Dynamic source parameters of the 2013 Tochigi-ken hokubu earthquake inferred from kinematic source model

*Kazuhiro Somei[1], Ken Miyakoshi[1], Kunikazu Yoshida[1]

1.Geo-Research Institute

Revealing detailed source rupture processes for past large earthquakes is an essential study to make the advanced characterized source model for reliable strong motion prediction. Though the concept of characterized source model in a “recipe” is based on the result from kinematic source model, the physics of source rupture process in nature is represented by dynamic model, which is described as an evolution of shear stress with the frictional property on the fault. For understanding a more physically accurate model to make the ground motion, the study on strong motion simulation with dynamic source model has been developed in decades. In this study, we estimate the spatio-temporal stress change and dynamic source parameters on and off the asperity from kinematic source model of the 2013 Tochigi-ken hokubu, Japan, earthquake (M_w 5.8) as a part of advanced characterized source modeling toward the prediction of strong motion.
The spatio-temporal stress change on the fault is calculated from kinematic source model using a three-dimensional finite difference method (FDM) for solving the elastodynamic equations (e.g., Ide and Takeo, J. Geophys. Res., 102, 27379-27391, 1997). We employ the heterogeneous source model inverted from strong motion records in 0.1-1.0 Hz by Somei et al. (JpGU, SSS23-P19, 2014) as the kinematic source model input to FDM calculation. Each subfault size is divided into 250 x250 m from 1.0 x1.0 km, which is original size of inversion model, by bi-linear interpolating. We use the Staggered grid in FDM calculation. From the estimated stress change and slip amount, we extract the dynamic source parameters assuming the frictional constitutive law for each subfault.
The obtained dynamic source parameters are static and dynamic stress drops, effective stress, strength excess, critical slip-weakening distance (D_c), and fracture energy (G_c). We tried to evaluate the average value for each dynamic source parameters on and off the asperity, and to compare them for each other. The asperity area is defined as a rectangular area by characterizing the final slip on kinematic source model. The principal findings in this study are as follows: 1) The asperities have 2 times larger D_c than the off asperity area. 2) D_c’s on and off the asperities are about 50 % of the final slip amount. 3) Static and dynamic stress drops on the asperity are 3-5 times larger than those on the off asperity area. 4) Average static and dynamic stress drops, and effective stress on the asperity are 6.0, 6.7, and 7.7 MPa, respectively. 5) Strength excess tends to be large on the edge of the asperity.

Acknowledgements: This study was based on the 2015 research project ‘Improvement for uncertainty of strong ground motion prediction’ by the Nuclear Regulation Authority (NRA), Japan.

Keywords: The 2013 Tochigi-ken hokubu earthquake, Dynamic source parameter, Kinematic source model

