The effect of supershear rupture speed on the high frequency content of ground motions

P. SPUDICH[1], and A. Bizzarri[2]

[1]U. S. Geological Survey, [2]Istituto Nazionale di Geofisica e Vulcanologia

It is well known that a linear rupture front propagating uniformly at supershear speed causes an S-wave Mach front, which is essentially a portion of plane wave that is not subject to geometric spreading (Bernard and Baumont, 2005). However, using isochrone theory the effect on ground motions of supershear rupture having an arbitrarily complicated speed distribution can be determined exactly in a whole-space for a finite fault with a position-independent slip velocity function. In a more complicated medium the effects can be determined asymptotically. For both far-field and near-field terms, the effect of supershear speed (for S waves) or transonic speed (for P waves) is to create an extremum in the arrival time function on the fault. Isochrone velocity is singular at such points, leading to the Mach pulse. At the time of extrema, the isochrone integral has a jump discontinuity in time, causing spectral enrichment proportional to frequency in the ground motions. This is the cause of Dunham's (2005) observation that the ground velocity pulse radiated from supershear rupture has the same time function as the slip velocity pulse. Heterogeneous ruptures may have many places where rupture speed is locally supershear, leading to brief high-frequency pulses radiated from each of these places. On the other hand, Burridge (1973) and Andrews (1976) have shown that during supershear rupture the slip velocity pulse at the crack tip might have less high frequency content than it has when travelling at subshear speed. Thus, the high frequency content of S pulses from supershear rupture depends on the balance of source-related diminution and propagation-related enrichment.