International Symposium of Soft Ground and Smart Geotechnology

7 January, 2022, Hong Kong, China

Organizer: **The Hong Kong Polytechnic University (PolyU)**

Department of Civil and Environmental Engineering (CEE)

Research Institute for Land and Space of PolyU

Co-Chairs: **Prof. Jian-Hua YIN (Co-Chair)** **(cejhyin@polyu.edu.hk)**

Prof. Zhen-Yu YIN (Co-Chair) **(zhenyu.yin@polyu.edu.hk)**

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Dr. Peichen WU **(elvis.wu@polyu.edu.hk)**

Venue: **N101, PolyU**

Zoom Meeting ID: **928 3569 2543**

Password： **01072022**

Introduction

Soft ground is often encountered in the construction of infrastructures and buildings in many countries and regions, especially in coastal cities. For example in Hong Kong, the 3rd runway of Hong Kong International Airport and Tung Chung New Town Extension works are all being constructed on newly reclaimed lands on seabed of soft Hong Kong Marine Deposits. Soft soils usually have a low shear strength and high compressibility with relatively low permeability. The stability and deformation/settlements of structures on or inside these reclaimed lands are a great concern to stakeholders.

During the last decade, there have been many advances in the development of various smart technologies for geotechnical applications, including optical fiber sensors, MEMS, IoT, AI, ML, etc. Smart geotechnology is developed based on these technologies and is getting wide applications.

The theme of this symposium is “soft ground and smart geotechnology”. The purpose of this symposium is to provide a forum for sharing the latest developments in theories, methods, and smart geotechnology for solving soft ground problems and other types of geotechnical issues. Prominent scholars and experts have been invited to give keynote speeches sharing their latest achievements in theories and methods, soft ground improvement technologies, smart geotechnology, applications, as well as ideas on specific challenges.

PROGRAM

Opening			
8:30 am - 08:40 am (HK Time, 7th January 2022)	**Opening speech by Prof. Jian-Hua Yin**		
Session 1 Session chair: Prof. Jian-Hua Yin			
Hong Kong Time (7th Jan)	**Local time of speaker**	**Speaker**	**Title**
08:40 am-09:20 am	7:40 pm-8:20 pm, 6th Jan. (Pennsylvania Time)	**Prof. Patrick J. Fox,** Pennsylvania State University	*Research on Large Strain Consolidation and Contaminant Transport in Soil*
09:20 am-10:00 am	8:20 pm-9:00 pm, 6th Jan. (New York Time)	**Prof. Steve Waiching Sun,** Columbia University	*Data-driven simulations geomaterials: from model-free poroelasticity to level set plasticity enabled by deep learning*
10:00 am-10:40 am	8:00 pm-8:40 pm, 6th Jan. (Kansas City Time)	**Prof. Jie Han,** Kansas University	*Design of Geosynthetic-Reinforced Column-Supported Embankments on Soft Soils: A Unified Approach (a short version of the RM Koerner Award Lecture)*
10:40 am - 11:20 am	6:40 pm-7:20 pm, 6th Jan. (Berkeley Time)	**Prof. Kenichi Soga,** University of California, Berkeley	*Distributed fiber optic sensing for smart geotechnical engineering*
11:20 am - 12:00 am	7:20 pm-8:00 pm, 6th Jan. (Stanford Time)	**Prof. Ronaldo I. Borja,** Stanford University	*Anisotropic elasticity, plasticity, and viscoplasticity in shale*
30 mins break (lunch boxes will be provided to all registered attendees in N101, PolyU)			

Session 2 Session chair: Prof. Zhen-Yu Yin			
Hong Kong Time	**Local time of speaker**	**Speaker**	**Title**
12:30 pm - 01:10 pm	3:30 pm-4:10 pm, 7th Jan. (Sydney Time)	**Prof. Buddhima Indraratna**, University of Technology Sydney	*Smart ground improvement technologies using waste materials*
01:10 pm - 01:50 pm	10:40 am-11:30 am, 7th Jan. (Sri Lanka Time)	**Prof. Nimal Rajapakse,** Sri Lanka Institute of Information Technology and Simon Fraser University	*Effects of Poroelasticity and Anisotropy on Dynamic Soil-Structure Interaction*
01:50 pm - 02:30 pm	02:50 pm-03:30 pm, 7th Jan. (Saga Time)	**Prof. Jin-Chun Chai**, Saga University	*Method for calculating cyclic load induced 1D and PVD unit cell consolidation deformations*
02:30 pm - 03:10 pm	02:30 pm-03:10 pm, 7th Jan. (Singapore Time)	**Prof. Jian Chu,** Nanyang Technological University	*Roles of advanced lab and in-situ testing in soft soil improvement*
03:10 pm - 03:50 pm	03:10 pm-04:00 pm, 7th Jan. (Beijing Time)	**Prof. Shuilong Shen,** Shantou University	*Jet grouting in soft soil: from technological development to scientific prediction*
03:50 pm - 04:30 pm	08:50 am-09:30 am, 7th Jan. (Paris Time)	**Prof. Yu-Jun Cui,** Ecole des Ponts ParisTech	*Lime-treated saline soils*
Closing			
04:30 pm - 04:40 pm (HK Time, 7th January 2022)		**Closing remarks by Prof. Zhen-Yu Yin**	

