The 1st Joint Workshop

Korean Geotechnical Society (KGS) &

Hong Kong Geotechnical Society (HKGES)

January 13, 2023

Yonsei University Campus, Engineering Hall, Room D604

Zoom URL :
https://us02web.zoom.us/j/88074105594?pwd=WFBJeGZOSFhiNnFFbHdKdTdESTZ1UT09

Meeting ID : 880 7410 5594

Password : 021888

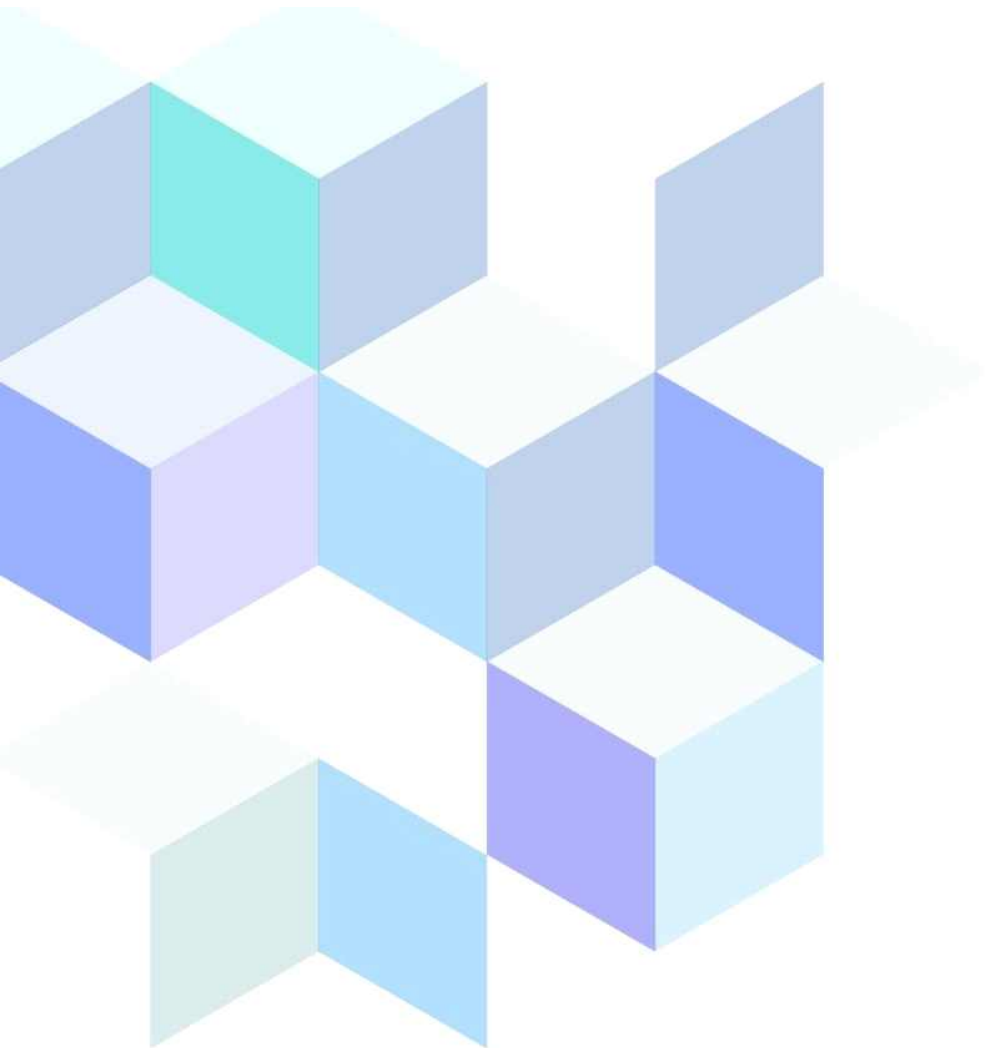

TABLE OF CONTENTS

Foreword

On behalf of the Organizing Committee and 12,400 members of the Korean Geotechnical Society (KGS), I welcome you to the 1st Joint Workshop between KGS and the Hong Kong Geotechnical Engineering Society (HKGES), held on January 13, 2023, at Yonsei University campus in Seoul, South Korea.

