Solid Earth Physics Seminar, Harvard University

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Faculty Lounge, 4th Floor, Hoffman Lab, 20 Oxford Street

On the Rupture Dynamics of Shallow Dip-Slip Earthquakes

Koji Uenishi
Department of Aeronautics and Astronautics
The University of Tokyo, Japan

Abstract:

One noticeable characteristic of a shallow dip-slip earthquake is the asymmetric ground motion near the rupturing fault plane. For instance, in the case of the 2014 Nagano-ken Hokubu (Kamishiro Fault), Japan, earthquake, the peak ground acceleration on the hanging wall is about 2.5 times as much as that on the footwall at nearly the same epicentral distance, although the dip angle of the ruptured fault plane is in a higher range (40-70 degrees) and it is almost 90 degrees near the hypocenter. The mechanics behind this asymmetry, however, has not been fully clarified yet. Here, we study numerically as well as experimentally the rupture dynamics of a flat dip-slip fault plane, dipping either vertically or at an angle, in a simplified two-dimensional, monolithic (scenario I) or layered (scenario II) linear elastic medium. Numerically, we use a finite difference technique developed on a PC basis, and experimentally, we utilize dynamic photoelasticity in conjunction with a high speed digital video camera system. We record the dynamic wave field generated by the crack-like primary rupture along a modeled fault plane, and find that the fundamental scenario I needs geometrical asymmetry to cause asymmetric seismic motion owing to the propagation of "corner waves." The corner waves are produced by the interaction of Rayleigh-type waves that follow primary fault rupture. In contrast, the scenario II does not require asymmetric geometry to induce asymmetry of the seismic motion. The (anti-)symmetry of mode-II seismic motion can be easily broken even in geometrically symmetric models if the secondary fracture is allowed at an interface between layers, and like in the 2014 event in Nagano, rupture of a fault plane with a rather large dip angle can indeed generate asymmetrically larger stresses in the hanging wall than in the footwall.