Use of Acoustic Emission to Evaluate Microscopic Mechanical Behavior of Sand in Triaxial Compression Tests

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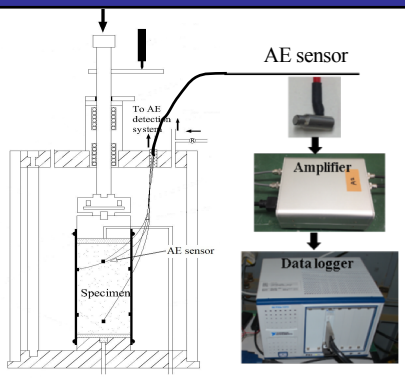
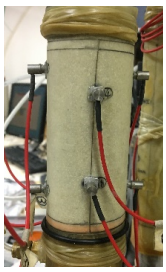
Introduction

Studying the mechanical behavior of granular soils from micro-scale prospective is of fundamental importance. While Acoustic Emission (AE) technique has become a promising approach for this purpose, its synthetic and corroborative study on granular soils is far from substantive. To this end, AE technique was applied in this study to explore the micro-mechanical behavior of sands subjected to drained-triaxial compression.



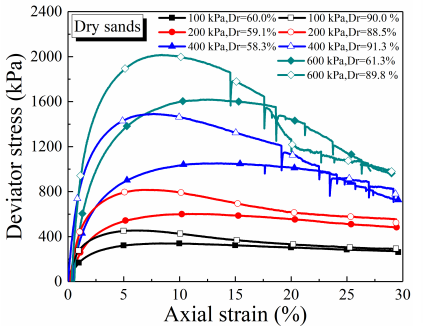
Traxial apparatus and AE instrument



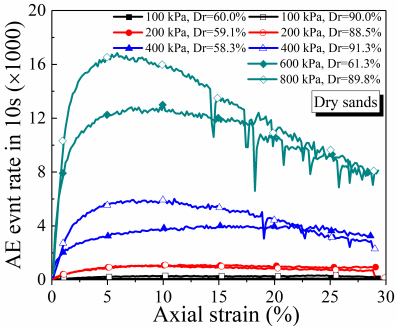
Test sample

AE behaviors in sands with various ground conditions

Several series of drained triaxial compression tests incorporated with AE measurement were conducted on sands with various conditions to corroborate and quantitatively interpret the relationship between AE behaviors and the macro-scale soil mechanical behaviors.

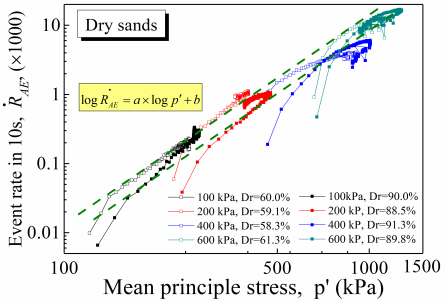


Stress-strain relations in dry sands



AE event rate evolution in dry sands

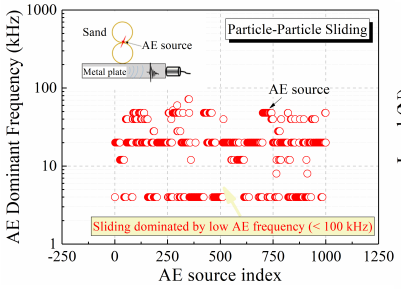
Correlation



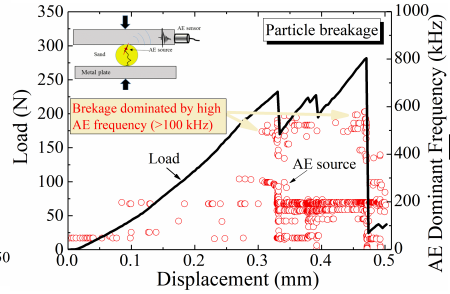
Mathematic relations between AE event rate and p'

Particle interactions in sands characterized by AE frequency response

In order to reveal the quantification evolution of micro-scale behaviors in sands, particle interaction (i.e. particle-to-particle sliding & particle breakage) tests were conducted and the frequency response of their induced AE sources were analyzed. The result revealed the dependence of AE frequency on the mode of particle interactions, which could be further extended to quantify the evolution of particle-to-particle sliding and particle breakage behavior in sands subjected to drained triaxial compression.

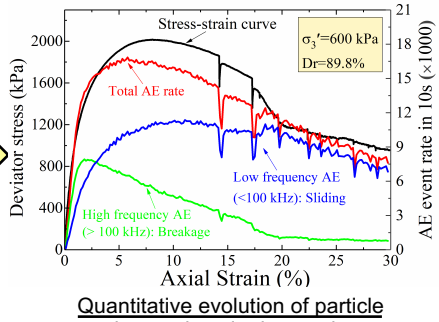


Frequency response for particle-particle sliding



Frequency response for particle breakage

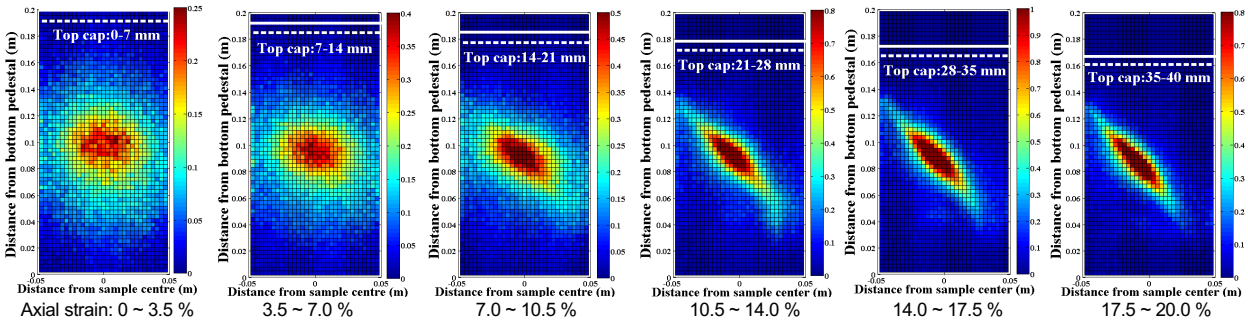
Application: 100 kHz



Quantitative evolution of particle interactions in dry sands

Development of AE 3D tracing technique and its application in sands

An AE 3D tracing technique that could trace the origin time and 3D coordinates of particle interaction-induced AE sources was developed by MATLAB programming based on the idea of Time Difference of Arrival (TDOA). The results revealed its feasibility and successful applications in tracing the initiation and evolution of shear banding in saturated sands subjected to drained triaxial compression.



Axial strain: 0 ~ 3.5 % | 3.5 ~ 7.0 % | 7.0 ~ 10.5 % | 10.5 ~ 14.0 % | 14.0 ~ 17.5 % | 17.5 ~ 20.0 %

Shear band

Distribution of AE sources during the process of drained triaxial compression in saturated dense sands