日本地すべり学会関西支部 若手研究発表会
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Effect of particle size on frictional instability in locally sheared granular materials

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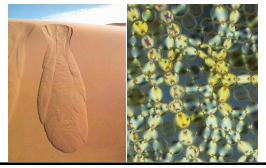
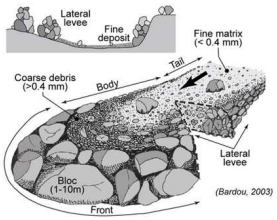
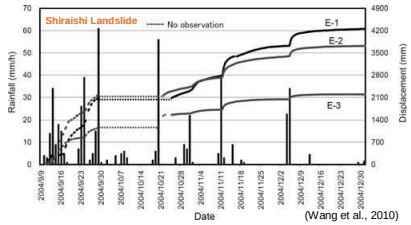


Friction Motions in Geo-science

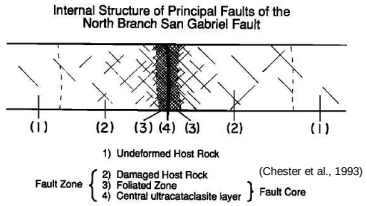


(Bardou, 2003)



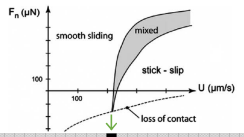
(Wang et al., 2010)

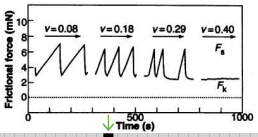
Kanji, et al., 2004.

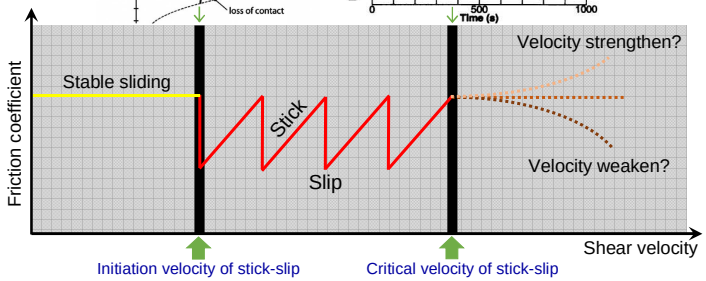


(Chester et al., 1993)

Velocity Dependence of Friction



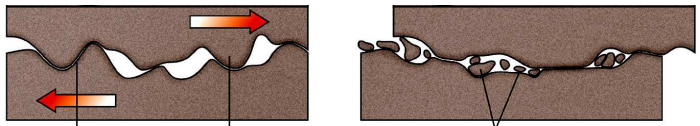




Summarized from Singh,1960; Banerjee,1968; Robbins and Thompson,1991; Yoshizawa, et al., 1993; Wu-Bavouzet, et al., 2007.

Possible Mechanism

◆ Rock-on-rock surface



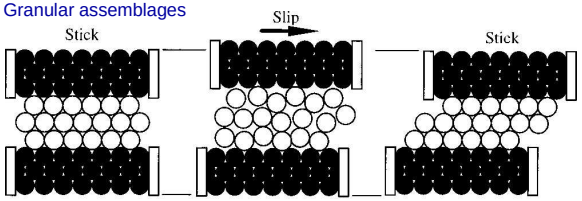
Two surfaces in contact

Asperity (protrusion)

Broken-off asperities

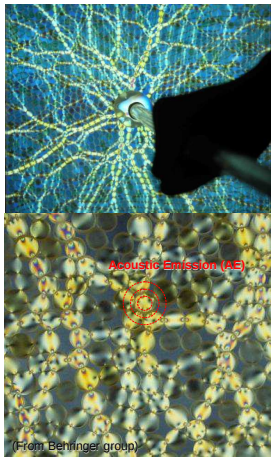
(Modified from Rice et al., 2006)

