REGISTRATION FORM

CCES CHINA AND IEM MALAYSIA
JOINT SOUTHEAST ASIA SYMPOSIUM & EXHIBITIONS ON THE CHALLENGES AND STRATEGIC SOLUTIONS OF HIGH PROFILE PROJECTS ON TUNNELS 2018 (SEASET2018)
18TH – 19TH SEPTEMBER 2018
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China Civil Engineering Society

IEM The Institution of Engineers, Malaysia

CCES CHINA AND IEM MALAYSIA JOINT SOUTHEAST ASIA SYMPOSIUM & EXHIBITIONS ON THE CHALLENGES AND STRATEGIC SOLUTIONS OF HIGH PROFILE PROJECTS ON TUNNELS 2018 (SEASET2018)

Organised by: China Civil Engineering Society (CCES) & The Institution of Engineers, Malaysia (IEM)

AN EVENT ENDORSED BY:

ITA AITES

Managed by: IEM Academy
(for inquiry please call +03-7931 5296 or visit www.iemasb.com)

Event Date: 18th – 19th September 2018

Time: 8.00 am – 6.30 pm

3 Coffee Breaks and 1 Buffet Lunch will be served in 5-Star Hotel!

Venue: Hilton Petaling Jaya, Kristal Ballroom 1, Level 1, West Wing, No. 2, Jalan Barat, 46200 Petaling Jaya, Selangor, MALAYSIA

BEM Approved CPD/PDP Hours: APPLYING
Ref. No.: APPLYING

Closing Date: 10th September 2018

IEM The Institution of Engineers, Malaysia

ITA-AITES WTC 2020 Kuala Lumpur, Malaysia

IEM IEM ACADEMY

REGISTRATION FEES (0% GST EFFECTIVE JUNE 2018):

Grade	Normal Fee (by fax & email)	Online Fee (Log-in IEMASB Website)
IEM/CCES Member	RM 950.00	RM 900.00
Non-IEM/CCES Member	RM 1,400.00	RM 1,350.00

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- ✓ Fee paid is not refundable. Registration fee includes lecture notes, refreshment.
- ✓ The Organizing Committee reserves the right to cancel, alter, or change the program due to unforeseen circumstances. Every effort will be made to inform the registered participants of any changes. In view of the limited places available, intending participants are advised to send their registrations as early as possible so as to avoid disappointment.

TENTATIVE PROGRAMME

Day 1: TUESDAY, 18TH SEPTEMBER 2018

08:00 – 08:30	Morning Breakfast & Scan-in Registration
08:30 – 09:30	Opening Ceremony
09:30 – 10:00	Networking and Tea Break
10:00 – 10:45	**Keynote Lecture 1**
10:45 – 11:30	**Keynote Lecture 2**
11:30 – 12:15	**Keynote Lecture 3**
12:15 – 13:15	Networking and Lunch
13:15 – 14:00	**Keynote Lecture 4**
14:00 – 14:45	**Keynote Lecture 5**
14:45 – 15:30	**Keynote Lecture 6**
15:10 – 15:40	Networking and Coffee Break
15:40 – 16:25	**Keynote Lecture 7**
16:25 - 17:10	**Keynote Lecture 8**
17:10 - 18:00	**Discussion**
18:00	End of Day 1

TENTATIVE PROGRAMME

Day 2: WEDNESDAY, 19TH SEPTEMBER 2018

08:00 – 09:00	Morning Breakfast & Scan-in Registration
08.10- 09.00	**Keynote Lecture 9**
09:00 – 09:45	**Keynote Lecture 10**
09:45 – 10:30	**Keynote Lecture 11**
10:30 – 11:00	Networking and Tea Break
11:00 – 11:45	**Keynote Lecture 12**
11:45 – 12:30	**Keynote Lecture 13**
12:30 – 13:30	Networking and Lunch
13:30 – 14:15	**Keynote Lecture 14**
14:15 – 15:00	**Keynote Lecture 15**
15:00 – 15:30	**Keynote Lecture 16**
15:10 – 15:40	Networking and Coffee Break
15:40 – 16:25	**Keynote Lecture 17**
16:25 -17:10	**Keynote Lecture 18**
17:10 -18:00	**Discussion**
18:00	Closure. Scan-out and Collection of Certificate of Attendance

