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

RECENT ADVANCES IN MULTIPHYSICS AND MULTIPHASE MODELLING OF LARGE DEFORMATION AND FAILURE IN POROUS GEOMATERIALS

Speaker

Prof. Ha Bui

Monash University

Abstract

Geomaterials subjected to environmental extremes, such as rainfall infiltration, internal erosion, and permafrost thaw, exhibit highly coupled thermo-hydro-mechanical (THM) behaviours and often undergo large deformation and failure. Capturing these complex processes presents fundamental challenges, not only for conventional numerical methods but also for the mathematical modelling of the underlying physics. Accurately describing multiphase interactions, phase transitions, and the coupled effects on mechanical, hydraulic, and thermal responses requires robust governing equations and advanced constitutive models, capabilities still limited in many existing frameworks. This talk presents recent advances in both mathematical modelling and computational techniques through a unified, mesh-free framework based on Smoothed Particle Hydrodynamics (SPH). This framework enables high-fidelity simulation of multiphysics-driven failures in porous geomaterials, from failure initiation to post-collapse flow. By integrating novel multiphase formulations and constitutive models, including those tailored for unsaturated soils, internal erosion, and frozen ground, the framework provides predictive capabilities for a wide range of climate-related geohazards, such as rainfall-induced landslides, embankment collapse, and thaw-triggered slope failures. Applications will demonstrate how this SPH-based approach advances our understanding of complex failure mechanisms and contributes to the development of more resilient infrastructure in the face of evolving environmental conditions.

Biography

Prof. Ha H. Bui is an ARC Future Fellow and Head of the Department of Civil and Environmental Engineering at Monash University. He is internationally recognised for pioneering computational solutions in geomechanics, particularly through the development and application of mesh-free methods such as Smoothed Particle Hydrodynamics (SPH). His seminal contributions introduced SPH to geomechanics, establishing a new research direction that has since enabled the simulation of complex failure processes previously considered intractable. Prof. Bui's research advances fundamental mathematical modelling in geomechanics, including the development of novel multiphysics governing equations and constitutive models. His work places particular emphasis on bridging scales in the simulation of localised failure in geomaterials. He is the founder of GeoXPM, an open software SPH platform built on the advanced multiphysics models developed in his research, enabling the simulation of a wide range of geohazard scenarios, from rainfall-induced landslides and internal erosion to rock fracturing and complex coupled flow-deformation processes. His work has redefined predictive modelling capabilities across civil, mining, and climate resilience applications. He is the recipient of several prestigious awards, including the 2021 ALERT Research Medal from The Alliance of Laboratories in Europe for Education, Research and Technology (ALERT Geomaterials), the ARC Future Fellowship, and a JSPS Invitational Fellowship from the Japan Society for the Promotion of Science. Prof. Bui currently serves as Editor of Computers and Geotechnics, Associate Editor of the European Journal of Environmental and Civil Engineering, and sits on the editorial boards of several leading journals in geomechanics.

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