

ACOUSTIC EMISSION AND FRICTIONAL ANALYSIS OF GRANULAR MATERIAL SYSTEMS

Beikang Liu, Dr. Min Yu, Dr. Thomas Reddyhoff

*BEIKANG.LIU18@IMPERIAL.AC.UK

Department of Mechanical Engineering, Imperial College London
South Kensington Campus, Exhibition Road, London SW7 2AZ, UK

KEYWORDS

Friction; Experiments in tribology; Machine learning / AI, Acoustic emission

ABSTRACT

Granular materials are important in many applications – for instance, ploughing in agriculture, debris in machines, and soil in geotechnics and mining. In many of these applications, there is a need to monitor material properties at the particulate level, such as the size, shape, distribution, and loading conditions. Currently, methods of particle monitoring typically involve removing samples from the field and subsequently evaluating them ex-situ, usually in a lab. Recording acoustic emission (AE) signals emitted by particle motions may contain useful information but this approach has mainly been used to study granular material failure instead of material properties at the particulate level. Therefore, this project develops an approach to study granular material properties by measuring and analysing AE signals and the friction from particle activities. This involves a newly designed test setup which incorporates horizontal axial shearing, while acoustic emission and friction signals are recorded. Using this setup, tests were conducted on spherical particles of numerous sizes and various confining stress levels. AE signals were processed and analysed in both the time and frequency domains and used to find the correlation among different AE parameters, including friction, particle sizes, and other parameters. In addition to this, mechanistic insights are gained by conducting pin-on-disc tests on single particle contacts while recording the AE signal's responses to different types of motions, loading, material deformations, and shearing surface conditions. The results from the tests and analyses were also used to train a machine learning models capable of identifying sizes of spherical particles based on

recorded AE signals. This demonstrates that AE is an effective tool in monitoring particle properties for a range of applications.

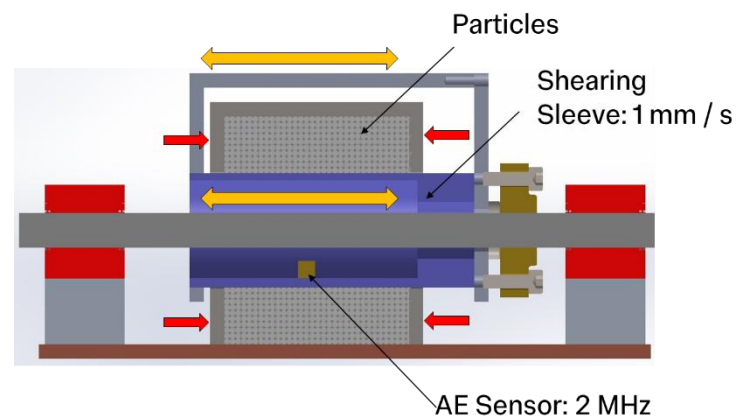


Figure 1 Axial shearing rig used for AE signal acquisition

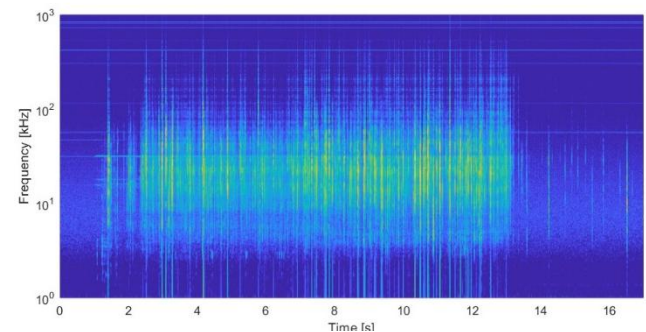


Figure 2 Example of the AE signal from particle shearing