Over the last two decades, KGS has partnered with several other member societies of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE) to promote international collaborations. One of the activities that KGS has organized is joint workshops with other member societies. We are thrilled to launch the very first joint workshop with HKGES and sincerely hope that this workshop will lay the foundation for active collaborations between KGS and HKGES in the coming years.

We welcome all of you from Hong Kong and South Korea. We wish that this workshop will be a truly fruitful and memorable event for every participant. We sincerely thank you for your participation and contributions.

Best regards,

Moonkyung Chung

President, Korean Geotechnical Society (KGS)
Senior Research Fellow
Korea Institute of Civil Engineering and Building Technology (KICT)

Organizing Committee

Moonkyung Chung (KICT)
Seong-Wan Park (Dankook University)
Jong-Sub Lee (Korea University)
Tae Sup Yun (Yonsei University)
Ilhan Chang (Ajou University)
Jinhyun Choo (Korea Advanced Institute of Science and Technology)

Presentation Schedules

Workshop Schedules

Time	Event
12:30 - 13:00	Registration
13:00 - 13:20	**Opening Ceremony**
13:20 - 15:00	**Session 1** (7 speakers)
15:00 - 15:20	Break
15:20 - 15:30	**MoU Ceremony**
15:30 - 17:10	**Session 2** (7 speakers)
17:10 - 17:20	**Closing Ceremony**
17:30 -	Dinner

Presentation Schedules

Session 1

Time	Event
13:20	Deep Learning for Image-Based Compressional Wave Velocity Prediction of Cement-Reinforced Soil Based on Core-Image **Tae Sup Yun (Yonsei University)**
13:32	The Use of Deep Cement Mixing for Land Reclamation in Hong Kong **Johnny C.Y. Cheuk (AECOM)**
13:44	Characterizing Suction Stress and Shear Strength For Unsaturated Geomaterials **Byeong-Su Kim (Dankook University)**
13:56	The Role and Importance of Regional and Site Soil Strength Data in Slope Reliability Assessments **Andy Y.F. Leung (Hong Kong Polytechnic University)**
14:08	A Novel Preloading Method for Foundation Underpinning for the Remodeling of an Existing Building **Jin-Tae Han (Korea Institute of Civil Engineering and Building Technology)**
14:20	Innovative Use of Thermo-Active Pile Rows for Enhancing the Winter Resilience of Infrastructure Embankment **Anthony K. Leung (Hong Kong University of Science and Technology)**
14:32	Enhancing the Stability of Earthen Levees Threatened by Global Climate Change with Biopolymer-Based Soil Treatment (BPST) **Ilhan Chang (Ajou University)**
14:45	Discussion

Presentation Schedules

Session 2

Time	Event
15:30	Advancement of Geotechnology in Hong Kong (Online) **Raymond C.H. Koo (Geotechnical Engineering Office)**
15:42	Estimation of Safety Factor Distributions through Machine Learning Algorithms **Hyung-Koo Yoon (Daejeon University)**
15:54	AI Empowered Automatic and Precise Numerical Modelling from Sparse Geotechnical Site Investigation Data (Online) **Yu Wang (City University of Hong Kong)**
16:06	Probabilistic-based Spatial Prediction Model of Sinkhole Geohazards – A Florida Case Study **Boo Hyun Nam (Kyung Hee University)**
16:18	Digital Application in Excavation and Lateral Support (ELS) Design **Alvin Lam (Arup)**
16:30	Computational Geotechnics toward Digital Twin Simulation **Jinhyun Choo (Korea Advanced Institute of Science and Technology)**
16:42	Engineered and Nature-based Solutions against Landslides **Clarence E. Choi (University of Hong Kong)**
16:54	Discussion

Deep Learning for Image-based Compressional Wave Velocity Prediction of Cement-reinforced Soil based on Core-image

