SSS28-17 会場:303 時間:5 月 23 日 11:30-11:45

大型二軸試験機によるスティックスリップ時のガウジ生成に消費されるエネルギーの見積もり
Energy Partition to Gouge Generation during Stick-slip as Studied by a New Large Biaxial Friction Ap

東郷 徹宏 [1*], 福山 英一 [2], 山下 太 [2], 溝口 一生 [3]
Tetsuhiro Togo[1*], Eiichi Fukuyama[2], Futoshi Yamashita[2], Kazuo Mizoguchi[3]

[1] 中国地震局地質研究所, [2] 防災科学技術研究所, [3] 電力中央研究所
[1]Institute of Geology, China Earthquake Administration, [2]National Research Institute for Earth Science and Disaster Prevention, [3]Central Research Institute of Electric Power Industry

To determine how much of the frictional energy consume in generating fault gouge and breccia is important because this fraction will affect the energy used for frictional heating which in turn can affect the mechanical properties of a fault during seismic fault motion. In addition, it is geologically important to understand the formation and developing process of the mature fault zones.

We have used the large biaxial machine newly constructed in National Research Institute for Earth Science and Disaster Prevention (NIED), Tsukuba (Fukuyama et al. 2012 and Yamashita et al. 2012). This machine is developed to bridge a scale-gap between natural earthquakes (~km) and conventional laboratory experiments (~mm). The machine is built on the shaking table and used the hydraulic actuator of the table as the shear loading jack.

We have conducted seven biaxial friction experiments on Indian gabbro at average slip rates of 1.09 to 110 mm/sec, at normal stresses of 0.66 to 1.32 MPa and with displacements to around 0.42 m. Rectangular specimens of $1.5 * 0.5 * 0.5$ m and $2.0 * 0.5 * 0.5$ m with the surface irregularity less than 24 microns are used. The same specimens are repeatedly used in all experiments but the generated gouge was collected in each experiment by using the brush to measure the surface energy.

All experiments showed violent stick slip events except for the first run (v = 1.09 mm/s, normal stress = 0.67 MPa) where a stick-slip amplitude increased from small to moderate values with increasing displacement. Overshooting of shear stress occurred during some stick-slip events at slip rates of 10 mm/s and 100 mm/s; that is, shear stresses dropped down to negative values during some stick-slip events. The entire stiffness of the apparatus and shaking table was determined as $1.19*10^8$ N/m by using shear force drop (dF) and the displacement during slipping stage (dD) in each stick-slip event suggested by Shimamoto et al. (1980). This value is consistent with the quasi-static analysis.

The energy fraction of the gouge generation is determined by the surface energy of gouge divided by the frictional energy during each experiment (Togo and Shimamoto, 2012). Specific frictional energy in each experiment was obtained by the integration of the shear stress multiply displacement and the values were 0.18 to 5.16 MJ/m^2. Total surface energy of generated gouge in each experiment (E_A) was obtained the following equation.

$E_A = A_{BET} * r * m$

Where A_{BET} is the specific surface area of generated gouge, r is the surface free energy and m is the mass of the generated gouge. Specific surface area was measured by the BET surface area using a BELSORP-mini made by BEL Japan, Inc. with nitrogen as adsorbate. Specific surface area of the generated gouge showed high value of 5.29+-0.59 m^2/g at the first two experiments and it decreased with the increasing of the cumulative displacement to around 2.20+-0.49 m^2/g and total surface energy of generated gouge was 37.3 to 627.0 J. Results show that grain crushing absorbed only $9.63*10^{-4}$ to $1.39*10^{-1}$ % of frictional work. Thus, host rock wearing and gouge generation is unlikely to be an important energy sink at least for mature faults with well-developed slip zone.