Estimation of Slip Velocity Function for the Region Shallower than Seismogenic Layer

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1. Introduction

The 2016 Kumamoto earthquake (Mw7.0) generated the expensive surface faulting, and recorded characteristic near-fault strong motions. For this reason the main attention has been directed to estimation of near-fault strong ground motion and the fling step. The theoretical method is widely used for estimation of near-fault strong ground motion, but little is known about slip velocity function required for estimation, especially the region shallower than seismogenic layer. According to Hikima et al. (2015), slip velocity function in the shallow section of the faulting area are different from that in the deep section. The purpose of this study is to estimate slip velocity function for the region shallower than seismogenic layer using near-fault strong ground motions and source fault models.

2. Study on the 1999 Chi-Chi Earthquake

The 1999 Chi-Chi earthquake (Mw7.6) recorded near-fault strong ground motions. TCU068, TCU102 are lying on the hanging wall, and TCU052 is lying on the foot wall. We simulated these observation records by theoretical method. Figure 1 shows slip velocity function identified by Wu et al. (2001) close to strong-motion stations. Figure 2 shows comparison of synthetic and observation waveforms fittings. Figure 2 include three sets of synthetic waves; the top waves (case1) simulated using source fault model by Wu et al.(2001). The middle waves (case2) correspond to simulated using only subfaults close to strong-motion stations, about 10km long and 6km wide. The bottom waves (case3) correspond to simulated using subfaults close to strong-motion stations similarly case2. In addition, we used average slip of subfaults close to strong-motion stations and a simple triangle time window as slip velocity function.
For TCU068 and TCU102 lying on the hanging wall, the synthetic waves of case1 and case2 are in good agreement with observation records. Subfaults close to strong-motion stations dominates in velocity and displacement waveforms. In addition, observation velocity waveforms are very similar to slip velocity function of subfaults close to strong-motion stations. Since we approximate slip velocity function as a simple triangle time window (that is case3). We estimated that the values for duration of triangle time window as slip velocity function and average slip of subfaults close to TCU068 were 5sec and 8.2m, TCU052 were 7sec and 12.1m, respectively. As a result, the synthetic waves of case3 are in good agreement with observation records.
Whereas, observation velocity waveforms of TCU052 lying on the foot wall has a different from slip velocity function. In addition, it cannot be said that subfaults close to strong-motion stations dominates in velocity waveforms. One reason for this is the greater are that displacement on the footwall is smaller than on the hanging wall because of low dip angle (about 30°). It was noted that it is difficult to approximate slip velocity function from only near-fault strong ground motions. Besides, it may be suspected that accuracy of slip velocity function is low if strong-motion stations lie only on the foot wall of low-angle fault. Incidentally, we estimated that the values for duration of triangle time window as slip velocity function and average slip of subfaults close to TCU102 were 6sec and 9.6m, respectively.

3. Estimation of Slip Velocity Function

In light of these considerations we estimated slip velocity function for the region shallower than seismogenic layer for other earthquakes in the same way as 1999 Chi-Chi earthquake. It was found that

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the duration of triangle time window as slip velocity function correlates positively with average slip of subfaults close to strong-motion stations as shown in Fig.3. Further studies for more earthquakes are needed in order to improve the accuracy of estimation of near-fault strong ground motion.

Acknowledgments: The source fault model for this work was provided by Dr. Wu. The authors wish to thank him.

Keywords: Near source region, Slip velocity function, the Seismic Waveform Inversion, Strong ground motion prediction

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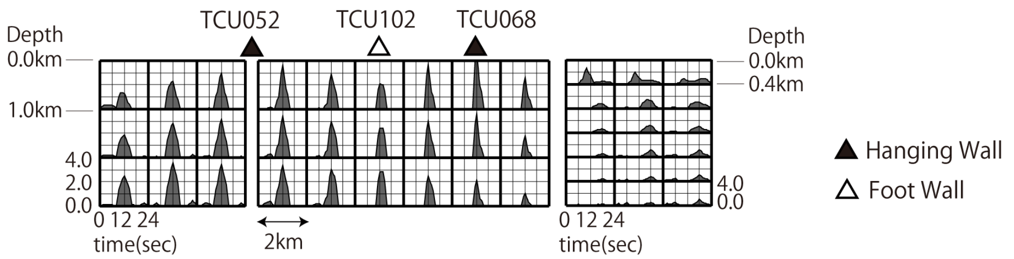

Figure 1. Slip velocity function by Wu et al.(2001) near strong-motion stations in the northern part of 1999Chi-Chi

