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Establishing procedure of evaluating fault parameters for predicting strong motions from intra-slab earthquakes with M8

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For precise prediction of strong motions from intra-slab earthquakes, it is necessary to establish a new procedure of evaluating fault parameters based on the characteristics of intra-slab earthquakes. Although such studies had been conducted by Sasatani et al. (2006) and Dan et al. (2006), procedures of evaluating fault parameters were not fully validated by reproduction of the actual earthquake records. So, Arai et al. (2013) simulated the ground motions of the intra-slab earthquake that occurred off the coast of Miyagi Prefecture on April 7, 2011, and they pointed out the problem of existing procedures of evaluating fault parameters and suggested the ideas to overcome the problem. Hence, in this study, we simulated the ground motion of the intra-slab earthquakes with M8, the 1993 Kushiro-oki earthquake of January 15 (Mw 7.6) and the 1994 Hokkaido Toho-oki earthquake of October 4 (Mw 8.2), using the procedures of evaluating fault parameter proposed by Arai et al. (2013) and we pointed out the problem of the procedure.

In the case of the intra-slab earthquakes of the 1993 Kushiro-oki earthquake and the 1994 Hokkaido Toho-oki earthquake, there was a possibility that the results of evaluation of strong ground motions using the equation of the short period spectral level proposed by Sasatani et al. (2006) or Dan et al. (2006) became too small. So, we tried to use the procedures of evaluating fault parameter proposed by Arai et al. (2013). But, the fault model of the 1994 Hokkaido Toho-oki earthquake was unnatural because the short period spectral level of the earthquake estimated by Morikawa and Sasatani (2004) was too large. For this problem, we developed the new fault model using a method to reduce the fault area while increasing the short period spectral level. We also developed the fault model using a crack model.

We set fault models of the intra-slab earthquakes of the 1993 Kushiro-oki earthquake and the 1994 Hokkaido Toho-oki earthquake, which were derived from the relationships of intra-slab fault parameters by Sasatani et al. (2006), Dan et al. (2006), Arai et al. (2013), and the procedure developed here. And we also set the fault model using a crack model. By using these five fault models, we evaluated strong ground motions by the empirical Green's function method. As a result, in the case of the 1993 Kushiro-oki earthquake, ground motion evaluation results by using Sasatani et al. (2006) and Dan et al. (2006) were smaller than the actual records. On the other hand, ground motion evaluation results by using the Arai et al. (2013), the procedure developed here, and the procedure of using a crack model showed better agreements with the actual records. In the case of the 1994 Hokkaido Toho-oki earthquake, ground motion evaluation results by using Sasatani et al. (2006) and Dan et al. (2006) were smaller than the actual records. And ground motion evaluation results by using Arai et al. (2013), the procedure developed here, and the procedure of using a crack model were larger than the actual records especially in the period of 0.5 seconds or less. This may result from overestimation of the short period spectral level obtained by estimating the S-wave acceleration source spectrum by Morikawa and Sasatani (2004). Actually, the short period spectral level calculated from the fault parameters by Morikawa and Sasatani (2004) is smaller than the short period spectral level obtained by estimating the S-wave acceleration source spectrum. So, we will reconsider the short period spectral level of 1994 Hokkaido Toho-oki earthquake for setting fault models. In this study, we targeted the intra-slab earthquakes of the Pacific Ocean plate. The study on intra-slab earthquakes of the Philippine Sea Plate remains as a future subject.

Keywords: Intra-slab earthquakes, Strong motion prediction, Fault model