INTRODUCTION

China ranks first in the world both in the number of tunnels and the speed of development. In 1979, China had only 374 road tunnels, with a total length of only 52 kilometers. By the end of 2001, that number had reached 1,782, in a total length of more than 700 kilometers, making China the country with the most tunnel and underground projects, the most complicated engineering and the fastest tunnel development in the world. By 2010, more than 155 kilometers of road tunnels will have been built in China. The 18.4-kilometer-long Zhongnan Mountain tunnel, which will pass through the Qinling Mountain range, will be the second longest in the world and the first in Asia. Many other mountain tunnels each with a length of 4-8 kilometers will also be constructed. Currently in 2018, China has 1.72 million kilometers of roads, including 200,000 kilometers of expressways. China ranks the world's second in expressway mileage, and the length will reach 230,000 kilometers by the end of 2018. Construction of road tunnels in Malaysia gained worldwide recognition as for the first time the SMART project, a dual purposes road tunnel was constructed for solving the drainage problem and traffic congestion in the business district of Kuala Lumpur.

The Joint Symposium was mooted to exchange experiences in tunnel construction industry in both Malaysia and China through the Institution of Engineers, Malaysia (IEM) and China Civil Engineering Society (CCES) respectively. Amongst the many tunnel projects to be presented in the symposium is the Hong Kong–Zhuhai–Macau Bridge (HKZMB) which is a Bridge–tunnel system, which consists of a series of three cable-stayed bridges and one undersea tunnel, as well as 3 artificial islands, spanning the Lingdingyang channel, that connects Hong Kong with Macau and Zhuhai, three major cities on the Pearl River Delta in the South China Seas. Construction cost: More than 100 billion yuan. Opening is scheduled for 1st July 2018. Construction ended on 14th November 2017 with total length of 49,968 metres.

The two days symposium will be held on 18-19 September 2018 in P J Hilton Hotel in Petaling Jaya in Selangor which is 10 km away from the City of Kuala Lumpur. The Joint symposium is the first of its kind to be held in the Institution of Engineers, Malaysia (IEM). There will be eight speakers from CCES and eight speakers from IEM. The Joint symposium is ITA endorsed event as part of the publicity of WTC2020 and 46th General Assembly to be held at the KLCC in Kuala Lumpur.

SYNOPSIS AND BIODATA

Representative Projects and Development Trend of Underwater Shield Tunnels in China

By: Xiao Mingqing

SYNOPSIS: In the 21st century, the underwater tunnels in China have been witnessing rapid development. A large number of projects both built and ongoing, give great opportunities for the development of underwater shield tunnel technologies in China and in the world. This paper summarizes the development history of underwater tunnel in China, and makes an presentation on technical challenges and breakthroughs encountered and achieved in built tunnels which are represented by Nanjing Yangtze River Tunnel and the Shiziyang Tunnel of Guangzhou-Shenzhen-Hong Kong High-speed Railway, as well as the characteristics and challenges of representative underwater tunnels under construction (Road-Railway Yangtze River Tunnel on Sanyang Road, Shiziyang Tunnel of Foshan ~ Dongguan Intercity Railway, Yangtze River Tunnel of Suzhou ~ Nantong UHV Power Transmission and Transformation Project) and to be constructed(Pearl River Estuary Tunnel on Shenzhen-Maoming Railway, Shantou Bay Subsea Tunnel on Shantou-Shanwei High-speed Railway, Nanjing Heyan Road Yangtze River Tunnel) in China. It also makes an overview on the development trend of China's underwater shield tunnels: 1) From single soft soil formation to the soil sand complicated formation. 2) From large diameter to super large diameter. 3) From medium water pressure to high and ultrahigh water pressure. 4) From conventional rock and soil to special rock and soil and unfavorable geological conditions. 5) From seismic regions with moderate intensity to those with high intensity. 6) From single construction methods to combination of multiple methods. This paper also puts forward the technical fields requiring further study and innovation and states that more efforts is demanded in the further enhancement and innovation of norms, codes, design, construction, equipment, materials and management.