Prof. Patrick J. Fox

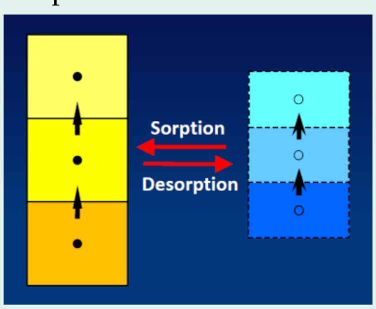
P.E., D.GE, F.ASCE, John A. and Harriette K. Shaw Professor and CEE Department Head, Pennsylvania State University, USA

Presentation title:

Research on Large Strain Consolidation and Contaminant Transport in Soil

ABSTRACT

This lecture will provide an overview of computational and experimental research conducted by Dr. Fox and his students on large strain soil consolidation and contaminant transport in soil. The basic method, coded into the model CS2, accounts for vertical strain, soil self-weight, relative velocities of solid and fluid phases, time-dependent loading, unload/reload effects, and variable hydraulic conductivity and compressibility during the consolidation process. The method has been adapted for layered systems (CS3), accreting soil layers (CS4), centrifuge loading (CC1), constant rate of strain (CCRS1), coupled-solute transport (CST1), and other applications. Solute transport is accomplished using a dual-Lagrangian framework to follow separately the motions of solid and fluid phases, and accounts for advection, diffusion, dispersion, non-linear and non-equilibrium sorption, and first order decay reactions. Applications include disposal of contaminated slurry wastes, coupled consolidation and transport through clay liners, and consolidation of contaminated sediments. Model simulations are verified using available analytical and numerical solutions and validated with experimental data.



SPEAKER'S BIOGRAPHY

Prof. Patrick J. Fox is the Shaw Professor and Head of the Department of Civil and Environmental Engineering at Penn State University, with specialization in geotechnical and geoenvironmental engineering. He has a broad range of expertise, including slope stability, landfills, geosynthetics, groundwater, consolidation, and retaining walls, and has won awards for research, teaching, and service. Research awards include the ASCE Casagrande Award, ASCE Middlebrooks Award (twice), IGS Award (twice) from the International Geosynthetics Society, Desai Medal and Booker Medal from the International Association for Computer Methods and Advances in Geomechanics, and best paper awards from the *Geotechnical Testing Journal*, *Geosynthetics International* (twice), and the *International Journal of Geomechanics* (three times). He is a Past-President and member of the ASCE Geo-Institute and Editorial Board Member for *Geosynthetics International*, *Geotextiles & Geomembranes*, and the *International Journal of Geomechanics*. Dr. Fox served as Editor-in-Chief of the ASCE *Journal of Geotechnical and Geoenvironmental Engineering* from 2010 to 2015, and is a member and past chair of the G-I Technical Publications Committee. He is a licensed professional engineer and Fellow of ASCE.

Prof. Steve Waiching Sun

Associate Professor, Department of Civil Engineering and Engineering Mechanics, Columbia University, New York, USA

Presentation title:

Data-driven Simulations Geomaterials: from Model-free Poroelasticity to Level Det Plasticity Enabled by Deep Learning

ABSTRACT

We present an adaptive hybridized model-based/model-free strategy that ensures the feasibility of multi-physics simulations when different amounts of data are available. In the data-rich situations, we extend the data-driven approach from Kirchdoerfer and Ortiz where the hydraulic and solid constitutive laws may switch from model-free to mode-based depending on the availability of data. Techniques related to identifying the constitutive manifold, the influence of the normed space, and the distance-minimized algorithm accelerated by the K-dimensional tree search will be discussed. In the cases where experimental data are less abundant, we build interpretable macroscopic surrogate elasto-plasticity models inferred from sub-scale direction numerical simulations (DNS) or experiments with limited data. To simplify these training processes and improve the interpretability of the trained models, we break down the training of material models into multiple supervised machine learning programs for elasticity, initial yielding, and hardening laws that can be conducted sequentially. To handle pressure- and rate-dependence of the plastic responses, we reformulate the Hamilton–Jacobi equation such that the yield function is parametrized in a product space spanned by the principal stress, the accumulated plastic strain, and time. To test the versatility of the neural network meta-modeling framework, we conduct multiple numerical experiments where neural networks are trained and validated against (1) data generated from known benchmark models, (2) data obtained from physical experiments, and (3) data inferred from homogenizing sub-scale direct numerical simulations of microstructures.