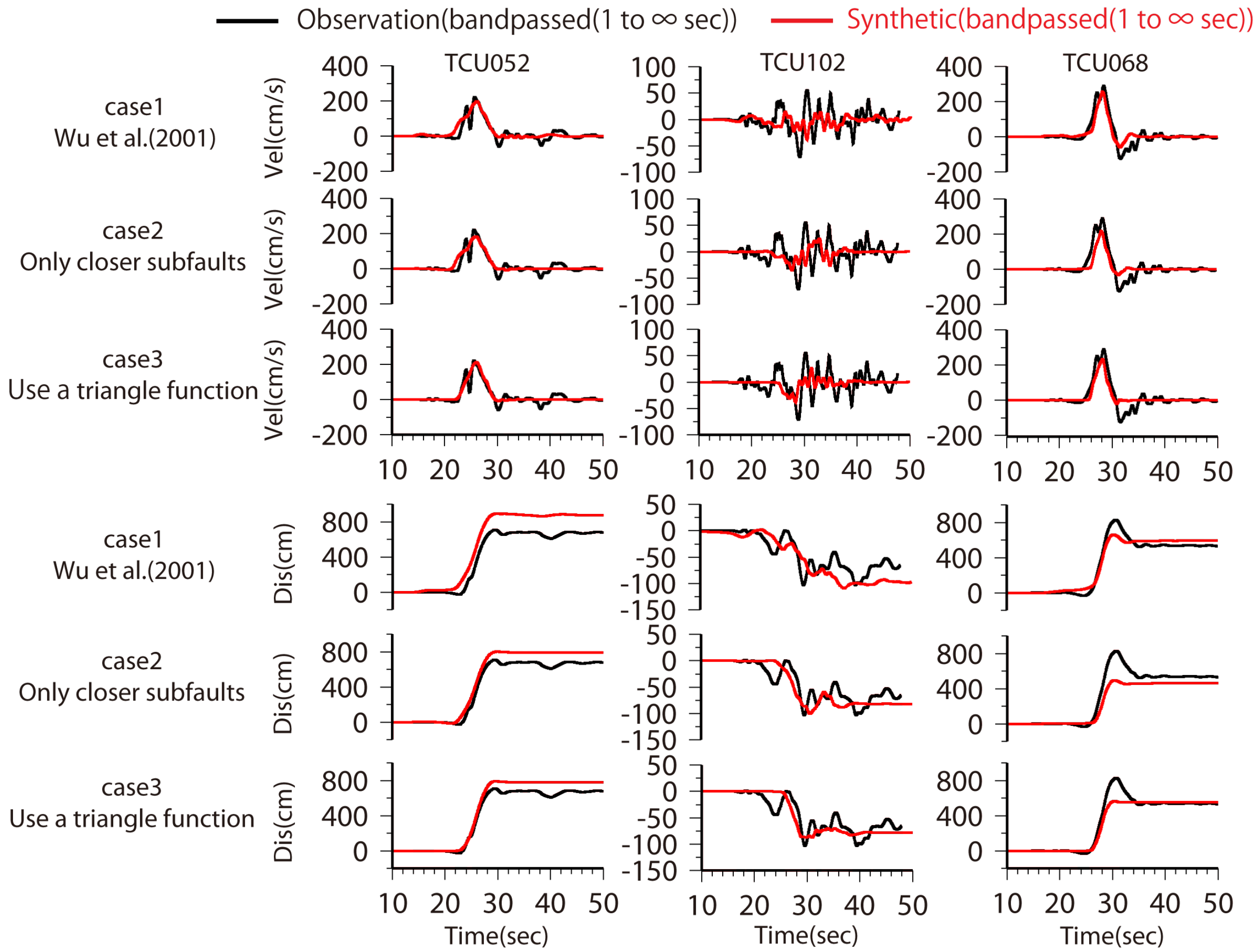

Figure 2. Comparison of synthetic and observation waveform fittings (NS component, 1999Chi-Chi)

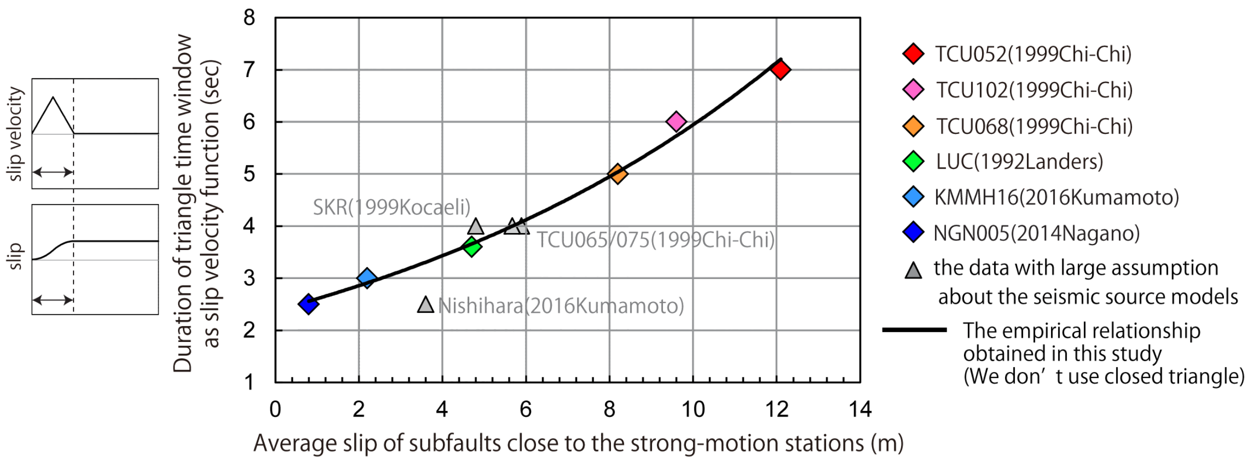

Figure 3. Relationships among slip velocity function and slip in shallower region than the seismogenic layer

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