Tae Sup Yun, Yonsei University

Abstract
This study proposed a novel approach to predicting the compressional wave velocity from surficial core images taken from a cylindrical core specimen of cement-reinforced soil using a convolutional neural network (CNN) regression model. Experimental measurement of Vp was conducted at hundreds of points along the horizontal direction in cylindrical cores, and the corresponding core images were cropped to include the measurement points. A dataset was prepared by pairing the pre-processed surficial core images with the measured Vp values, and a CNN regression model with a pre-trained backbone network by transfer learning as a feature extractor was constructed. The predictive results of the trained network model achieved a convincing R-squared value of 0.78. The internal structure of the over- and under-estimated specimens was observed using 3D x-ray computed tomographic imaging, and it revealed that surficial core images insufficiently reflected their internal structure. This study showed that consecutive Vp profiles could be obtained by estimating Vp at unmeasured points based on core images, and the proposed approach demonstrates the feasibility of image-based prediction of geotechnical properties.

Biography
Tae Sup Yun joined Yonsei University in 2009. He was a P.C. Rossin Assistant Professor at Lehigh University (2007-2009). His research scopes include geo-energy engineering in the field of carbon dioxide sequestration, production of gas hydrates, development of sustainable and engineered construction materials, and geo-image processing. Professor Yun devises hybrid and customized experimental systems to observe the micro- to macro-scale phenomena to meet research needs in conjunction with numerical analysis schemes. He currently focuses on machine learning & deep learning-based study to predict and estimate the behaviors and fate of geo-infrastructures.

The Use of Deep Cement Mixing for Land Reclamation in Hong Kong

Johnny C.Y. Cheuk, AECOMHKIE Geotechnical Division Chairman

Abstract
Deep Cement Mixing (DCM) has been used as a ground treatment method for land reclamation in Hong Kong. Its use has gained popularity as it expedites the time required to deliver useable land compared to conventional reclamation methods whereby completion time largely hinges on the consolidation characteristics of the seabed materials. It also allows very soft marine sediments to be left in place during reclamation, thereby minimising adverse environmental impact arisen from dredging works which were necessary to avoid excessive long-term settlements. In this presentation, lessons learnt from recent reclamation projects adopting DCM will be presented. On-going research work which focuses on the interplay mechanisms between cement mixed materials and untreated soil will be discussed.

Biography
Johnny Cheuk obtained his PhD from Cambridge University and is currently Vice President, Geotechnical of AECOM Hong Kong. He leads a team of over 200 geotechnical practitioners in delivering a wide spectrum of geotechnical projects for public and private clients. Johnny is the Chairman of the Hong Kong Institution of Engineers (HKIE) Geotechnical Division for Session 2022/23, and a Past President of the Hong Kong Geotechnical Society. He is a Fellow of HKIE and a Fellow of the Institution of Civil Engineers (ICE), as well as an Adjunct Professor at the University of Hong Kong and the Hong Kong University of Science and Technology.

Characterizing Suction Stress and Shear Strength for Unsaturated Geomaterials

Byeong-Su Kim, Dankook University

Abstract

This paper focuses on the theoretical representation of suction stress as an added confining pressure in evaluating the mechanical behavior of unsaturated soil under various confining pressure conditions. The concept of the suction stress derived from the triaxial compression test results for unsaturated soil and examples of its application were described in this study. By adding suction stress to the confining pressure, the geometric relationship between the failure criteria of unconfined compression test and existing theories on failure envelope for unsaturated soils was discussed. By evaluating the test results obtained in this study and the past results of silty soils, it was found that the interpretation of suction stress in terms of confining pressure is valid regardless of the density condition.

Biography

Byeong-Su Kim received a bachelor's degree in 2005 and a master's degree in 2007 from Dankook University. In 2010, he was awarded a Dr. Eng. from Kobe University in Japan on the subject of the mechanical behavior of unsaturated sandy soils. After two and a half years of postdoctoral fellow, he was appointed as an assistant professor at Okayama University in Japan in 2013, then served as an associate professor from October 2020. Since September 2022, he has been an associate professor in the Department of Civil and Environmental Engineering, Dankook University. He is interested in geotechnical disaster prevention technology and the development of new geotechnical materials, etc.

