Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS25-17 Room:A04 Time:May 25 15:15-15:30

Effects of Accretionary Prisms on Long-Period Ground Motions Associated with Velocity Structure Models and Sources

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Subduction earthquakes along the Nankai Trough can generate significant long-period ground motions in the Osaka, Nobi, and Kanto basins. Accretionary prisms along the Nankai Trough play an important role to excite and prolong long-period ground motions. Yamada and Iwata (2005), Yoshimura *et al.* (2008), and Watanabe *et al.* (2014) reported that accretionary prisms can reduce amplitudes of direct waves and prolong durations of later phases. Goto and Nagano (2013) and Watanabe and Kato (2013) implied that the source location can control accretionary prism effects. Three-dimensional velocity structure models have been constructed for ground motion simulations in Japan. However, these models contain a larger uncertainty at the ocean region rather than the land region. There are only a few studies to validate S-wave velocity structure models, which affect seismic waves significantly. To evaluate precisely accretionary prism effects on long-period ground motions, we should take into account not only the uncertainty of velocity structure models but also the source diversity of subduction earthquakes. Furthermore, it is important to discuss accretionary prism effects in different frequency ranges, since long-period ground motions with different dominant periods are excited in the Osaka, Nobi, and Kanto basins.

We here performed three-dimensional simulations of long-period ground motions for the event (M_w 7.2) that occurred off the Kii peninsula at 10:07 on 5 September 2004 (UT), to clarify the variation of accretionary prism effects resulting from different accretionary prism models. Our simulations used three kinds of velocity structure models that are composed of a different accretionary prism model: (A) the Japan Integrated Velocity Structure Model (Koketsu *et al.*, 2008. 2012); (B) the model where the accretionary prism layer in the Model A is replaced with accretionary prism layers presented by the previous studies as Takahashi *et al.* (2002), Fujiwara *et al.* (2009, 2012), and Tsuji *et al.* (2011, 2014); (C) the model without accretionary prisms by replacing the S-wave velocity with 3.2 km/s. Long-period ground motions simulated for these models were compared in several frequency ranges. A finite element method with voxel meshes (Ikegami *et al.*, 2008) was used for simulations, and topography, ocean water as well as an attenuation with constant Q-value were implemented into the code. The valid frequency range was 0.05-0.3 Hz. We assumed the point source of Yamada and Iwata (2005) and used the source time function of Yagi (2004).

We then focused on the dependence of accretionary prism effects on seismic source as pointed out by previous studies, and investigated the performance of accretionary prism effects in terms of source location and rupture propagation effect using the above method and velocity structure models. We assumed several finite source models estimated by the Cabinet Office of Japan (2012).

Our simulations suggested that amplitudes of direct waves are not always smaller than those for the model without accretionary prisms, which is not consistent with the previous studies. In the Osaka and Nobi basins, the amplitude of peak ground motions at sites where sedimentary layers are thick is sensitive to the change of accretionary prism models. On the other hand, in the Kanto basin, such sensitivity is not significant and peak ground motions are attenuated because the main arrivals to the Kanto basin propagate through the accretionary prisms. We confirmed a difference in propagation characteristics at the eastern edge of the accretionary prisms between the Models A and B: for the Model B, later phases with periods of 9-12 sec at the Izu peninsula and the Kanto basin have a potential to be developed. We also indicated that the amplification effect of accretionary prisms on later phases is enhanced in the forward direction of rupture propagation for shallow sources located near the trough axis.

Keywords: Long-period ground motion, Accretionary prism, Nankai Trough, Subduction earthquake, Ground motion simulation, Velocity structure model