SPEAKER'S BIOGRAPHY

Prof. Sun is an Associate Professor in the department of civil engineering and engineering mechanics at Columbia University. He obtained his Ph.D. from Northwestern in 2011 and worked as a senior member of technical staff at Sandia National Laboratories from 2011-2013. His research focuses on theoretical, computational, and data-driven mechanics for multiphase materials with complex microstructures. He is the recipient of several awards including the IACM John Argyris Award, ICE Zienkiewicz Medal Prize, the ASCE EMI da Vinci Award, the NSF CAREER award, Young Investigator Awards from the Army Research Office and Air Force Office of Scientific Research.

Prof. Jie Han

P.E., F.ASCE, Glenn L. Parker Professor of Geotechnical Engineering, the University of Kansas, USA

Presentation title:

Design of Geosynthetic-Reinforced Column-Supported Embankments on Soft Soils: A Unified Approach

ABSTRACT

Geosynthetics have been successfully used to improve performance of column-supported embankments on soft soils. Geosynthetic-reinforced column-supported embankments involve complex load transfer mechanisms, including soil arching, tensioned membrane, stress concentration, and downdrag. Different theoretical models are available to describe soil arching but often result in different predicted stresses because pattern and degree of soil arching depend on the magnitude of differential settlement between columns. This presentation will propose a unified design procedure based on the ground reaction curve and considering subsoil resistance and tensioned membrane effect, and verify the design procedure with two case studies of geosynthetic-reinforced column-supported embankments.

SPEAKER'S BIOGRAPHY

Prof. Jie Han is the Glenn L. Parker Professor of Geotechnical Engineering in the Civil, Environmental, and Architectural Engineering Department at the University of Kansas. He is a board governor of the ASCE Geo-Institute, the chair of the US Transportation Research Board (TRB) Transportation Earthworks committee, and the specialty chief editor of Frontiers of Built Environment. Prof. Han has gained extensive teaching, research, and industry experiences in geosynthetics, ground improvement, pile foundations, buried structures, and roadways. He is the sole author of the book entitled "Principles and Practice of Ground Improvement" and has published approximately 450 peer-reviewed journal and conference papers. Prof. Han has been invited to give more than 200 keynote/invited lectures and short courses around the world, including the State of the Practice Lecture at the 21st Annual George F. Sowers Symposium in Atlanta, Georgia in 2018, the 18th UK IGS Lecture in London in 2018, and the 3rd Robert M. Koerner Award Lecture in 2021. He has received numerous awards from the profession including but not limited to the 2014 the International Geosynthetics Society Award, the 2017 ASCE Martin S. Kapp Foundation Engineering Award, and the 2018 ASCE Kansas City Section Engineer of Year Award. Prof. Han was elected to the ASCE Fellow in 2014.

Prof. Kenichi Soga

Donald H. McLaughlin Chair and a Chancellor's Professor at the University of California, Berkeley, USA

Presentation title:

Distributed Fiber Optic Sensing for Smart Geotechnical Engineering

ABSTRACT

Distributed Fiber Optic Sensing (DFOS) is one of the promising tools for structure health monitoring. It can measure physical quantities (such as temperature, strain, and vibration) of the fiber continuously along its length for long distance due to its low-loss characteristic. By attaching an optical fiber cable to a structure or embedding it inside a structure, it is possible to monitor the changes of ambient parameters of the structure. In this talk, the measurement principles and their state-of-the-art status in terms of their capabilities for geotechnical engineering are discussed.

SPEAKER'S BIOGRAPHY

Prof. Kenichi Soga is the Donald H. McLaughlin Chair and a Chancellor's Professor at the University of California, Berkeley. He is also a faculty scientist at Lawrence Berkeley National Laboratory. He obtained his BEng and MEng from Kyoto University in Japan and PhD from the University of California at Berkeley. His current research activities are infrastructure sensing, performance based design and maintenance of infrastructure, energy geotechnics, and geomechanics. He is a Fellow of the UK Royal Academy of Engineering, the Institution of Civil Engineers (ICE) and American Society of Civil Engineers (ASCE). He is the chair of Technical Committee TC105 "Geotechnics from Micro to Macro" of the International Society for Soil Mechanics and Geotechnical Engineering and of ASCE Infrastructure Resilience Division's Emerging Technologies Committee.

Prof. Ronaldo I. Borja

Professor, Stanford University, USA

Presentation title:

Anisotropic Elasticity, Plasticity, and Viscoplasticity in Shale

ABSTRACT

Shale is a clastic sedimentary rock consisting of softer materials such as clay and organics; stiffer minerals such as quartz, feldspar, and pyrite; and void spaces in the nano-pores and micro-fractures. It is the most common sedimentary rock on Earth, estimated to represent between 44 to 56% of all sedimentary rocks. The talk will explore the anisotropic mechanical properties of this material, from elasticity to plasticity to viscoplasticity. Of particular interest is the impact of degree of saturation on the evolution of anisotropy in the stiffness and strength of this material. Anisotropic viscoplasticity will be discussed in the context of multiscale creep processes occurring across space and time.