The Role and Importance of Regional and Site Soil Strength Data in Slope Reliability Assessments

Andy Y.F. Leung , Hong Kong Polytechnic University (PolyU)HKGES President

Abstract

Recent years have seen rapid developments of probabilistic analysis approaches that are becoming popular in reliability assessments of slopes. From a practical standpoint, however, a major challenge remains regarding the selection of representative probability density functions (PDFs) that characterise uncertainty in soil parameters at a project site. Such difficulties often arise from the scarcity of site-specific information, even with ample previous knowledge of the same soil types in the regional scale. This presentation introduces the hierarchical Bayesian model that rationally assimilates regional and site-specific information to produce hybrid PDFs of soil shear strength parameters. Newly compiled regional databases of c'-ϕ' parameters for various soil types in Hong Kong are presented, which enable model training and combination with site data for project-specific analyses. The hybrid PDFs reflect the site-specific features of soil parameters, leading to profound impacts on the evaluation of failure probability of the slope.

Biography

Dr Andy Y.F. Leung is currently Associate Professor and Associate Head (Partnership) at the Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University. He has been serving as President of the Hong Kong Geotechnical Society since June 2022, and as the Secretary-General from 2018-2022. His research interests include soil-structure interaction, distributed fibre optic sensing techniques, reliability of geotechnical and structural systems, probabilistic analysis approaches, and risk management in infrastructure developments. Some of his recent awards include the PolyU Departmental Teaching Excellence Award, Dean's Award for Outstanding Achievement in Research Funding, and Faculty Award in Knowledge Transfer (Team Award).

A Novel Preloading Method for Foundation Underpinning for the Remodeling of an Existing Building

Jin-Tae Han, Korea Institute of Civil Engineering and Building Technology (KICT)

Abstract
The utilization of buildings can be improved by extending them vertically. However, the added load of the extension might require building foundations to be underpinned; otherwise, the loads on the foundations might exceed their bearing capacity. In this study, a preloading method was presented aiming at transferring partial loads from existing piles to underpinning piles. A pneumatic-type model preloading device was developed and used to carry out centrifuge experiments to evaluate the pile behavior. The results showed that the preloading devices effectively transfer load from existing piles to underpinning piles. Further, two full-scale preloading devices, the screw-type and hydraulic-jack type devices were developed for the practical application of foundation underpinning during vertical extension, and their operability and load transfer effect were verified via full-scale structural experiments.

Biography
Dr. Han received bachelor's, master's, and doctoral degrees from the Department of Civil Engineering at Seoul National University. His doctoral thesis is the analysis of the dynamic behavior of piles embedded in liquefied soil. After working as a postdoctoral researcher at UC Davis for two years, he has been working as a research fellow at the Korea Institute of Civil Engineering and Building Technology since 2011. His main research topics are experimental research about liquefaction phenomena during earthquakes, the study on seismic design for geotechnical structures, and the optimal reinforcement foundations during vertical extension remodeling.

Innovative Use of Thermo-active Pile Rows for Enhancing the Winter Resilience of Infrastructure Embankment

Anthony K. Leung, Hong Kong University of Science and Technology (HKUST) HKGES Secretary General

Abstract

Installing a row of discretely-spaced energy piles at the mid-height of an unsaturated soil slope has been proposed as an innovative means to increase the slope stability and also to harvest solar and geothermal energy for road surface de-icing. Centrifuge modelling of the thermomechanical interaction between unsaturated soils and energy piles is challenging. This presentation aims to share three new inventions to improve our capabilities of modelling unsaturated soil-energy structure interaction in a geotechnical centrifuge, namely (i) small-scale model reinforced concrete, to capture the thermomechanical behaviour and nonlinear quasi-brittleness of RC energy piles in prototype; (ii) centrifuge-mounted heating system, to deliver/extract heat energy into/from a model structure during a centrifuge flight; and (iii) large-size direct-shear box apparatus, to test the shearing behaviour of unsaturated soils, with and without reinforcing elements, under realistic stress and suction regimes. The performance of these inventions on an unsaturated soil-energy pile system relevant to the engineering application above will be reported.

