香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

土木及環境工程學系
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

SEMINAR

PORE-SCALE MORPHOLOGICAL ANALYSIS AND THEORETICAL MODELING OF HYSTERETIC WATER RETENTION BEHAVIORS IN GRANULAR MEDIA

Speaker

Prof. Yosuke HIGO

Kyoto University

Abstract

Understanding the microscopic mechanisms of water retention is essential for predicting the hydro-mechanical behavior of unsaturated soils. This study investigates the pore-scale drainage and imbibition processes along main and scanning curves through high-resolution X-ray micro-computed tomography (CT). By applying affine transformation for precise image registration and extracting discrete liquid/gas phase clusters, we quantitatively evaluated the evolution of fluid morphologies. Our morphological analysis reveals that drainage occurs primarily from the pore centers in a relatively simple manner. In contrast, the wetting process is more complex, characterized by the growth of liquid bridges on soil surfaces at high suction, followed by the filling of pore centers at lower suction. Based on these observations, we identified five distinct saturation regimes linked to phase continuity and cluster shapes. Furthermore, we developed a theoretical water retention curve (WRC) model using an assembly of unit cells. By incorporating pore-scale air-entry and water-entry thresholds based on the Young-Laplace equation and observed geometries, the model successfully predicts hysteretic behavior and scanning curves without empirical fitting. This work bridges the gap between pore-scale fluid physics and macroscopic soil properties, providing a robust framework for simulating unsaturated soil behavior.

Biography

Professor Yosuke Higo is an expert in geotechnical engineering and geomechanics, currently serving as a Professor at Kyoto University's Graduate School of Engineering. He also holds a concurrent position at the Graduate School of Management. His research focuses on understanding the complex behaviors of geomaterials—multi-phase mixtures of soil particles, water, and air—by linking microscopic interactions to macroscopic phenomena such as deformation, failure, and groundwater seepage. Utilizing advanced techniques like X-ray microtomography, he develops multi-scale and multi-phase analytical methods to predict and evaluate geomaterial behaviors. His work has practical applications in addressing geotechnical challenges, including the design of robust earth structures like river levees and road embankments to withstand natural hazards such as earthquakes and heavy rainfall. His academic carrier started at Kyoto University, where he earned his undergraduate, master's, and doctoral degrees in civil engineering. His professional career includes roles as Research Associate, Assistant Professor, and Associate Professor at Kyoto University's Graduate School of Engineering, leading to his current professorship. Beyond his research and teaching responsibilities, he contributes to the academic community through editorial roles. He has served on the editorial boards of Computers and Geotechnics and Marine Geotechnics, as well as on the editorial board, the executive board, and the associated editor of Soils and Foundations.

12 March 2026
Thursday

4:30pm-5:30pm

Room 3598 (Lift 27/28), Academic Building, HKUST

Enquiry:

Ms. Crystal Lau
cecrystal@ust.hk