PORE PRESSURE CHANGES INDUCED BY DYNAMIC SLIP ON A PLANE BETWEEN DISSIMILAR MATERIALS

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Recent, detailed observations of mature fault zones have revealed that primary slip is confined to a very narrow zone that is much less permeable than the adjacent material and that slip often occurs at an interface between dissimilar materials that are more damaged than material further from the slip zone. Because a propagating slip pulse induces compression on one side of the slip plane and extension on the other, a pore pressure change is induced on the slip plane when the poroelastic properties of the materials abutting the slip plane differ. In particular, the pore pressure is increased if the compressive side is less permeable than the extensile and decreased if the compressive side is less permeable. The magnitude and effects of these induced pore pressure changes are examined by incorporating them into the steady-state, slip weakening pulse model of Rice, Sammis and Parsons (BSSA, 2005). Calculations assume undrained conditions except for narrow boundary layers, of the order of a few 10's of millimeters, adjacent to slip plane where diffusion can be effective over the time scale of slip propagation. An expanded model of this region shows that the effect of the dissimilarity of near-fault properties can be incorporated in the Rice et al. model simply by altering the Skempton's coefficient. Because the induced pore pressure change is proportional to the along fault gradient of the slip, it has the same form as does the normal stress change induced by slip between dissimilar elastic solids. Because both effects may be of either sign, they can augment or offset each other. For a representative difference in properties, the effective normal stress change due to the pore pressure can exceed that for slip between dissimilar elastic solids if the permeability contrast is large and the rupture velocity is not too large. The magnitude of the normal stress change for slip between dissimilar solids increases rapidly as the rupture speed approaches the generalized Rayleigh velocity and may be likely to dominate at higher rupture speeds.

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