◆ Granular assemblages

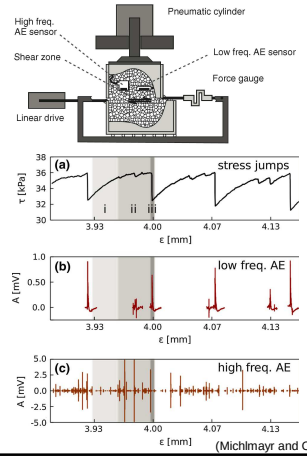


(Cain, et al., 2001)

Force Chains

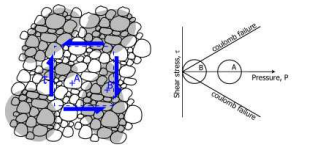


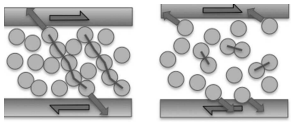
(From Behringer group)



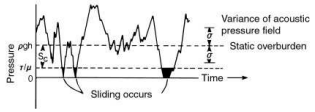
(Michlmayr and Or, 2014)

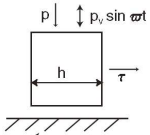
Acoustic Fluidization and Instability





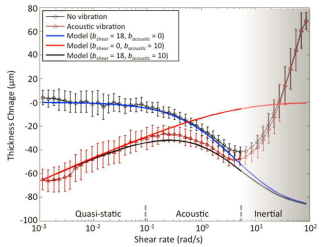
(a) Low shear rate (b) High shear rate





$f = \mu[p + p_v \sin \varpi t]$

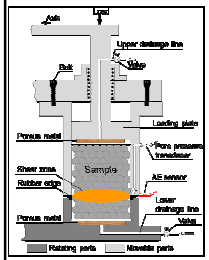
(Melosh, 1990,1996, 2005)

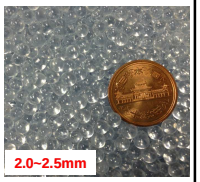


(van der Elst et al., 2012)

Research Gap and Motivations

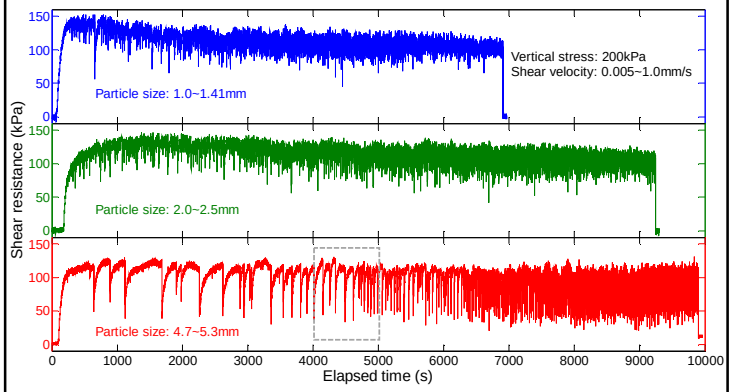
- Whether the particle sizes have significant influence on the frictional instability among granular materials?
- Whether the particle sizes and shear velocities affect the characteristics of AEs (e.g., frequency content, magnitude and activity)?
- Whether the generated AEs can enhance the mobility of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



