Geotechnical Engineering Challenges in Penang: Climate, Urbanization, and Sustainable Solutions
By Dato' Ir. Rajendran P. Anthony

SPEAKER CV:

Dato' Ir. Rajendran P. Anthony, is the current Mayor of the City Council of Penang Island (Majlis Bandaraya Pulau Pinang – MBPP) and a civil engineer with nearly four decades in public service and municipal governance. Born and raised on Penang Island, he holds a Bachelor of Engineering (Hons) in Civil Engineering from the University of Hertfordshire, UK, and is a registered Professional Engineer with Practising Certificate (PEPC) under the Board of Engineers Malaysia. Dato' Ir. Rajendran began his career in 1986 with the then Municipal Council of Penang Island and steadily rose through the ranks, serving as Chief Engineer, Deputy Director, and Director of Engineering before being appointed City Secretary in 2022 and Mayor in May 2023. Under his leadership, MBPP has embraced a smart city framework, prioritizing sustainable, inclusive, and technology-driven urban development. In recognition of his outstanding contributions, he was conferred the Honorary Fellow of the Institution of Engineers Malaysia in 2024. Dato' Ir. Rajendran is known for his unwavering dedication to engineering excellence and his visionary approach to making Penang Island a Progressive, Resilient, and Happy City.

SYNOPSIS:

Penang faces formidable geotechnical engineering challenges, shaped by its tropical climate, rapid urbanisation, and the imperative for sustainable infrastructure development. The state's steep central topography and intense rainfall render it particularly susceptible to landslides, soil erosion, and slope instability—especially in vulnerable areas such as Paya Terubong and Bukit Bendera. These issues are further compounded by climate change, rainfall variability and therefore heighten the frequency of geohazards, thereby placing both public safety and critical infrastructure at considerable risk. The transformation of Penang from a predominantly rural landscape into a densely urbanised region has escalated the demand for residential, commercial, and industrial development, prompting large-scale projects including hillside construction and coastal land reclamation. Such interventions frequently disrupt natural drainage systems, increase surface runoff, and exacerbate slope instability. A notable example is the Silicon Island reclamation project, which, while aiming to generate industrial land, raises pertinent concerns regarding coastal soil erosion and deposition and long-term settlement risks—issues typically associated with reclaimed coastal terrain. In response to these challenges, Penang has introduced a suite of regulatory measures. The *Penang Safety Guideline for Hill Site Development* necessitates rigorous geotechnical assessments and slope

stabilisation for all hillside developments. Similarly, the *Safety Guidelines for Agricultural Activities in Hilly Areas* serve to regulate land use in rural highlands, mitigating erosion risks. Complementing these is the *Safety Guideline for Developments with Basement*, which addresses the hazards of deep excavations and groundwater ingress, particularly within soft or reclaimed soils. Further supporting these efforts, the *Penang Structure Plan 2030* emphasises GIS-based land-use analysis and low-carbon urban planning as critical tools in shaping sustainable growth and enabling informed spatial decision-making. Collectively, these frameworks exemplify Penang's commitment to fostering a resilient, secure, and environmentally responsible urban future in the face of escalating geotechnical and climatic challenges.

Earthquake Disaster Prevention in Japan and its Challenges

By Prof. Taiki Saito

SPEAKER CV

Taiki Saito is a Professor in the Department of Architecture and Civil Engineering at Toyohashi University of Technology. He earned his Doctor of Engineering degree from Tohoku University in March 1990.

He began his career as a Research Associate in the Department of Architecture at Tohoku University (1990–1996) and later served as a Senior Research Engineer at the Building Research Institute, Ministry of Construction (1996–2012). Since November 2012, he has been a Professor at Toyohashi University of Technology, specializing in Earthquake Engineering.

Professor Saito has held significant positions in professional societies, including serving as Chairman of the Committee of International Affairs at the Japan Society of Seismic Isolation and Chairman of the Executive Committee for the 13th World Conference on Seismic Isolation, held in Sendai in 2013. He is also the Convenor of the Working Group responsible for establishing ISO 23618: "Bases for Design of Structures — General Principles on Seismically Isolated Structures." Additionally, he is a Board Member and former Vice President of the Anti-Seismic Systems International Society (ASSISi).

SYNOPSIS

The 2011 Great East Japan Earthquake caused devastating damage, including nearly 20,000 casualties due to the tsunami. The 2024 Noto Peninsula Earthquake, characterized by distinctive crustal movements, resulted in more than 500 casualties, with recovery efforts in the affected areas remaining delayed.

Key challenges in Japan’s earthquake disaster prevention include population decline, aging, and the concentration of resources in Tokyo. At the same time, advancements in earthquake disaster prevention technologies, such as the development of seismic observation networks, the establishment of an emergency earthquake warning system, and improvements in building earthquake resistance rates, have been made.

