The development of pressure vessel on gouges for rock deformation at seismic rates under water-saturated conditions

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To understand earthquake mechanism and fault behavior during earthquake ruptures, experimentalists commonly conduct rock deformation tests with rotary shear apparatus (e.g., low-to high-velocity rock friction experiment, LHVR) which allow deformed at seismic rates. In general, the materials utilized for rotary shear apparatus are both cohesive rocks (e.g., gabbro and carbonate) and incohesive rocks (natural fault gouges and synthetic rock powders), while the latter are deformed at seismic rates and, commonly at low normal stresses (0.5 to 2 MPa confining with a plastic Teflon ring). However, using Teflon rings has issues of gouge extrusion and chemical contamination, in particular, at high normal stresses (>3MPa) and water-saturated condition, and the obtained mechanical data and associated experimental products seem to be questionable. Here we develop a metal pressure vessel for LHVR to deform gouges at seismic rates and, importantly, expand the normal stress capability (up to 15 MPa) and under water-saturated condition. Our results show the resistance from the pressure vessel itself (metal-to-metal contact) is extremely low (friction coefficient ≈0.02), and the result of kaolinite is similar to the previously published data. In particular, both gouge-extrusion and water-leaking was not observed deformed at a normal stress of 15 MPa and equivalent velocity 1 m/s. The designed pressure vessel could fill the gap of experimental conditions among the current used pressure vessels and complete the understanding of fault ruptures.

Keywords: pressure vessel, water-saturated condition, fault gouge, rotary shear experiment

