Shear strength of a shear zone in the brittle-plastic transition based on tensorial strain partitioning

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A constitutive law of shear zones in the brittle-plastic transition (BPT) is of great importance to understanding loading at the bottom of the seismogenic layer preceding large earthquakes. Previous microphysics-based models are based on the partitioning of slip and dilation normal to the shear zone into different deformation mechanisms. Here, I account for the remaining 2-D strain component, inelastic extension of the shear zone, and associated stress buildup parallel to the shear zone, and investigate the steady-state behavior of a shear zone in which slip on inclined planes and bulk plastic flow coexist. Kinematic constraints and constitutive laws of the two mechanisms were solved numerically. The results show that the inclination of slip planes causes weakening relative to the friction law. Whereas the previous two-mechanism model yields a larger strength than the friction law for a rate-weakening slip element in the BPT, the present model qualitatively resolves this problem. Fault-parallel stress buildup can exceed the normal stress in the BPT and the brittle regime if the friction coefficient of the slip planes is in the range of Byerlee’s law. This study illuminates the importance of fault-parallel stress in understanding the fabrics and strengths of shear zones.

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