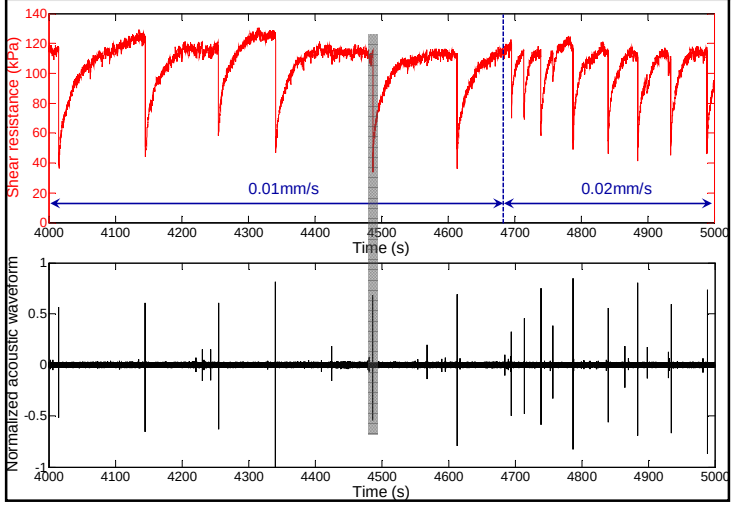


- **Test Conditions:**
  - Fully dry glass beads;
  - Vertical stress: 200kPa;
  - Shear rate: 0.005~1.0mm/s;
  - Particle size: 1.0~1.41mm;
    2.0~2.5mm;
    4.7~5.3mm;
- AE Sensor: NF 900S-WB;
- Sampling frequency: 1MHz;

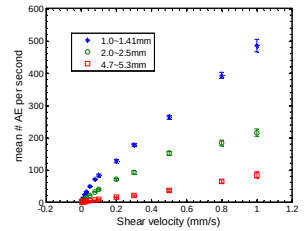
Frictional Instabilities

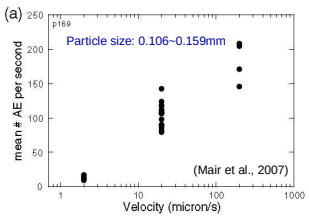


Particle size and shear velocity dependence of frictional instability



Occurrence Rate of AE Events

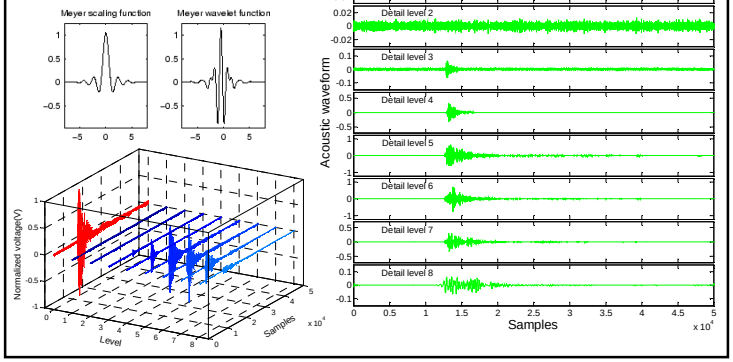




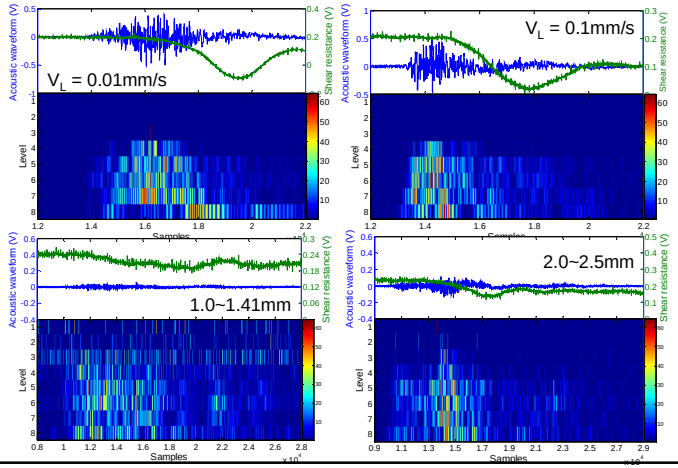
Frequency Analysis

Method: Discrete Wavelet transform

Purpose: To analyze the frequency characteristics in time-domain for acoustic signals.



Time-frequency Spectra of AEs



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.

Acknowledgments: I would like to extend my sincerest gratitude to Dr. Issei DOI for his helpful discussions and invaluable suggestions in analyzing the AE waveforms.