SPEAKER'S BIOGRAPHY

Prof. Ronaldo I. Borja works in theoretical and computational geomechanics, geotechnical engineering, and geosciences. His research includes the development of mathematical and computational frameworks for multiscale and multi-physical processes in geomechanics and related fields. He is the author of a textbook entitled Plasticity Modeling and Computation published by Springer and serves as executive editor of two journals in his field: the International Journal for Numerical and Analytical Methods in Geomechanics and Acta Geotechnica. Ronaldo Borja is the recipient of the 2016 ASCE Maurice A. Biot Medal for his work in computational poromechanics.

Prof. Buddhima Indraratna

Distinguished Professor of Civil Engineering and the Director of Transport Research Centre, at University of Technology Sydney, Australia

Presentation title:

Smart Ground Improvement Technologies using Waste Materials

ABSTRACT

The need for transport infrastructure that will perform over the long term has recently been accentuated by an expectation that heavy haul transport networks will be able to withstand higher speeds and heavier axle loads. Several ground improvement techniques used worldwide to improve track embankments built on soft ground are Prefabricated Vertical Drains (PVDs) combined with surcharge and vacuum preloading. These techniques have proven to be efficient, cost-effective, and popular methods for accelerating consolidation. Moreover, energy absorbing layers manufactured from waste tyres, such as ballast mats, under sleeper pads, rubber crumbs, and tyre cells will also help to attenuate dynamic train loads and also alleviate the degradation and deformation of ballast. Recycling these waste materials not only helps to solve geotechnical issues, it is also economically beneficial and environmentally sustainable. This keynote lecture briefly reviews some key aspects of soft ground improvement via PVDs combined with surcharge and vacuum preloading, and it also discusses our current knowledge of the ability of energy-absorbing materials to mitigate track deterioration induced by fast-moving heavy haul trains. Since the factors which govern the stress-strain behaviour and the strength and degradation of ballast, as well as the ability of geosynthetics and synthetic energy-absorbing mats to minimise ballast breakage and track settlement have been analysed, our research outcomes are expected to contribute to design solutions that will enhance track stability and reduce the maintenance costs.

SPEAKER'S BIOGRAPHY

Prof. Indraratna is a Civil Engineering graduate from Imperial College, London. Since his PhD at University of Alberta in Canada in 1987, his contributions to geotechnical and railway engineering have been acknowledged through numerous national and international awards, including 1st Ralph Proctor Lecture and 4th Louis Menard Lecture of the International Society of Soil Mechanics and Geotechnical Engineering. He also delivered the 2009 EH Davis Memorial Lecture of the Australian Geomechanics Society for contributions to Theory and Practice of Geomechanics.

For his pioneering contributions, he was honoured with the 2009 Business and Higher Education award by the Australian Commonwealth, 2011 Engineers Australia Transport Medal and 2015 Australia-New Zealand Railway Technical Society's Outstanding Individual Award. Other numerous international awards include Thomas Telford Premium by the Institution of Civil Engineers (UK), Robert Quigley commendation awards by the Canadian Geotechnical Society, and the Medal of Excellence for life-time contributions by the International Association of Computer Methods and Advances in Geomechanics.

Prof. Nimal Rajapakse

P.E., Deputy Vice-Chancellor of the Sri Lanka Institute of Information Technology, Sri Lanka, and Professor at Simon Fraser University, Canada

Presentation title:

Effects of Poroelasticity and Anisotropy on Dynamic Soil-Structure Interaction

ABSTRACT

This presentation examines the influence of poroelasticity and anisotropy on dynamic soil-structure interaction under time-harmonic loading. We consider foundations on multi-layered transversely isotropic poroelastic soils within the linear elastodynamic theory. An exact stiffness matrix method based on the explicit analytical general solutions of a transversely isotropic poroelastic medium is used to derive the solutions for buried time-harmonic vertical loading and a time-harmonic pore pressure discontinuity acting in the interior of a layered medium. The general solutions are derived by using integral transforms. The solutions for interior loading can be used to analyze various dynamic soil-structure interaction problems. The solutions for circular and strip foundation cases are presented as practical examples. A set of numerical results for the displacements and stress resultants of foundations are presented to illustrate the influence of governing parameters such as poroelastic materials constants, degree of soil anisotropy, foundation rigidity, frequency of excitation and distance between foundations.

