A Study for the cause of earthquake damages by the 2014 Nakagano-ken Hokubu earthquake (M_J 6.7) –consideration using the strong motion simulation –

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- INTRODUCTION -

During the 2014 Nagano-ken Hokubu earthquake, distinct surface ruptures were observed along the known Kamishiro fault, so it suggests that fault slip was occurred near the shallow parts on the fault plane. However, the damage caused by strong motion was not so heavy near Shiojima district, where the most distinct surface rupture was observed, and the fatal damage befall around Horinouchi district, where locate at 7 to 8 km south from Shiojima. To study the reason of the discrepancy among these damages and the fault slip is important for understanding the cause of strong motions.
In previous study (Hikima *et al.*, 2015: SSJ, 2018:JpGU), we carried out source process inversion using strong ground motion records. In this study, we performed the strong motion simulation using the derived source model and the 3D structure model and discussed the cause of the strong ground motions and the damages.

- SOURCE MODEL -

The outline of the source model by Hikima *et al.* (2018) is as follows.
Basically, the waveforms of KiK-net borehole stations (by NIED) within about 50 km from the source area were used for the analysis. The acceleration waveforms were filtered between 0.03 and 0.8 Hz, and were integrated to velocity waveforms for the inversion analysis. In addition, two displacement waveforms at K-NET Hakuba (NGN005) and KiK-net Hakuba (NGNH36), which were adequately integrated from acceleration waveforms (Nakamura *et al.*, 2015:SSJ), were also incorporated to the analysis.
The source process was inverted by the multi time window analysis (Yoshida *et al.*, 1996, Hikima, 2012). We calculated the Green's functions by 3D finite difference method using a 3D velocity structure model. The 3D velocity structure was taken from the model constructed for the long period ground motion prediction map by the HERP.
The parameters of the hypocenter were taken from Sakai *et al.* (2015). Although the strike of the fault plane was set as 25 degree in Hikima *et al.* (2018), we also consider other strike angles in this study. The dip angle was varied according to depth, and the values were 60 and 50 degree for deep and shallow part, respectively. The fault size was 19 km for length and 15 km for width. The subfault size was 1.0km. Some large slip areas were estimated on the fault plane. One was slightly deeper from the hypocenter and the other one was on the shallow and small part of the fault plane. Although the amount of final slip was similar on these area, the time functions on shallow part were broader than those on deeper part, so it suggests that the strong motions from the shallow portion relatively lack high frequency components than those from deeper parts. Furthermore, large slip was not estimated on the fault plane near Horinouchi district.

- STRONG MOTION SIMULATION -

The strong motion simulation was performed by 3D finite difference method using the inverted source model and the 3D velocity structure. We used finer grid spacing than the calculation for the Green's function to consider higher frequency.

Although large PGV values were calculated near the region where the surface rupture was emerged, almost same level strong motions were estimated also near the Horinouchi. To survey the reason of these strong motions, we checked the snap shots and found that the directivity effect from the large slip which lies on the shallow part of the fault. Furthermore, when the amplification by the surface geology was also considered, the amplitude around Horinouchi became larger than the region near Shiojima and so on. It seems that the results correspond to the observed damage distribution in the source region. From these results, we think that the causes of the strong ground motion around Horinouchi are the source process (directivity effect) and the amplification by the surface geology.

Keywords: 2014 Nagano-ken Hokubu earthquake, Strong motion simulation, Source process, Near fault ground motion

