Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)
©2009. Japan Geoscience Union. All Rights Reserved.

SSS020-P02 Room: Convention Hall Time: May 25 17:15-18:45

Experiments on transition from stick-slip to steady-sliding in granular materials

Hajime Tsubota[1*], Ikuro Sumita[1]

[1]Kanazawa University

We report the results of shear experiments of dry granular materials to understand how the transition from stick-slip to steady-sliding depend on the particle size, shear rate, and the area of the slip plane. We sheared sorted glass beads as analog materials of fault gouges using a rotating viscometer, where a fault velocity was the driving velocity of a rotating viscometer and the area of the slip plane is defined by the size of a spindle. Using the obtained time-series data, We studied how the parameters affected the friction behavior of glass beads. First, we found that stick-slip changed to steady-sliding as shear rate increased, which is consistent with the previous works. Second, we found that transitions also depended on the particle size. The critical shear rate above which stable sliding appeared was faster for larger particle size. In addition, amplitude of shear stress fluctuations increased for larger particle size and smaller shear rate. The average shear stress increased with particle size but its shear rate dependence was unclear. The stress-times series data in the stick-slip regime is characterized by a saw-tooth pattern, whereas that in the stable-sliding regime is characterized by a sinusoidal pattern. Accordingly, in order to define the transition, I used the skewness 's' of time derivative of the stress-time series data. Here we used s =-1,-0.36 as the threshold values and defined stick-slip for s<-1, transition for -1<s<-0.36, and steady-sliding for s>-0.36. We also find that the skewness had parameter dependence and became smaller as particle size increased and as shear velocity decreased. Finally, from frequency analysis we find that when the particle size is small, there is a characteristic frequency corresponding to the periodic stick-slip. We are currently looking into the origin.of this behavior.

References:
Baumberger T., F. Heslot, and B. Perrin, Crossover from creep to inertial motion in friction dynamics, Nature, 367, 544-546, (1994)
Higashi, N., I. Sumita, Experiments on granular rheology: Effects of particle size and fluid viscosity, JGR, doi:10.1029/2008JB005999, (2009)
Nasuno, S., A. Kudrolli, A. Bak, and J. P. Gollub, Time-resolved studies of stick-slip friction in sheared granular layers, Phys. Rev. E., 58, 2161-2171, (1998)
Scholz, C.H., Earthquakes and friction laws, Nature, 391,37-42,(1998)

Keywords: granular materials, friction experiments, stick-slip, steady-sliding, rotating viscometer