BIODATA: **Dr Xiao Mingqing,** Ph.D., graduated from Southwest Jiao Tong University, major in bridge and tunnel engineering. Now he is assistant chief engineer of China Railway SIYUAN Survey and Design Group Co., Ltd, and his research achievements in the underwater tunnel have won the Second Award of the Scientific and Technological Progress in China three times (two items ranking first and one item ranking second). He won the title of National Master of engineering survey and design in 2016. Dr. Xiao presided over the design of the first batch of high speed railway tunnel with a total length of nearly 1000 kilometers and the standard design of the tunnel lining, new portal and buffer structure of the high speed railway tunnel with speed of 350 km/h, which contributed to the establishment of the high speed railway tunnel technology in China. Dr. Xiao also presided over the design and research of more than 40 underwater tunnels, formed a complete set of technology for the design of large diameter underwater shield tunnel with composite stratum, which greatly expanded the application scope of the shield tunnel. In the field of urban tunnel design, a large number of pioneering designs are carried out, including the Guangzhou–Shenzhen–Hong Kong High-Speed Railway tunnel, the first batch of China's first intercity railway (the Pearl River Delta Intercity railway and the Changsha-Zhuzhou-Xiangtan Intercity railway) and so on. In addition, he also chaired or participated in the National High Technology Research and Development Program of China (863 Program) and the National Key Research and Development Program of China.

The Technical Innovations and Practice in Island and Tunnel Engineering Works of Hong Kong – Zhuhai – Macau Bridge Project

By: Lin Ming

SYNOPSIS: Hong Kong – Zhuhai – Macau Bridge links Hong Kong, Zhuhai and Macau and is of total length above 50km with design life of 120 years and adopts design of combination of bridges, islands and one tunnel. This mega project due to its large scale is praised as one of the new seven major engineering miracles in the world. Hong Kong-Zhuhai-Macau bridge is featured with its mega scale, joint efforts of the Three Regions under two different systems and the construction of the immersed tunnel and artificial islands distinguishes as the most outstanding characteristic , which consists of two man-made islands at open sea with each island of 100000 m^2 areas and one 6.7km long immersed tube tunnel. The construction technique of immersed tunnel is a complex and comprehensive technique integrating workmanships of offshore marine engineering, marine works, underground engineering and tunnel engineering. The challenges to tunnel design and construction is extremely high. Nevertheless, the immersed tunnel of Hong Kong-Zhuhai-Macau Bridge Project has set four world records, namely the largest span, deepest embedment and greatest volume and weight of the immersed tunnel completed. The challenges faced by the constructors include such extreme conditions as the severe marine conditions at open sea, unique and great depth of embedment, deep and thick soft soil layers, deep water and deep trench, rigid and high demand on environmental protection, tight and challenging works schedule, the exceptionally difficult and risky design and construction techniques involved. In the process of tunnel construction, guided by new and innovative concept and ideas more than one hundred testing and studies have been conducted and completed which have given birth to more than 500 technical patent rights. Substantial breakthroughs in designs and construction techniques have been achieved and have reached leading level of the world. Brand new concepts and ideas on environmental protection were practiced on site with emphasis on low energy consumption by use of effective construction technique and workmanship and low disturbance to surroundings, resulting in better harmony and friendliness between the construction and the surroundings. The commitment on protection of Chinese White Dolphins has been effectively achieved which has won the attention of the world. This engineering project demonstrates the power and capability of China Highway Communication Construction and reflects the current status and future of China Highway Communication Construction. This article reviews the new technical achievements and evaluation generated in this great project and the technical achievements comprise technical breakthrough of rapid formation of man-made islands by deeply driven steel cylinder, accurate and fine dredging techniques, and deep water foundation techniques and immersed tunnel technique at open sea. The innovative techniques represented by rapid formation of islands by use of steel cylinder, semi-rigid immersed tunnel structure system and new typed closure joint of elements have completed and developed the constructional engineering systems of man-made islands at open sea and immersed tunnel and these new innovations are hoped to provide examples for similar forthcoming engineering works in the world.

