Strong Ground Motion along the Joetsu Shinkansen during the 2004 Chuetsu Earthquake and Aftershock Sequence

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During the 2004 Chuetsu earthquake occurred at 17:56 on 23 October 2004, many relatively large-magnitude aftershocks occurred following the main shock (Mw 6.6). In the main shock, the seismic intensity meter of Kawaguchi-cho in Niigata prefecture recorded seismic intensity level 7, and equivalent seismic intensity level 7 was observed at K-NET Ojiya of NIED and Shinkawaguchi electrical substation of JR East (ARAIC, 2007). There were more than 10 earthquakes observed whose seismic intensity level were larger than 5+. All of them were observed in the areas such as Ojiya, Nagaoka, and Uonuma of Niigata prefecture. Large seismic intensity was observed in the watershed of the Shinano river where was near the epicenter and has a complex velocity structure with large site amplification factors.

During the 2004 Chuetsu earthquake, the first derailment of Shinkansen under operation ever occurred in which was slight south of the Nagaoka station of the Joetsu Shinkansen. The strong motion along the Joetsu Shinkansen has been discussed by Mori and Kazuni (2005), Nakamura (2006), and ARAIC (2007). Mori and Kazuni (2005) pointed out the influence of strong motion whose period was less than 0.5 second. On the other hand, the predominant period of the observed strong motion ranged from Ojiya to Nagaoka during the 2004 Chuetsu earthquake was 1 second. The 2004 Chuetsu earthquake and its aftershocks occurred in conjugated fault plane systems, both the hypocenter and velocity structures of which were complex. For that reason, it is difficult to obtain ground motion simulation results which are consistent with observation records. In this research, we focus on the arrival times of P-wave and S-wave for the 2004 Chuetsu earthquake and the importance of the distribution of strong ground motions. We also discuss the distribution of strong motion in the 2004 Chuetsu earthquake along the Joetsu Shinkansen by conducting ground motion simulation of aftershocks whose point-source assumption are easy to assume.

In the analysis, we deal with seismic intensity meters such as Niigata prefecture, JMA, K-NET, and KiK-net, using earthquake source models from F-net and Hikima and Koketsu (2005). We use J-SHIS as the initial velocity structure model. We also conduct ground motion simulation by using 3-D finite difference method from Aoi and Fujiwara (1999) in a period rang longer than 2 second and the stochastic Green’s function method by Dan and Sato (1998) in a period range shorter than 2 second. Calculation results are compared with the ground motion prediction equation of Si and Midorikawa (1999).

Keywords: 2004 Chuetsu earthquake, Joetsu Shinkansen, strong motion data, strong motion simulation

