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Fast Shear Behavior of Granular Materials and Rapid Landsliding Phenomena

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1 Introduction

The rapid landsliding events are known to be spectacular and catastrophic events in which granular masses flow with unusually long runout characteristics. In order to prevent and mitigate these disasters, it is significant to understand the mechanisms of initiation, motion and deposition. Although a great deal of research and attention has been focused on the unusual physical features for rapid landsliding events, the dependence of frictional resistance on shear rate and displacement has not yet been clearly understood. The present research attempts to improve the understanding of frictional properties by examining the fast shear behavior of rock debris and glass beads.

2 Methods

Firstly, we sheared the dry rock debris, sampled from the shear surface of Daguanbao landslide, to investigate the possible shear rate dependence at different shear rate and normal stress.

Secondly, we employed a series of ring shear tests to examine the dependence of shear rate and the influence of particle size on the shear behavior for glass beads. Discrete Fourier Transform (DFT) method was utilized to gain a deeper insight into the stress fluctuation. We chose 2^{11} continuous data points from residual state range to analyze the frequency spectra for two grain sizes of glass beads.

3 Results

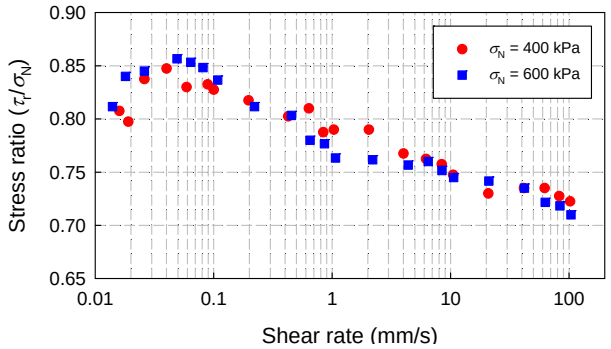

Fig. 1 Stress ratio versus shear rate for Daguangbao landslide

The dependence of shear rate for dry rock debris of Daguangbao landslide was shown in Fig. 1. We performed multistage tests at different shear rate (0.01-100 mm/s) and normal stress (σ_N = 400 kPa, and 600 kPa). Two different normal stresses were chosen to investigate the possible influence of normal stress on shear rate effect. We found that the effect of shear rate on the stress ratio was significant. The stress ratio was slightly increased when the shear rate was smaller than 0.05 mm/s, but dramatically decreased with increasing the shear rate. Although the reason for this change in stress ratio with shear rate is unclear, it can be concluded that the shear resistance will be weaken when the displaced material of Daguangbao landslide moved faster.

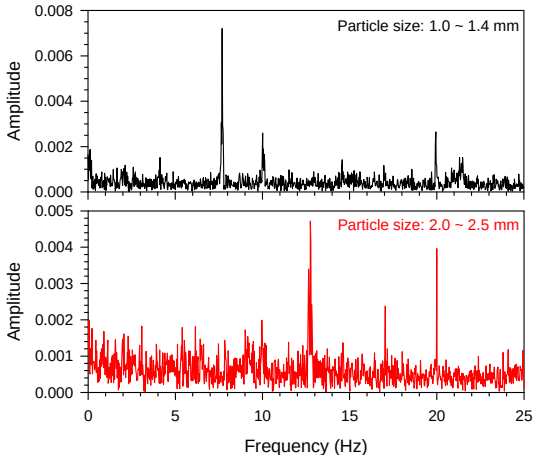

Fig. 2 Frequency spectrums for glass beads at residual state

The influence of shear rate on the residual strength for glass beads is negligible, while the stress fluctuation was observed for different particle sizes. Three distinct spectral peaks were identified in the frequency spectra for the two glass beads (Fig. 2). For small particle size sample (1.0-1.4 mm), the three spectral peaks ranged from 7-8 Hz, 10-11 Hz and 20-21 Hz; for large particle size sample (2.0-2.5 mm), the three spectral peaks ranged from 12-13Hz, 16-17 Hz and 20-21 Hz, respectively. The maximum amplitude of small particle size sample was higher, but the amplitude at maximum frequency was lower than large particle size sample.