Biography

Dr Anthony Leung is an Associate Professor in the Civil and Environmental Engineering and the Associate Director of the Geotechnical Centrifuge Facility (GCF) at the Hong Kong University of Science and Technology (HKUST). His research interest includes geo-energy and geo-environmental engineering, developing climate-adaptive systems. Dr Leung is the awardee of the 2022 *Outstanding Young Geotechnical Engineer Award*, 2019 *Bright Spark Lecture Award* and 2018 *International Award for Innovation in Unsaturated Soil Mechanics*, all awarded from the ISSMGE. He is currently the Editor-in-Chief of the ISSMGE Bulletin, the Secretary General of the Hong Kong Geotechnical Society (HKGES), TC106 (Unsaturated Soils) and TC107 (Tropical and residual soils).

Enhancing the Stability of Earthen Levees Threatened by Global Climate Change with Biopolymer-based Soil Treatment (BPST)

Ilhan Chang, Ajou University

Abstract
Global climate change is increasing both frequency and intensity of heavy downpours and accompanying floods in Korea nowadays. The erosion resistance of soil to the tractive force of flowing water is one of the essential parameters for the stability of the geotechnical engineering structures when directly exposed to the movement of water such as in rivers and ocean beds. Biopolymer-based soil treatment (BPST), which is new to sustainable geotechnical engineering practices, is known to enhance the mechanical properties of soil. This study presents recent attempts to employ BPST to enhance the stability of shoreline structures made of earth under conditions of severe hydraulic erosion.

Biography
Dr. Ilhan Chang is an Associate Professor in the Department of Civil Systems Engineering at Ajou University. Dr. Chang graduated from KAIST (Korea Advanced Institute of Science and Technology) with a Bachelor of Science (2000), Master of Engineering (2004), and Doctor of Philosophy (2010) in Civil and Geotechnical Engineering. Prior to his current appointment, Dr. Chang worked as a Research Assistant Professor at KAIST (2010-2011), Senior Researcher at the Korea Institute of Civil Engineering and Building Technology (2012-2017.02), Lecturer (2017.04-2018.06) and Senior Lecturer (2018.07-2020.08) at the University of New South Wales (UNSW) in Australia. Dr. Chang is leading the SURE3 (Sustainable, urban Utilization, Resilient, Environmental-, Emerging, and Extreme) geotechnical engineering laboratory with variable research schemes. Please visit www.ilhanchang.com for more information.

Advancement of Geotechnology in Hong Kong

Raymond C.H. Koo, Geotechnical Engineering Office (GEO)

Abstract
Innovations have always been the GEO priority in enhancing geotechnical services and practice in Hong Kong. GEO has been taking a steering role in promoting the advancement of geotechnology and applying technologies such as BIM, digital twin and design automation that are affordable and suitable for wide adoption by the industry.
In this presentation, a rational framework of Geotechnical Information Infrastructure coupled with digital technology will be presented. In addition, examples of successful applications for BIM and digital twin technology such as smart landslide debris-resisting barrier system, Po Shan drainage tunnels and design automation for slope works in geotechnical engineering will be illustrated.

Biography
Ir Dr Raymond Koo obtained his PhD degree in Civil Engineering from the Hong Kong University of Science and Technology. He is a chartered geotechnical engineer and has been working for the Consultants and the Government of HKSAR over 20 years. He has a variety of working experience in geotechnical engineering projects and particularly developed his skills in advanced geotechnology. He is currently a Senior Geotechnical Engineer of the Geotechnical Engineering Office and working on the implementation of BIM and Digital Twin technology in geotechnical engineering projects.