BIODATA: **Prof. Lin Ming,** is chief engineer of China Communication Construction Company, general manager and chief engineer of Hong Kong-Zhuhai-Macao Island and Tunnel Project, and a professorate senior engineer. He completed many nation's model projects; he specialised in the field of the deep excavated trench, deep water foundation, immersed tunnel, large-scale roadway and bridge. He solved many difficulties and contributed many innovative outcrops, and broke many construction records in China or in the world scope.

Design Method of Support Structure for Underground Station with a Lot of Caves and a Large Span

By: Lu Gang

SYNOPSIS: Badaling Greatwall Station of Beijing-Zhangjiakou high-speed railway is a large underground station which consists of 78 caves with minimum horizontal spacing of 2.27m and the minimum vertical spacing of 4.55 m. The largest cave is a four-line tunnel with a span of 32.7 m, and excavated in the soft rock. A new method is presented to design the support structure of the station. This method regards surrounding rocks as an arch structure to design bolts, cables, sprayed concrete and lining in order to satisfy the intensity, rigidity and stability of the arch structure. This method attaches importance to the self-supporting of the rock arch. The lining designed by this method will be thin, economical and safe. A reasonable excavation contour line is helpful to improve bearing capacity of rock arch. The optimal excavation contour line appears when there is only axial force in the rock arch and the shear force disappears. The mechanical optimal excavation contour line is a vertical ellipse when vertical ground stress is more than horizontal ground stress, and it is a horizontal ellipse when vertical ground stress is less than horizontal ground stress, and it is a circle when vertical ground stress is equal to horizontal ground stress.

BIODATA: **Mr. Lu Gang** is a deputy chief engineer of CHINA RAILWAY ENGINEERING CONSULTING GROUP CO., LTD. (CREC) and the Director of the Tunnel and Underground Engineering Research and Development Centre of CREC. He was born in July 1976, and graduated from Beijing Jiaotong university with a master of engineering. He is currently the project chief engineer of Badaling Greatwall Station of Beijing-Zhangjiakou high-speed railway. He presided over the design of 24 sets of general drawings of China Railway Corporation, including Design drawing of support structure and portal for 160km/h ordinary cargo transport tunnels or 200km/h double layer container transport tunnels". He presided over the design of Baotou to Shenmu railway which is a 200km/h standard passenger and cargo railway, and Zhajiakou to Hohehot railway, Chongli Railway, and Beijing to Zhangjiakou railway which are high speed railways of 250 km/h.

Risk Analysis and Countermeasure Study of Shield Tunnelling at Karst Stratum in China

By: Zhong Changping

SYNOPSIS: In China, many cities have the experience of shield construction practice at Karst stratum, such as Guangzhou, Nanning, Changsha, Wuxi and Dalian. At the Karst stratum, there are many construction risks such as groundwater inflow, sand inflow, "discharge lag" of rocks or mud cake inside shield machine, surface subsidence, damage of cutter or cutter head of shield machine. Based on the analysis of the development mechanism of the Karst and the practice of the shield tunneling at the Karst stratum of Guangzhou and Nanning Metro, this paper deeply analyzes the main risks in the process of shield tunneling at Karst stratum including both "digging" and "discharging" phase, and puts forward six concrete countermeasures from the aspects of geological exploration, planning of the Metro line, pre-treatment of the Karst cave, shield equipment selection and arrangement, construction control and emergency

rescue, which provides significant guidelines for the shield tunneling at the similar Karst stratum.

