UNRAVELING THE PHYSICAL MECHANISM OF LARGE AND LONG-PERIOD, NEAR-FAULT GROUND VELOCITIES IN SURFACE-BREAKING EARTHQUAKES

Yoshihiro KANEKO [1], ***Jesse KEARSE*** [2], ***Yoshito NOZUKA*** [1], ***Hiroyuki GOTO*** [3]

[1] Graduate School of Science, Kyoto University, Kyoto, Japan
[2] School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Wellington, New Zealand
[3] DPRI, Kyoto University, Uji, Japan

contact: kaneko.yoshihiro.4e@kyoto-u.ac.jp

Near-fault ground motions in recent, well-recorded surface-breaking earthquakes exhibit large (greater than 1 m/s) and long-period (a few seconds) velocity pulses, posing substantial hazards to tall buildings and large infrastructures. However, the physical mechanism behind their generation remains unclear. In this study, we utilize dynamic rupture simulations to investigate the origin of large and long-period velocity pulses observed during the 2022 Mw7.0 Chihshang (Taiwan) and 2024 Mw7.5 Noto (Japan) earthquakes. Notably, some stations for the Chihshang earthquake are as close as 250 m from the fault trace, providing a rare opportunity to examine the origin of near-fault ground motion in detail. We show that a relatively simple dynamic rupture model with uniform along-strike pre-stress and frictional properties can reasonably reproduce a set of near-fault waveform data and other geophysical datasets. Our results suggest that the dynamic interaction between propagating rupture and the Earth's surface, enhanced by reflected waves from the boundaries of shallow low-velocity layers, leads to large, long-period ground velocities in near-fault regions. This generic mechanism suggests that large, long-period ground motion is a common occurrence in near-fault regions during surface-breaking earthquakes. Our conclusion underscores the significance of dynamic interaction between propagating rupture and Earth's free surface, which must be accounted for to accurately predict near-fault ground motions.