Estimation of Safety Factor Distributions through Machine Learning Algorithms

Hyung-Koo Yoon, Daejeon University

Abstract

Many input parameters are necessary to calculate safety factors based on existing deterministic methods. The objective of this study is to expand the application of high-risk area (HRA) model to find the safety factor using a machine learning algorithm. The HRA model is suggested through consulting group and the eight kinds of geotechnical parameters are selected with an analytic hierarchical process technique. The geotechnical parameters are recognized as input variables and the safety factors calculated by Mohr-Coulomb failure theory in infinite slope are designated as output parameters. The Levenberg−Marquardt and Bayesian regularization are applied as optimization techniques for enhancing reliability. The sensitivity analysis is also performed through a random forest algorithm to find the order of influencing factors in the HRA model. This study demonstrates that HRA can be applied to estimate the safety factor for predicting landslide susceptibility.

Biography

Hyung-Koo Yoon is a Professor at the Department of Construction and Disaster Prevention Engineering, Daejeon University. Hyung-Koo Yoon received his Bachelor's, Master's, and Ph.D. degrees in civil and environmental engineering from Korea University in 2006, 2008, and 2011, respectively. He was hired as an Assistant Professor at Daejeon University in 2012. His research interests are non-destructive testing and in-situ subsurface characterization.

AI Empowered Automatic and Precise Numerical Modelling from Sparse Geotechnical Site Investigation Data

Yu Wang, City University of Hong Kong (CityU)

Abstract
In this presentation, a data-driven framework is proposed for geotechnical numerical modeling with explicit modeling of stratigraphic variability and spatial variability of soil properties by machine learning of limited site investigation data (e.g., borehole or CPT data). Performance of the proposed framework is demonstrated using an illustrative example, which is modified from a real reclamation project in Hong Kong. Machine learning offers an effective, automatic, and fast way of developing geotechnical numerical models with high-spatial-resolution stratigraphic variability and soil property spatial variability from limited site investigation data. Such precise numerical models are crucial for development of digital twins of subsurface geo-structures.

Biography
Dr. Yu Wang is a professor of geotechnical engineering at the City University of Hong Kong and an elected Fellow of the American Society of Civil Engineers (ASCE). His research interests are digital twin of subsurface geo-structures, machine learning in geotechnical engineering, geotechnical uncertainty, reliability and risk, soil-structure interaction, and seismic risk assessment of critical civil infrastructure systems. His research has earned a number of international/national recognitions, including the 2020 Higher Education Outstanding Scientific Research Output Awards (the First-class Natural Science Award) by the Ministry of Education, China, the Highly Cited Research Award by the international journal of Engineering Geology in 2017 and the Wilson Tang Best Paper Award in 2012 in Singapore.

Probabilistic-based Spatial Prediction Model of Sinkhole Geohazards – A Florida Case Study

Boo Hyun Nam, Kyung Hee University

Abstract
Sinkhole is one of the major geohazards in karst areas. Groundwater recharge easily erodes the overburden soils away into cavities in the bedrock, and ultimately structural collapse in the ground. The induced ground collapse/subsidence may pose a great threat to human safety, the environment, and buildings and infrastructure. The talk introduces two main research: (1) the development of a probabilistic spatial prediction model of sinkhole susceptibility and (2) a geographical information system (GIS)-based regional-scale sinkhole susceptibility map. The study area is the east-central Florida (ECF) region that has been experiencing more abrupt and larger cover collapse sinkholes. The research methodology employs two statistical methods for the spatial prediction model, frequency ratio (FR) and logistic regression (LR).