SPEAKER'S BIOGRAPHY

Prof. Nimal Rajapakse is currently the Deputy Vice-Chancellor of the Sri Lanka Institute of Information Technology and a Professor (on leave of absence) in the School of Engineering Science at Simon Fraser University (SFU), Canada. He received B.Sc. (Hons.) from the University of Sri Lanka in 1977, and master's and doctoral degrees from the Asian Institute of Technology in Bangkok in 1981 and 1983, respectively. He was the Head of the Department of Civil Engineering at the University of Manitoba (UM), Canada from 1997 to 2000. He joined the University of British Columbia (UBC), Canada as Head of the Department of Mechanical Engineering in 2000 and served in that capacity until 2007. He became the Director of the Institute for Computing, Information and Cognitive Systems at UBC in 2007. He was the Dean of the Faculty of Applied Sciences at SFU from 2009 to 2015. He served as Vice-President (Research and International) of Carleton University, Ottawa from September 2015 to October 2016. Dr. Rajapakse's research interests are in Applied Mechanics, with emphasis on the computational mechanics and coupled-field problems involving advanced materials and geomaterials. He is the author of over 150 journal papers. His Google Scholar h-index is 44 with over 5000 citations.

Prof. Jin-Chun Chai

Professor (Geotechnical Engineering)
Department of Civil Engineering and Architecture, Saga University, Japan

Presentation title:

Method for Calculating Cyclic Load Induced 1D and PVD Unit Cell Consolidation Deformations

ABSTRACT

Consolidation deformation induced by low frequency cyclic loads was investigated by finite element analysis (FEA) and some available test data. Both one-dimensional (1D) consolidation and the consolidation of a prefabricated vertical drain (PVD) unit cell were considered. With theoretical reasoning and using the results of FEA, it has been established that the amount and the rate of consolidation deformation induced by a continuous cyclic load with a maximum load increment of q, can be calculated using the consolidation result of a static load with a magnitude of q/2. Providing the compression increment (ΔS) near the drainage boundary where the effective stress increment is larger than q/2 is taking into account. The magnitude of ΔS is cyclic load frequency dependent and a method for evaluating it has been proposed. Further, it has been proposed that during the cyclic loading period, the creep deformation induced by sustained static load on a soil layer should be included into the total deformation. The proposed method was applied to two 1D and one PVD unit cell laboratory tests of cyclic load induced consolidations. Good agreement between the measured and the calculated settlement – time curves was obtained.

SPEAKER'S BIOGRAPHY

Prof. Chai graduated from Tongji University with a Bachelor degree, and graduated with a Master degree from the China Academy of Railway Sciences. In 1992, he received a doctorate degree in Geotechnical Engineering from Asian Institute of Technology. He is currently a professor in Department of Civil Engineering and Architecture, Saga University, Japan. His main research areas are soft soil ground improvement (prefabricated band drains, vacuum preloading, deep mixing piles, etc.), geoenvironmental engineering and numerical simulation of geotechnical engineering, etc. He is currently the associate editor of the SCI journal Canadian Geotechnical Journal, and the editorial board member of SCI journals such as Computers and Geotechnics, Geotextiles and Geomembranes, Ground Improvement, and Geomechanics and Engineering. He received outstanding reviewer award from the journal of Computers and Geotechnics, outstanding paper award from Geosynthetics International and other journal outstanding paper awards. He is currently a member of the International Society of Soil Mechanics and Geotechnical Engineering, the International Geosynthetics Association and the Japanese Society of Civil Engineering. He has published 4 books such as "Deformation analysis in soft ground improvement"; published more than 200 papers with more than 90 SCI-indexed papers.

Prof. Jian Chu

Chair of the School of Civil and Environmental Engineering and the Director of the Centre for Urban Solutions at the Nanyang Technological University in Singapore

Presentation title:

Roles of Advanced Lab and In-situ Testing in Soft Soil Improvement

ABSTRACT

Soil characterization by laboratory and in-situ tests plays an important role in geotechnical design and construction on soft ground. In this presentation, case histories are used to illustrate how advanced laboratory and in-situ testing can be used for the assessment of the safety of a cut slope in soft soil and the design of soft soil improvement for land reclamation projects. The use of laboratory tests including K0 consolidated triaxial compression, extension and direct simple shear and in-situ tests including self-boring pressuremeter, CPTU and seismic cone is discussed.

SPEAKER'S BIOGRAPHY

Prof. CHU Jian is the Chair of the School of Civil and Environmental Engineering and the Director of the Centre for Urban Solutions at the Nanyang Technological University (NTU) in Singapore. He was professor and James M. Hoover Chair in Geotechnical Engineering at Iowa State University, USA, from 2011 to 2014. Prof Chu is a past President of the Geotechnical Society of Singapore, the Chair for ISSMGE Technical Committee TC217 on Land Reclamation. He is an editor for Acta Geotechnica. In addition to leading a number of large-scale research projects, Prof Chu is also actively involved in construction projects in Singapore or overseas as either a consultant or advisor. He received several awards including the R. M. Quigley Award from the Canadian Geotechnical Society in 2004 and the Outstanding Geotechnical Engineer Award from the Geotechnical Society of Singapore in 2018.

