Rupture arresting in Large Aspect-ratio Faults ($L >> W$)

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It is expected that large earthquakes, such as the 2002 Mw 7.9 Denali and the 2008 Mw 8.0 Wenchuan earthquake in China, both with fault length about 300km, rupture the entire seismogenic thickness. Then these large events are originated in large aspect-ratio faults, $L >> W$, in which L and W are respectively the length and width of the fault. Previous studies (Day, 1982) shows that this kind of fault initially ruptures as a crack-like (a simply-connected patch) around the hypocenter, but subsequently, at a time greater than that required for the rupture to cross the fault width, the rupture bifurcates into two separate pulses traveling in opposite directions due to the stopping phases coming from the top and bottom of the fault. When this process occurs in the bi-material case (Dalguer and Day, 2009), it evolves interacting with the normal stress perturbation (characteristics of bimaterial fault rupture) and under very limited conditions it can lead to unilateral rupture, in which rupture is arrested in the non-preferred direction and rupture propagates indefinitely in the preferred direction. Here we continue the investigation in this direction to further understand the W effect on rupture propagation. Our numerical investigation in homogeneous fault shows that W takes an important role on rupture arresting and the generation of steady-state pulse-like rupture in strike slip as well as dipping faults due to the arrival of the stopping phases at the rupture front. Rupture velocity depends on W. This dependence leads to slowdown the rupture speed, capable to arrest the rupture for small Ws. For $W/L_c <\sim 4$ rupture arrests in strike slip faults and for $W/L_c <\sim 5.3$: rupture arrests in dip slip faults, in which L_c is the critical length. At distance $L >> W$, the rupture propagates with a steady-state velocity pulse, suggesting that the cohesive zone length in the rupture front remains constant. In a bimaterial fault, for the same problems, rupture never stops. These results suggest that the bimaterial effects promote rupture and W effects promote rupture arresting. When combining W and bimaterial effects, both are competing, and only under some limited conditions (as shown by Dalguer and Day, 2009) unilateral rupture originates. In these cases, the W effects successfully arrest the rupture in the non-preferred direction, while in the preferred direction the bimaterial effect is stronger enhancing rupture propagation.