Biography
Dr. Boo Hyun Nam is an Associate Professor in the Department of Civil Engineering at Kyung Hee University (KHU). He received his Ph.D. in Civil Engineering at The University of Texas at Austin. Before joining KHU, he had worked at the University of Central Florida (with tenure). While working at UCF, he served as the director of UCF Sinkhole Research Center and also a faculty advisor of the ASCE-UCF Student Chapter (recipient of the Faculty Advisor of the Year in 2016). Over the years, Dr. Nam has worked in the areas of geohazards sensing/monitoring, remote sensing, nondestructive evaluation, building and construction materials, etc. His research outcomes have been published (over 150) in peer-reviewed international journals and conferences. He has given a number of invited talks over the world (e.g., U.S.A., Germany, Japan, China, Korea, Egypt, etc.). Dr. Nam currently has been serving in multiple technical committees of ASCE Geotechnical-Institute (GI) and Transportation Research Board (TRB), and the organizing committees of The Sinkhole Conference, AEG Karst Hazards Forum Conference, and so on. He has served the editorial boards of Frontiers in Built Environment, Frontiers in Earth Sci. (guest editor), Materials (guest editor), Journal of the Korean Geotechnical Society, and KSCE Journal of Civil Engineering (2015-2018). He also served as the chairman of The First US-Korea Geotechnical Workshop in 2022

Digital Application in Excavation and Lateral Support (ELS) Design

Alvin Lam, Arup

Abstract

Geotechnical engineers always work with complicated terrains and geologies, which are usually interpreted from the topographical survey, LiDAR data, geophysical survey, and ground investigation boreholes. In the old days, these data were mapped or modelled but could only be visualized or transformed to 2D sections for excavation and lateral support (ELS) design, which may not be easily visualized in a 3D space. With the advancement of computing power and the development of digital tools, they enable engineers to work and visualize their design in a 3D environment.

In this presentation, Alvin will showcase the first tool ever built to enable free-form ELS systems to be created in an automated or semi-automated manner using the 3D modelling program, Rhinoceros, and its plug-in graphical algorithm editor, Grasshopper. With the tool, users can build an integrated 3D Rhino model with geological, groundwater, topographical and geometrical data, which can then be extracted for numerical analysis, design optimisation and drawing production at a much faster speed.

Biography

Ir Alvin Lam is currently the Director of Geotechnics, the East Asia Skills Leader of ground engineering and the Registered Geotechnical Engineer (RGE) in Arup. With over 23 years of working experience in managing large-scale infrastructure and building projects in Hong Kong and other East Asia Regions, he has been taking a leading role in various aspects of geotechnical works including ground investigation planning, engineering study, pile study, foundation design, site formation design, slope assessment, deep basement excavation and site supervision.

Computational Geotechnics toward Digital Twin Simulation

Jinhyun Choo, Korea Advanced Institute of Science and Technology (KAIST)

Abstract
The digital twin paradigm has been reshaping a wide range of fields involving physical objects and processes. To unleash the full potential of digital twins, one needs the ability to simulate physical processes based on high-fidelity digital representations of physical entities. Yet it remains highly challenging to incorporate the accurate and complex geometry of structures, terrains, and machines into the existing simulation methodologies in geotechnics. As to address this challenge, I will introduce a highly efficient approach for enabling the material point method – a popular numerical method for large soil deformation – to interact with rigid objects with complex shapes. The performance of the new approach will be showcased with various examples ranging from granular flow over complex terrains to soil–wheel interactions.

Biography
Jinhyun Choo is an Assistant Professor of Civil and Environmental Engineering at the Korea Advanced Institute of Science and Technology (KAIST). Prior to KAIST, he was an Assistant Professor at the University of Hong Kong. Born and raised in South Korea, he received his B.S. and M.S. from Seoul National University. He later obtained his Ph.D. from Stanford University as a Fulbright Scholar and conducted postdoctoral research at Columbia University. Dr. Choo researches a variety of next-generation methods to better understand, predict, and manage the behavior of subsurface systems as they relate to safeguarding and decarbonizing the built environment.

Engineered and Nature-based Solutions against Landslides

Clarence E. Choi, University of Hong Kong (HKU)

Abstract
Landslide risks increase with urbanisation and climate change. Physical countermeasures are needed to protect people and infrastructure from landslide hazards. This short talk looks at the state-of-the-art in engineered and nature-based solutions against flow-type landslides.

Biography
Clarence Choi is Assistant Professor in the Department of Civil Engineering of the University of Hong Kong. His research interests are on landslides and ground improvement. He was awarded the Hutchinson and Oldrich Hungr Lectures.