin. Computed accelerations by the new method are obviously improved in duration and amplitude compared with those computed the conventional technique. In particular, the shortcoming of the conventional stochastic method, rapid decrease with the focal distance, was completely removed in the new method. We think that this new method becomes a practical method to generate high-frequency motions.