Base isolation technology, in particular, has become widely adopted, with its effectiveness reported during the Noto Peninsula Earthquake. Furthermore, promoting international technological cooperation is crucial for advancing earthquake disaster prevention efforts.

Enhancing the Quality of Site Investigation Works: Initiatives for Progress

By Ir. Som Pong Pichan

SPEAKER CV

Ir. Som Pong Pichan is currently the Head of the Site Investigation Division under the Geotechnical Engineering Branch of the Public Works Department Malaysia (JKR). He holds a Bachelor's degree in Civil Engineering from Universiti Sains Malaysia (2000) and a Master's degree in Civil Engineering (Geotechnics) from Trinity College Dublin, Ireland (2012). Since joining JKR in 2002, he has accumulated over 25 years of experience in civil and geotechnical engineering, with a strong background in both design and construction.

He is a Registered Professional Engineer with Practicing Certificate (PEPC) under the Board of Engineers Malaysia and a Corporate Member of The Institution of Engineers, Malaysia (IEM). In 2015, Ir. Som Pong was awarded the Geotechnical Engineering Competency Certificate – Level 4 by JKR, acknowledging his advanced technical expertise in the field.

His previous appointments include serving as the Gombak District Engineer in Selangor (2017–2020) and as the inaugural Head of the Research and Development Division of the Geotechnical Engineering Branch, established in 2016. He has played a pivotal role in numerous high-impact government infrastructure and building projects since 2002.

Ir. Som Pong is actively involved in national and international technical committees. He currently appointed as Chairman of TC17 – Geotechnical Works under the National Standards Committee and serves as a member of ISSMGE's TC222: Geotechnical BIM and Digital Twins, and PIARC's TC4.3 – Earthworks, World Road Association (PIARC). He has also authored and presented technical papers at various national and international conferences and seminars.

SYNOPSIS

Effective site investigation is crucial for ensuring safety, efficiency, and sustainability in construction and infrastructure projects. This presentation highlighted initiatives by JKR Malaysia aimed at improving the accuracy, efficiency, and reliability of site investigation works. The paper will cover the current challenges, such as data inconsistencies, outdated techniques, and constraints within the field that hinder optimal site assessments. Key areas of focus will be the adoption of standardized methodologies and best practices to ensure consistency and quality across projects. Furthermore, the presentation will include the proposed integration of automation and digitalization, geophysics, and big data analytics in site investigation to enhance the accuracy and effectiveness of subsurface information utilization. Ultimately, these initiatives aim to modernize site investigation activities, ensuring that professionals can make well-informed decisions, mitigate risks, and optimize project outcomes.

Ground Improvement by Prefabricated Vertical Drain (PVD) Method

By Dr. Seah Tian Ho

SPEAKER CV

Dr. Seah Tian Ho is a renowned Geotechnical Specialist with over 30 years of International experience across Southeast Asia, including Malaysia, Thailand, and Vietnam. He holds a Doctor of Science in Geotechnical Engineering from the Massachusetts Institute of Technology (MIT), USA, and a First-Class Honours degree in Civil Engineering from King's College, University of London.

Dr. Seah specializes in soft soil behavior, ground improvement using Prefabricated Vertical Drains (PVD), and foundation design for large-scale infrastructure such as railways, airports, and MRT systems. He has led and advised on landmark projects including KLIA2 (Malaysia), Suvarnabhumi Airport (Thailand), and the Long Son Petrochemical Complex (Vietnam).

Dr. Seah is a Special Member of the Council of Engineers Thailand and serves as an Advisory Member of the Engineering Institute of Thailand. A prolific researcher, Dr. Seah has published extensively in leading journals such as ASTM *Geotechnical Testing Journal* and *Journal of Geotechnical Engineering*, as well as in International geotechnical conferences. He has also held academic appointments at the Asian Institute of Technology, Chulalongkorn University and King Mongkut University of Technology, where he mentored postgraduate students and advanced soil testing methodologies.

SYNOPSIS

Soft clay presents a major challenge in geotechnical engineering due to its slow consolidation behaviour. This lecture introduces the **Prefabricated Vertical Drain (PVD) method**, a cost-effective and efficient ground improvement solution to accelerate consolidation in such conditions.

The session will cover key concepts, including how PVDs work, critical design parameters (spacing, depth, layout), and the role of soil properties. Real-world case studies from embankment and infrastructure projects will illustrate the effectiveness of technique and lessons learned. Attendees will also explore the sustainability advantages and decision criteria for choosing PVDs over alternative techniques.