Prof. Shuilong Shen

Dean of College of Engineering, Professor, Shantou University, China

Presentation title:

Jet Grouting in Soft Soil: from Technological Development to Scientific Prediction

ABSTRACT

This presentation introduces the recent advances of jet grouting both from the point view of technological development and scientific prediction conducted in Shanghai. The subsoil in Shanghai is a multi-stratum, that is, one-layer cohesive soil covered by one layer of sandy soil. Technological development included enhanced triple fluid type (RJP) tests, twin jet grouting, and low impact horizontal jet grouting with spoil extraction. The results show that RJP can create high quality jet grouted columns in clayey soil, however, in sandy soil the quality jet grouted columns was poor. In order to solve this problem, twin-jet technology, using two binders, was invented and filed test was conducted and get successful results in 2007. Since 2009, a series of scientific methods both to predict the diameter of columns and effect on surroundings was conducted. Later on, artificial intelligence technology was developed to do both diameter prediction and displacement prediction. The total research funding was over 4.6 M RMB. These series research applied 12 patents and published 20 papers in international journals, e.g., Géotechnique, ASCE Journal of Geotechnical and Geoenvironmental Engineering, Canadian Geotechnical Journal etc.

SPEAKER'S BIOGRAPHY

Prof. Shui-Long Shen received his BSc. in Underground Space Technology from Tongji University in 1986 and his MPhil in Structural Engineering from the same university in 1989. He obtained his Ph.D. in Geotechnical Engineering from Saga University, Japan, in 1998. From 2001 to 2003, Dr. Shen worked in National Institute for Environmental Studies in Tsukuba-the Science City of Japan. In 2003, he joined the Department of Civil Engineering (DCE) of Shanghai Jiao Tong University (SJTU) as a faculty member. In 2019, Dr. Shen joined the College of Engineering, Shantou University as the Dean. Dr. Shen now is a distinguished leading talent of Guangdong Province, China. Dr. Shen's research interests focus on the urban underground infrastructural system, smart maintenance of urban underground facilities. He published/edited six books, of which three conference proceedings published by ASCE. Dr. Shen published more than 354 technical papers in Journals and International conferences, in which over 250 papers were published in International Journals with total citation over 13000 times (google). Dr. Shen's H-Index in Google Scholar is 66, in SCOPUS is 60, in Web of Science is 60. Dr. Shen also serves as an Associate Editor/Editorial board member of Canadian Geotechnical Journal, Geotextiles and Geomembranes (Associate Editor), Computers and Geotechnics, Tunnelling and Underground Space Technology (TUST), Elsevier; Frontiers of Structural and Civil Engineering, Springer; Marine Georesources and Geotechnology, Taylor and Francis, and Geotechnical Engineering – SEAGS etc. and domestic journals, e.g. Chinese Journal of Geotechnical Engineering.

Prof. Yu-Jun Cui

Professor, Ecole des Ponts ParisTech, France

Presentation title:

Lime-treated Saline Soils

ABSTRACT

Lime treatment can improve the workability and hydro-mechanical properties of soil through different physical-chemical reactions. The effectiveness of lime treatment is expected to be water chemistry and climate dependent. To understand the effects of water chemistry and climate on lime-treated soils, a laboratory work was conducted on a saline soil taken from Salin-de-Giraud with and without lime treatment. New methods were proposed to determine the dissolved salinity and the induced osmotic suction for unsaturated soils with consideration of dissolved and precipitated salts. The mechanisms of salinity effect on the liquid limit and compaction behaviour of untreated soil, and of the drying effect on the microstructure of compacted saline soil were clarified. The optimum lime content of soil mixed with deionized water, synthetic seawater, mixed salts solution were determined by pH method. The effects of salinity and aggregate size on the mineralogy, microstructure and water retention property of lime-treated saline soil were investigated, showing that there were no cementitious compounds detecting on X-ray diffraction pattern even after a curing time as long as 150 days, due to its low quantity and poorly crystallized or amorphous phase. As a result, the microstructure of lime-treated soil varied slight during curing. The matric suction of lime-treated specimens increased significantly during curing, while the total suction increased slightly. Both total and matric suctions of lime-treated specimens increased as salinity increased. The lime-treated specimens with larger aggregates exhibited a larger modal size and thus had a smaller air entry value. The mechanical behaviour and durability of lime-treated soils were investigated by performing mercury intrusion porosimetry, bender element and oedometer tests on untreated/lime-treated specimens and the specimens subjected to wetting-drying cycles, showing a higher resistance of treated soil to wetting-drying cycles. The synthetic seawater, compared to deionized water, resulted in higher soil stiffness.