BIODATA: **Dr. Zhong Changping,** is Vice General Manager and Chief Engineer of Guangzhou Mass Transit engineering Consultant Co. Ltd. He is Doctor of Tunnelling Engineering and Professorate Senior Engineer. He has been to France for studying shield tunnelling technique, and participated the technology import and negotiation work of Herrenknecht shield machine. He worked as chief supervising engineer in many Metro projects around China, and involved into the examination and approval work for the major construction plan of shield tunnelling project in many cities. He participated the international bidding and construction management of Guangzhou Metro Line 1 between Huangsha and Lieshilingyuan by shield tunnelling method, and he was appointed as the Chief Supervising Engineer of Shield Tunnelling Project of Chunfeng Tunnel, Shenzhen, China, in 2017. He attended the review and approval of Chinese code of Metro construction as expert in 2016. He works on Project management of Metro construction and Technology research of shield tunnelling, published more than 20 academic papers, and 5 monographs as chief editor or participant. He also attended many international academic conferences, and many papers were awarded. Dr. Zhong won the awards of the National Technology Advancement Prize, the silver prize of National Excellent Engineering Project and so on.

Design Management of Single Largest Underground Construction Contract in Malaysia – A Client's Perspective

By: Poh Seng Tiok

SYNOPSIS: Following the successful opening of the entire Klang Valley Mass Rapid Transit (KVMRT) Line 1 in July 2017, Malaysia continues to embark on the construction of KVMRT Line 2 which stretches from Sungai Buloh to Serdang and ends at Putrajaya for a length of 52.2km, of which 13.5km is underground tunnels with 10 new underground metro-stations. The reference design for the underground works started in early 2015 and the design and build contract was eventually awarded as single underground work package, set to be the largest underground construction contract in Malaysia. Like all other metro stations/ tunnels designed as part of the underground urban city, the KVMRT Line 2 underground construction faces challenges from a technical (engineering design and construction) as well as social (environmental and land related) point of view. Needless to say, underground construction in Klang Valley is intensified with the inherent challenges presented by difficult ground conditions ranging from hard granite, heterogenous Kenny Hill formation and extreme karstic limestone with fully developed weathered profiles to soft recent deposits including alluvium and mine tailing that is under-consolidated in places due to past mining activities. Ground subsidence/ sinkholes resulted from the underground excavation and tunnelling works in karstic formation has been encountered in past projects in Klang Valley. The key is how to manage the multidisciplinary underground works design effectively and efficiently commencing from the ground investigation, alignment planning, architecture and engineering design, interface management, etc. within an accelerated timeframe to enable timely construction implementation. Hence, management of design has to be carried out in accordance to the approved guidelines and good engineering practices in order to meet the overall design objectives, quality and safety within the allotted project timeframe. The KVMRT design criteria and design objectives will be firstly presented. Focusing on the geotechnical design management, this presentation will outline some geological challenges along the underground alignment of KVMRT Line 2, ground investigations make use of the advances in engineering geophysics to highlight the areas of potential ground risks in facilitating detailed investigation, use of digital engineering tools and workflow (Building Information Modelling and Geographical Information System) to boost the design coordination and productivity. Strategic measures adopted to address some of the geotechnical challenges and risk management are briefly discussed. Looking ahead, the KVMRT project has not only opened up tremendous underground works and new frontier for underground space engineering in Malaysia, but it is tempting to potentially revise and re-purpose geological knowledge-base of underground Kuala Lumpur armed with the wealth of subsurface information as well as the unique geotechnical accomplishments and experience to be gained from this remarkable underground construction.