Key takeaways include understanding the benefits of faster settlement, minimizing long-term deformation, and achieving more reliable outcomes in soft soil projects.

This session is ideal for geotechnical engineers, civil engineering students, and contractors involved in infrastructure development on challenging ground conditions.

Empoldering: A Sustainable Approach to Climate-Resilient Coastal Protection
By Dr. Muthusamy Karthikeyan

SPEAKER CV:

Dr. Muthusamy Karthikeyan is the Director of Coastal Engineering at Surbana Jurong Consultants Pte Ltd, Singapore, with extensive experience in geotechnical and coastal engineering. He holds a Ph.D. and a Master's degree in Geotechnical Engineering from the National University of Singapore and is a Chartered Engineer in Infrastructure. Dr. Karthikeyan has contributed to studies on the impacts of climate change on slope stability and played a key role in the design and construction of the Pulau Tekong Pilot Polder Development Project, along with several other major coastal projects. His areas of expertise include offshore site investigations, seabed characterization, ground improvement, empoldering design, and coastal engineering. He has received several awards, including the ASTM C.A. Hogentogler Award (2007), the Best Research Paper Award from the Japanese Geotechnical Society (2009), and the Outstanding Geotechnical Engineer Award (2024) from GeoSS for his contributions to the profession and industry. Dr. Karthikeyan represents Singapore on the ISSMGE Technical Committees for Land Reclamation (TC217), Ground Improvement (TC211), and Coastal and River Disaster Mitigation (TC303). He has been a member of the Geotechnical Society of Singapore (GeoSS) since 2008 and has served actively on its committee. He was the President of GeoSS for 2022–2023 and is currently the Immediate Past President.

SYNOPSIS:

Empoldering is an innovative engineering approach that enhances coastal resilience in low-lying, flood-prone areas. It involves constructing a ring of protective dikes around a designated zone and draining the enclosed area to lower its water level. By reducing the use of sand and other fill materials, empoldering offers a cost-effective and environmentally sustainable alternative to traditional flood protection methods. With rising sea levels and more frequent extreme weather events, empoldering provides a long-term solution for protecting vulnerable coastlines. Its adaptable design can respond to changing coastal conditions, offering reliable defense against tidal surges, heavy rainfall, and storm-related flooding. Effective implementation requires integrating key components—dikes, drainage channels, retention ponds, outfall structures, and pumping stations—into a coordinated water management system. Careful planning ensures that engineering design, spatial development, and operations function smoothly together. This seminar will present the engineering principles and practical applications of empoldering, demonstrating its value as a sustainable, climate-resilient strategy for coastal protection in the face of increasing environmental challenges.

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Geohazard Risk Assessment Using Machine Learning

By En Muhammad Joehan Bin Rohani

SPEAKER CV

M. Joehan Rohani obtained his Bachelor of Engineering in Civil Engineering from Queensland University of Technology, Australia in 1996 and Master of Science from University of Warwick, UK in 2006. He has over 25 years of experience in fields of Geotechnical and Structural Engineering. Specialising in offshore geotechnical engineering, he has also been involved in various research projects in the area of effect of shallow gas on soils, pile ageing effects, remoulded soil properties, lateral soils stiffness, predictive analytics, use of machine learning and remote sensing methods for geohazard assessment. Joehan has publised in more than 25 international and local conferences and holds IP on use of machine learning for geohazard assessment. He is a working member in the ISO Marine Soil Investigation, API-ISO WG10-Foundations and Standard Malaysia-Offshore Structures Technical Committee.

SYNOPSIS

There is an industry need to continue to improve means to measure geohazard risk to achieve reasonable accuracy in predicting geohazard impact to onshore structural assets. The effect of rain intensity and duration has been much researched in the context of understanding slope failures in Malaysia's context, however timely prediction of hydrological conditions triggering ground deterioration impact to structural assets remains challenging. An aspect of difficulty arise from the fact that the variables used i.e targeted terrain related parameters and structural strength/strain parameters to derive PR (Risk Index based on ISO 20074 – Geological Hazard Risk Management for Onshore Pipeline) predictions involved are numerous making conventional Geohazard Risk Scoring arduous. Also, uncertainties inherent in soil strength parameters, subterrain geological conditions, occurrences of external disturbances that are outside zone of concerns and various structural asset related parameters renders understanding interaction influences complex.

To further provide improved methodology for predicting geohazard impact to pipeline, Machine Learning capabilities were explored to develop a tool called IMGESA (Integrated Meteorological and Geohazard System Advisory) leveraging on probabilities method to assess terrain degradation that are impacted by rain intensity and its duration. Probabilistic algorithms were used to manage multitude of interactive soil and structure input variables to enhance understanding in predicting terrain and ground degradation that can impact structural assets.