A point source model considering the directivity effect

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In strong ground motion simulations, we often assume that strong ground motions are generated from an extended area on the fault plane, which is called an asperity. Spacio-temporal distribution of slip is considered by dividing the asperity into small subfaults and superposing motions from them. One of the problems of this method is the existence of artificial fall-off frequencies due to coherent interference of small motions, which is not clear in observed records. These frequencies depend on the asperity size and the manner of the division. Countermeasures have been developed to avoid this problem and to make synthetic spectra follow the omega-square model, for example, by introducing random rupture velocity.

In this study, we propose a simpler solution to this problem using the pseudo point-source model and two newly introduced parameters to model the directivity effect. The pseudo point-source model is a simple source model that follows omega-square model and have shown good agreements with observations for past large earthquakes. However, this model did not consider the directivity effect, which is an important factor of strong ground motions especially for crustal earthquakes.

One of the newly introduced parameters is the direction of the rupture propagation. The other represents the magnitude of the directivity effect. Since apparent rupture duration depends on the direction of the rupture propagation and the relative location of the site from the source, we represent the directivity effect by a corner frequency model of these two parameters. The model is designed to be smooth with respect to the target orientation. Using the model, we can synthesize strong ground motions with directivity effect without unnatural spectral fall-offs. We apply this method to the 2007 Chuetsu-oki earthquake, in which the directivity effect was clear. In addition, we investigate the effect of asperity shape on the directivity effect by comparing our model with characterized source model.

Keywords: strong ground motion simulation, point source model, directivity, corner frequency

