Effect of particle size on frictional instability in locally sheared granular materials

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Friction Motions in Geo-science

Falling Mountain Landslide

Korup, et al., 2004.

(Wang et al., 2010)

Shiraishi Landslide

Velocity Dependence of Friction

Possible Mechanism

\(\text{Initiation velocity of stick-slip} \quad \text{Critical velocity of stick-slip} \quad \text{Shear velocity} \)

Velocity strengthen?

Velocity weaken?

\(\text{Stable sliding} \quad \text{Stick} \quad \text{Slip}\)

\(\text{Background} \quad \text{Experimental results} \quad \text{Discussion and Summary} \)


\(\text{(Modified from Rice et al., 2006)} \)

\(\text{Rock-on-rock surface} \quad \text{Asperity (protrusion)} \quad \text{Broken-off asperities} \)

\(\text{Granular assemblages} \)

\(\text{Solidlike} \quad \text{Liquidlike} \quad \text{Solidlike} \)

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Research Gap and Motivations

- Whether the particle sizes have significant influence on the frictional instability among granular materials?
- Whether the particle sizes and shear velocities affect the characteristics of AEs (e.g., frequency content, magnitude and activity)?
- Whether the generated AEs can enhance the mobility of catastrophic landslides?
- To better understand the involved physical processes and failure mechanisms for landslides.

Test Conditions:
- Fully dry glass beads;
- Vertical stress: 200 kPa;
- Shear rate: 0.005–1.0 mm/s;
- Particle size: 1.0–1.41 mm;
- 2.0–2.5 mm;
- 4.7–5.3 mm;
- AE Sensor: NF 9005-WB;
- Sampling frequency: 1 MHz;
Frictional Instabilities

- Particle size: 1.0~1.41mm
- Vertical stress: 200kPa
- Shear velocity: 0.005~1.0mm/s

Occurrence Rate of AE Events

- Method: Discrete Wavelet transform
- Purpose: To analyze the frequency characteristics in time-domain for acoustic signals.

Frequency Analysis

- Background
- Experimental results
- Discussion and Summary
Key Findings and Future Work

- Larger particle size shows more catastrophic instability.
- AE occurrence rate (per second) increases with increase of shear rate for granular materials.
- Resistance release events are associated with AE generation.
- Characteristic frequency of AEs is in kHz-range for sheared granular materials.

Outlook

- Further dig out the possible relationship among AE frequency spectra, particle sizes and shear velocities.
- Attempt to study the evolution of force chains and patterns of particle movement by using more AE sensors.

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