AOGS 2005

Differences in Earthquake Source and Strong Ground Motion Characteristics Between Shallow and Buried Faulting

PAUL G. SOMERVILLE
Risk Frontiers, Macquarie University, Sydney

Earthquakes typically nucleate near the bottom of the seismogenic rupture zone in the crust. Large earthquakes usually break the surface, but small earthquakes usually do not. Over one-half of the earthquakes in the magnitude range of 6.0 to 6.5 do not break the surface; this fraction decreases to about one-third for the magnitude range of 6.5 to 7, and about one-fifth of earthquakes in the magnitude range of 7.0 to 7.5. If it is assumed that all of the slip on a fault occurs during earthquakes, then larger earthquakes are characterized by relatively larger amounts of shallow slip than are smaller earthquakes. These differences in the depth distribution of slip and are important, because the ground motions generated by earthquakes that do not have large surface faulting are stronger than those of earthquakes that do. This was demonstrated in recent large earthquakes having large surface slip, including the 2002 Denali, 1999 Kocaeli, and 1999 Chi-Chi events, which have surprisingly weak ground motions at short and intermediate periods. Although the shallow events have large near-surface displacements, they do not have correspondingly large slip velocities. The slip velocities of the deep events are larger than those of the shallow events, causing larger ground motion levels because slip velocity is an important determinant of strong motion levels. Averaged over 9 shallow events and 8 deep events, the slip velocity of shallow events is about 70% that of deep events, both for the fault as a whole and for the asperities on the fault. This difference in slip velocity between surface faulting and buried faulting earthquakes is an important aspect of earthquake source characterization for the simulation of strong ground motion.