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Asymmetric normal and shear stresses along bimaterial interfaces

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Earthquakes may occur along bimaterial interfaces where rupture directivity and subshear to supershear transition are influenced by material contrast. Studying bimaterial interfaces is important to estimate earthquake hazards in regard to strong ground-motion caused by supershear transition and to identify regions where rupture directivity may influence the properties of earthquakes. Laboratory experiments and numerical simulations are used to model rupture along bimaterial interfaces. The dimensionless parameter S - the ratio of the stress increase required to initiate slip to the final stress drop [1] - is an indicator for the transition from subshear to supershear rupture.

Using numerical uniaxial compression tests we find highly asymmetric normal and shear stresses as well as a non-constant parameter S along bimaterial interfaces. Consequently, the asymmetry of the stresses should be considered when analysing the transition to supershear ruptures in laboratory experiments and numerical work. Using results from dynamic rupture simulations we discuss to what extent rupture directivity in general and the supershear transition in the so called preferred direction specifically would be influenced by a non-constant S. We relate these results to common explanations of rupture directivity. We propose geometrical changes and the application of reasonable boundary stresses to achieve a constant S value in supershear lab experiments and numerical simulations.

[1] Andrews, D.J. (1976), Rupture velocity of plane strain shear cracks, Journal of Geophysical Research, Volume 81, Issue B32, p. 5679-5689.