A new characterized source model for long-period strong motions near surface-earthquake-faults of the 2016 Kumamoto earthquake

*Kojiro Irikura[1], Susumu Kurahashi[1]

1. Aichi Institute of Technology

Introduction

Strong ground motions are more closely related to regions of slip heterogeneity rather than the entire rupture area and total seismic moment (Irikura and Miyake2011). A characterized source model was proposed, consisting of one or several asperities with large slips and a background area with less slip (Miyake et al. 2003) based on source characterizations defined based on slip distributions from the waveform inversion of strong-motion data. The synthetic ground motions from the 2016 Kumamoto earthquake using the conventional characterized source model have been found to agree well with the observed motions in terms of acceleration, velocity, and displacement within the frequency range of 0.3–10 Hz (Irikura et al., 2017). Contributions from the background area of the characterized source model are not important for strong-motion records but need to match long-period motions, including the seismic moment (Miyake et al. 2003; Irikura and Miyake 2011).

For the 2016 Kumamoto earthquake, surface breaks caused by the mainshock were found associated with Futagawa-Hinagu fault system by field surveys. Near-field strong motions with high accuracy during the earthquake were recorded by the NIED strong motion network (K-NET and KiK-net) and the JMA and local-government seismic-intensity network. In particular, there are located two stations, Mashiki Town-hall station (93053) less than 2 km and Nishihara Village-hall station (93048) less than 1 km away from the surface traces along the Futagawa fault zone (Iwata, 2016).

We found the long-period motions more than 3 s seen at Station 93048 and Station 93048 are not well simulated against the observation.

A long-period motion generation area (LMGA) near earth-surface above the SMGA has been taken into account to explain long-period ground motions at those near-source stations. Therefore, we propose a new characterized source model for long-period strong motions near surface-earthquake-faults of the 2016 Kumamoto earthquake

Long-period ground motions from SMGA-LMGA model

Many studies of slip distributions in the source faults obtained from the waveform inversion of the strong-motion data for this event have so far been published (e.g., Asano and Iwata 2016; Kubo et al. 2016; Yoshida et al. 2016). The rupture area and asperity area were determined based on the slip distributions obtained from the inversion results. The long-period ground motions including permanent displacement are calculated using the Hisada’ s code (Hisada and Bielak, 2003).

We successfully simulated short-period ground motions from the 2016 Kumamoto earthquake using a characterized source model consisting of strong motion generation areas (SMGAs) based on the empirical Green's function (EGF) method except the two near-fault stations, Stations 93048 Nishihara Village-Hall) and 93053 (Mashiki Town-Hall). The locations and areas of the SMGAs were determined inside the

seismogenic zone deeper than 3 km through comparison between the synthetic ground motions and observed motions.

We put a long-period motion generation area (LMGA) near earth surface above the SMGA to produce long-period ground motions at those near-source stations. The LMGA has a rectangle area with a long-period (about 3 s) modified-ramp-functions as slip velocity time function between surface and seismogenic zone. We find that the synthetic ground motions as a sum of not only ground motions from the SMGA but also those from the LMGA agree well with the observed ones.

The spatial slip distributions on earth surface calculated from the SMGAs, LMGAs, and background area are compared with those derived from ALOS-2/PALSAR-2 data (Himematsu and Furuya, 2016). The observed slip distributions are integration of slips caused by series of earthquakes including three Mw > 6. Predominant contributions of the slip are attributable to the mainshock with Mw 7.0.

Keywords: characterized source model, long-period strong motions, strong-motion generation area, long-period motion generation area

