Geophysical Research Abstracts
Vol. 12, EGU2010-3882, 2010
EGU General Assembly 2010

A new state-of-the-art tool to investigate rock friction under extreme slip velocities and accelerations: SHIVA

André Niemeijer (1), Giulio Di Toro (1,2), Stefan Nielsen (1), Piergiorgio Scarlato (1), Gianni Romeo (1), Giuseppe Di Stefano (1), Steven Smith (1), Fabio Di Felice (1), and Sofia Mariano (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy (andre.niemeijer@ingv.it), (2) Dipartimento di Geoscienze, Universita' di Padova, Italy

Despite considerable effort over the past several decades, the mechanics of earthquakes rupture remain largely unknown. In order to complement fault drilling projects and field and seismological observations, recent friction experiments strive to reproduce as closely as possible in-situ (natural) conditions of slip velocity and acceleration on intact and fault rocks.

In this contribution, we present a novel state-of-the-art experimental rotary shear apparatus (SHIVA or Slow to HIgh Velocity Apparatus) capable of shearing samples at sliding velocities up to 10 m/s, accelerations of $\sim$ 40 m/s^2 and normal stresses up to 50 MPa. In comparison with existing high speed friction machines, this apparatus extends the range of sliding velocities, normal stresses, sample size and, more importantly, accelerations.

The apparatus consists of a pair of brushless electric motors (a low velocity motor, 10^{-6}-10^{-3} m/s, power 5 kW, and a high velocity motor, 10^{-3} – 10 m/s, power 270 kW), that are connected by a gear system that allows a switch between motors without loss of velocity and force. The motors drive a rotary shaft which clamps ring-shaped samples (diameter 40- 50 mm). On the other side of the rotary shaft, a stationary shaft holds the other half of the sample assembly. The shaft is held stationary by a pair of stainless steel arms, one of which is attached to the side of the concrete-filled base where torque is measured by a tension cell. Axial force (maximum 37 kN) is applied on this side by a piston-cylinder couple with an arm to increase the force. The entire machine measures by 3.5 by 1.2 meters and weighs 3700 kg.

We aim to perform experiments on rock samples of a variety of compositions using slip velocities and accelerations that simulate slip velocity functions that occur during earthquakes. In addition, we plan to develop a pore fluid system and a pressure vessel in order to perform experiments that include the physical-chemical processes that occur during slow interseismic periods. Moreover, experiments will be run where we control the shear stress rather than the shear displacement. By doing so, we will be able to simulate the transient load variation expected during seismic failure on natural faults and measure the related dynamic weakening, frictional evolution and slip velocity on the sample. The characterization of rock frictional behavior under combined conditions of low to high slip velocity and extreme and rapidly variable load, is expected to provide important insights into the mechanics of earthquakes.