

Stress concentration ahead of supershear rupture

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We report the shear strain field ahead of a supershear rupture. The strain data was obtained during the large-scale biaxial friction experiments conducted at NIED in March 2013. We conducted friction experiments using a pair of meter-scale gabbro rock specimens whose fault area was 1.5m x 0.1m. We applied 2.6MPa normal stress and loading velocity of 0.1mm/s. At the long side of the fault edge, which is parallel to the slip direction, 32 2-component semi-conductor strain gauges were installed at an interval of 50mm and 10mm off the fault. The data are conditioned by high frequency strain amplifiers (<0.5MHz) and continuously recorded at an interval of 1MHz with 16-bit resolution. Many stick slip events were observed and a unilateral rupture event was chosen in this analysis that propagated with supershear rupture velocity. By focusing at the rupture front, stress concentration was observed and sharp stress drop occurred immediately inside the rupture. We found that the stress concentration becomes mild as the rupture propagates and length of the stress concentration area becomes longer. This observation is quite interesting because the rupture propagates at a constant speed close to square root two times the shear wave velocity and thus a longer stress concentration region suggests more energy dissipation. We might speculate that such longer stress concentration area suggests longer plastic region ahead of the rupture (or longer cohesive distance). I.e. The cohesive zone length might be longer as the rupture propagates to maintain constant rupture velocity propagation.

Keywords: Earthquake rupture, Stress concentration, Supershear rupture