Observations on the Fault Dynamic Rupture of the 1999 Chi-Chi (Mw7.7), Taiwan, Earthquake

James Mori[1], Kuo-fong Ma[2]

[1] RCEP, DPRI, Kyoto Univ., [2] Institute of Geophysics, National Central University

http://www.rcep.dpri.kyoto-u.ac.jp/

The 1999 Chichi, Taiwan earthquake produced the best strong-motion data ever recorded for a large event. We note that the accelerations and corresponding damage to buildings were larger in the southern part of the fault but the displacements were higher in the northern part of the fault.

We ran a fault inversion for 23 stations to obtain the distribution of slip and slip velocity. Due to dynamic rupture behavior, melting or fluid pressurization lubricates the fault zone. This behavior smoothes the roughness of the fault zone and generates longer period seismic waves. This region of low dynamic friction, thus produces less high frequency waves and consequently less shaking damage in the area, despite the large amount of slip.

The 1999 Chichi, Taiwan earthquake (Mw 7.7) produced the best set of strong-motion data ever recorded for a large earthquake. We use these data to study the rupture dynamics of the faulting process. In particular we investigate the observations that the accelerations and corresponding damage to buildings were larger in the southern part of the fault. In contrast, the largest observed fault displacements and instrumentally recorded ground velocities were higher in the northern part of the fault.

We ran a finite fault inversion for three-component data from near-field 23 stations to obtain the distribution of slip and slip velocity on the fault plane. The results show a region with very large slip and slip velocity in the northern part of the fault, which corresponds to the area where very large surface displacements (up to 8 m) were observed. The large slip velocities for this asperity imply a large dynamic stress drop. We suggest that the large dynamic stress drop is an indication of reduced dynamic friction. As the rupture propagates to the north, heat generated by the slip melts the fault zone or pressurizes fluids, which reducing the frictional stress. This allows increased the slip velocity, and promotes the extensive sliding. Due to this dynamic rupture behavior, melting or fluid pressurization lubricates the fault zone, which is initially rather heterogeneous. This behavior smoothes the roughness of the fault zone and generates relatively longer period seismic waves and lower ground accelerations. This region of low dynamic friction, thus produces less high frequency waves and consequently less shaking damage in the area, despite the large amount of slip.