SPEAKER'S BIOGRAPHY

Prof. Cui is the head of Geotechnical Engineering Group (CERMES) of Navier Laboratory at Ecole des Ponts ParisTech, concurrently a member of the Council of French Society for Soil Mechanics, a member of Technical Committee of ISSMGE for unsaturated soils (TC106) and for transportation geotechnics (TC202). He is also an Associate Editor of "Canadian Geotechnical Journal", "Journal of Rock Mechanics and Geotechnical Engineering", "Transportation Geotechnics" and a Panel Member of "Géotechnique Letters". He has participated in the management of a number of EU projects and industrial projects related to different applications of unsaturated soil mechanics. His research interests include laboratory testing, constitutive modelling, environmental geotechnical engineering, railway geotechnical engineering, nuclear waste disposal, lime/cement treatment, soil-vegetation-atmosphere interaction, etc.

About PolyU and CEE

The Hong Kong Polytechnic University (PolyU) is ranked the 66^{th} position in Quacquarelli Symonds (QS) World University Rankings 2022 where institutions are ranked according to their academic and employer reputation, faculty/student ratio, research impact and internationalisation performance. PolyU is also ranked the 91^{st} in the 2022 Times Higher Education (THE) World University Rankings, up 38 places from the 129^{th} in 2021. It is the first time that PolyU has been ranked among the world top 100 by THE World University Rankings.

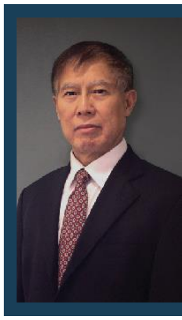
Department of Civil and Environmental Engineering (CEE) of PolyU is a leading department in the field of civil and environmental engineering. We take great pride in our research excellence, high quality education as well as the power of synergy achieved by a pool of renowned scholars and professional faculty members in the field. We offer not only a broad-based and high-quality interdisciplinary education in the areas of structural, geotechnical, hydraulic, transportation and environmental engineering, but also an advanced practical training enabling our students to be competent engineers in this ever-changing world.

PolyU is ranked the 2^{nd} best university for Civil Engineering in the U.S. News & World Report's Best Global Universities Rankings 2022. 27 scholars in CEE were ranked in "World's Top 2% Scientists" in 2021 Released by Stanford University (25 Nov 2021). Riding on the international recognition in the rankings, we have performed particularly well in securing external research grants, including two Theme Based Research projects with a total funding of HK$85.79 million in 2017/18 and 2018/19 and four Research Impact Fund projects with a total funding of HK$25.86 million in 2018/19. In 2020/21, We have secured a total external research funding of HK$32.8 million.

Our People

The Department has over 60 academic members in five academic units, including one Member of the Chinese Academy of Sciences and seven Chang Jiang Scholars, supported by 15 office staff and 22 technical staff. They are serving 32 SCI journals as Editors-in-chief, Editors or Associate Editors. The Department has also six world-class scholars as our Distinguished Chair Professors and Honorary Professors. The Department attracts quality local, non-local students to apply for our postgraduate research programmes. There are currently more than 230 PhD students and around 180 research staff members (Postdoctoral Fellows, Research Associates/Assistants).

Academic staff in Geotechnical Unit of CEE



Prof. Jian-Hua Yin (Unit Leader)
PhD, Manitoba U, Canada

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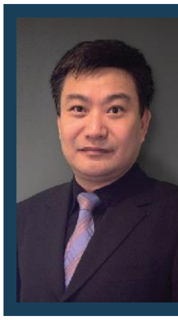
Research Interests:
Testing Study and Constitutive Modelling of Behaviour of Soils and Soft Soil Improvement; Smart Monitoring of Geotechnical Structures Using Optical Fibre Sensors; Analyses of Consolidation Settlements and Geotechnical Structures



Dr Zhen-Yu Yin
PhD, Ecole Centrale de Nantes, France

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Research Interests:
Microstructure and Micromechanics of Soils; Multiscale and Multiphysics Modelling in Geotechnics; Practice of Artificial Intelligence in Geotechnics

Dr Andy Y.F. Leung
PhD, Cambridge U, UK

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Research Interests:
Interaction between Foundation and Superstructure; Optical Fibre Strain Sensing; Spatial Variability of Soil Properties

Dr Chao Zhou
PhD, HKUST

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Research Interests:
Fundamental Thermo-hydro-mechanical Behaviour of Saturated and Unsaturated Soils; Constitutive Modelling of Soils; Geo-energy Engineering and Pavement Engineering

Dr Qi Zhao
PhD, University of Toronto, Canada

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Research Interests:
Experimental Rock Physics; Digital Rock Physics Based on Micro-CT technology; Fault/joint Surface Roughness and Frictional Behaviour

Mr Lin Hoi-yung
MSc, National Sun Yat-Sen U

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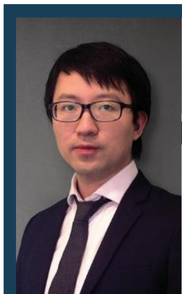
Research Interests:
Sedimentology; Petrology and Petrographic Study; General Geology



