Dynamic Rupture Simulation of Near Fault Ground Motions for Surface and Buried Faults: Comparison of Dip Slip and Strike Slip Faults

*Kenichi Kato[1], Yasuhiro Ohtsuka[1], Monika Tadokoro[1], Tetsushi Watanabe[1], Tomiichi Uetake[2], Kazuhito Hikima[2]

1. Kobori Research Complex Inc., 2. Tokyo Electric Power Company Holdings, Inc,

From the view point of earthquake engineering, it is interesting topics which fault types, surface faults or buried faults, generate stronger ground motions. Somerville (BSSA 2003) and Kagawa et al. (EPS 2004) indicate from observed records in near faults region that ground motions from the buried faults show larger response spectra than those from the surface faults, in particular at high frequency range. Since the observational findings were derived from the restricted number of data, Dalguer et al. (BSSA 2008) and Pitarka et al. (BSSA 2009) conducted dynamic rupture simulation of near fault ground motions for strike slip events at many points on the surface. They conclude that the buried faults show larger amplitude than that of the surface faults, consisting to the observational findings by Somerville (2003) and Kagawa et al. (2004).

Because the target of these studies is strike slip events, Kato et al. (SSJ autumn meeting, 2016) carried out dynamic rupture simulation for reverse faults. They indicate that the surface faults show larger amplitude than the buried faults at near fault region with shortest distance from the fault plane, Xsh, shorter than 2km. This is the opposite relation obtained from strike slip events by Dalguer et al. (2008) and Pitarka et al. (2009), but they do not deal with such the short distance. Since near fault strong motion is remained to be solved, we carried out dynamic rupture simulations for strike slip events assuming the consistent fault parameters for dip slip events by Kato et al. (2016). We compare near fault strong motions for the strike slip events between buried and surface faults, and also compare to those from dip slip events.

Fault plane with 20 km length and 20 km width with dip angle of 90 degree is embedded in the homogeneous half space. Rupture initiation depth, H, for the surface fault model (SFM) is 7.5 km, and the stress drop is assumed to be 5 MPa. Two types of H, 7.5 km and 10.0 km, are set to the buried fault model (BFM), and the stress drop is assumed to be 7.5 MPa, which is higher than that of SFM. The stress drop shallower than 3 km is set to be depth dependent; 5 MPa to 0 MPa or -2.5 MPa for the SFM and 7.5 MPa to -20MPa for the BFM. We applied 3D-FDM with slip weakening law for the simulation (Kase and Kuge, GJI 2001).

From the spontaneous rupture, we obtained the moment magnitude, Mw, 6.9 from the SFM, and Mw 6.8 for the BFM. The peak ground velocity (PGV) of fault parallel component, FP, with Xsh shorter than 2km from the SFM show larger amplitude than that of the BFM due to the effects of fling step indicated by Hisada and Bielak (BSSA 2003). On the other hand, the PGV of fault normal component, FN, from the BFM show larger amplitude than that of the SFM due to the combined effect of large stress drop and rupture directivity.

Relatively large PGV of dip slip events are obtained at the foot wall side for FN, and the hanging wall side for vertical component with Xsh shorter than 2 km (Kato, 2016). When we compare the above PGV, the SFM show larger amplitude than that of BFM.

Summarizing the results of strike and dip slip events for the near fault region with Xsh shorter than 2 km from spontaneous rupture simulation, the PGV from the SFM show larger amplitude than that of the BFM, except for FN component of strike slip events. The strong ground motions in near fault region depend largely on the assumption of fault parameter at shallow depth. Note that the PGV from BFM show larger amplitude than that of the SFM at the region with Xsh longer than 2 km. We will further investigate the modeling of surface and buried fault, constraining the observed findings.

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Keywords: Dynamic Rupture Simulation, Surface Fault, Buried Fault, Near Fault, Ground Motions