Dr Han-Lin Wang
PhD, Zhejiang U, China

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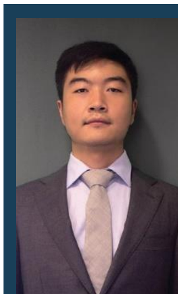
Research Interests:
Soil-structural Interaction; Unsaturated Soil Mechanics; Microbially Induced Calcium/Carbonate Precipitation (MICP) in Soil; Pile-supported Embankment



Dr Dao-Yuan Tan
PhD, HKPU

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Research Interests:
Geohazards Management; Intelligent Monitoring of Geotechnical Structures; Development of Smart City Infrastructure

Dr Wen-Bo Chen
PhD, HKPU

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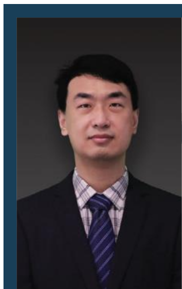
Research Interests:
Characterization of Geomaterials; Geoenvironmental Engineering; Smart Monitoring of Geostructures; Development of Novel Testing Techniques



Dr Pei Wang
PhD, Georgia Institute of Technology, USA

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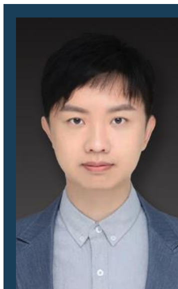
Research Interests:
Behavior of Granular Materials; Particle Breakage; Discrete Element Method; and Soil-structure Interface



Dr Xiang Wang
PhD, Central South University, China

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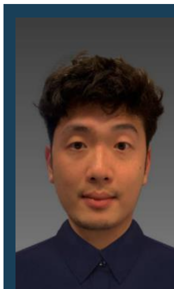
Research Interests:
Discrete Element Method; Granular Material, AI in Geotechnics



Dr Pei-Chen Wu
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Research Interests:
Physical and Numerical Modelling of Marine Deposits; Ground Improvement Techniques on Soft Soils; Geosynthetics

Research by Geotechnical Unit: From Advanced Testing, Modelling, Smart Geotechnology to Applications

➢ A new sustainable approach for marine reclamations in coastal cities

A team from this unit led by Professor JH YIN has been awarded a Research Impact Fund (RIF) from Research Grants Committee (RGC) of HKSAR of China for a project entitled "Study of Super-fast Large-area Economical Marine Reclamations for Housing and Infrastructural Developments in the Guangdong-Hong Kong-Macau Greater Bay Area" (HK$14,108,800). The main objective is to study key fundamental and technical issues to develop a feasible method for super-fast large-area economical marine reclamations in the Greater Bay Area.

➢ Study on methods and technologies for urban geohazard mitigations in hilly regions

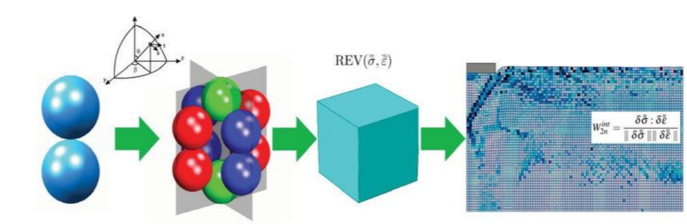
Our efforts on geohazards and mitigation relating to landslides and debris flows can be classified into two main domains: (a) physical modelling, theoretical study, and numerical analysis (FEM, DEM, material point method, etc.) on geohazards such as landslides, rockfalls, and debris flows, and their mitigations and (b) field monitoring technologies for monitoring geohazards.

Photo of facility | Rockfall impact | Granular flow impact | Debris flow impact

A Collaborative Research Fund has been granted by RGC for building the first large-scale debris flow flume model in Hong Kong (HK$8,208,882) (see photos above).

➢ Multi-scale and multi-physics modelling of geotechnical structures

Due to the complicated characteristics of geotechnical structures, we develop multi-scale and multi-physics modelling in the relevant field (see figure below) (integrating inter-grain/aggregate contacts in all directions from micro to macro; developing a hydro-mechanical coupled numerical model; macro-element modelling of soil-structure interaction; solving large deformation problems by CEL, SPH, MPM, coupled FDM-DEM, and SPFEM).



Micro scale (contact) | Meso scale (Hexagan) | Macro scale (REV) | Engineering scale (BVP)

➢ Smart geotechnology for monitoring geotechnical structures including slopes, debris flows, and retaining walls with trees

Advanced smart technologies including fibre optic sensing technologies (FBG, BOTDA, OFDR) and conventional sensors have been developed and applied firstly by our unit in Hong Kong. See right photos of automatic monitoring and risk warning of movement and possible failure of stonewalls with trees and large trees.