BIODATA: **Er. Poh Seng Tiok** has more than 20 years' experience in large scale mass transit, railway design and construction projects in Singapore, Hong Kong, Malaysia and other parts of Asia. Currently, he is the Planning and Design Director for Mass Rapid Transit Corporation (MRTC) in Malaysia, implementing the MRT projects in Kuala Lumpur. He manages the MRTC design group covering disciplines such as Architectural, Civil & Structural, Alignment, Geotechnical & Tunnels, Interface Coordination, Digital Engineering - BIM/GIS, Programme & Planning, Transport Planning, Land Survey and Development Building Control. He leads the multi-disciplinary team in supporting the implementation of the KVMRT Line 1 of 51km railway as well as KVMRT Line 2 with 52.2km of railway. Concurrently, he also leads in the Engineering Feasibility and Reference Design phase of the upcomming 40km KVMRT Line 3, which is a circle line connecting all the radial MRT lines and other forms of public transport. Prior to joining MRTC, he held senior positions in international Consultancy firms involving in major metro projects in Singapore and Hong Kong. Before 2008, Seng Tiok worked in the Singapore Land Transport Authority (LTA) and was involved in almost all the major railway projects in Singapore such as Down Town Line Stage 1, Circle Line stage 1 to 5 and North East Line.

Advances in Tunnel and Underground Construction Technology

By: Leslie J. Pakianathan

SYNOPSIS: Tunnels are constructed to serve several purposes such as road and rail transport, transfer of fresh and waste water, routing of power and other utility services as well as storage of storm water and hydrocarbons ventilation. With the continued growth of population in the cities, it is becoming increasingly cost effective and sustainable to exploit the underground space for many purposes. At present tunnelling is being pursued in many countries around the world and rapid advances in technology are being achieved in terms of both hardware and software. The presentation will cover recent advances in tunnelling and underground construction technology. It will address a range of topics such as site investigation, risk management, tunnel linings, tunnel boring machines as well as instrumentation and monitoring of tunnelling projects.

BIODATA: **Mr. Leslie J. Pakianathan** has been engaged in the planning, design and construction of tunnels since 1986. At present he is Project Director with Changi Airport Group overseeing construction of tunnels for road, rail, automated people mover & baggage handling systems and common services. From his experience of working with clients, contractors and consulting engineers covering procurement, construction supervision, project management to commissioning of tunnels, he has been able to participate in different aspects of the construction of structures underground. Prior to current appointment, Leslie has contributed to high priority tunnelling projects such as the Victoria Dam hydroelectric project in Sri Lanka; Channel Tunnel, Jubilee Line Extension, Heathrow Express Railway and Cross Rail project in the UK; Harbour Area Treatment Scheme Stage 1 in Hong Kong; North South Expressway, MRT and Cable Tunnel projects in Singapore. He is an Alumni of the Imperial College of Science and Technology and Medicine, UK and a Fellow of the Institution of Civil Engineers (CEng FICE), UK.

Three-dimensional Interaction Mechanisms: Twin Tunnels and Pile Foundation; and Basement Excavation and Existing Tunnel

By: Charles W.W. Ng

SYNOPSIS: In densely populated urban cities such as Shanghai, London and Singapore, the use of tunnels and basements has become an effective means to increase the use of underground space, to reduce congested traffic and minimize adverse environmental impacts. Construction of an advancing metro tunnel is not uncommon to encounter existing underground structures such as pile foundations. Either the construction of tunnels or the excavation of basements will inevitably induce stress changes in the ground. These stress changes may affect the capacity and deformation of the existing adjacent pile foundations (i.e., tunnel-pile interaction) and also induce adverse basement-tunnel interaction effects. Relatively limited research work on these two types of interaction has been reported in literature. In the first part of the lecture, three-dimensional interaction mechanism between advancing twin tunnels and existing adjacent pile foundations will be explored. Results from a series of three-dimensional centrifuge model tests and numerical back-analyses conducted will be reported and described. Moreover, the effects of the construction sequence of twin tunnelling on an existing pile will be explained. In the second part of the lecture, the fundamental interaction mechanisms between a new basement and an existing tunnel in sand will be investigated three-dimensionally. Results of dimensional analysis, three-dimensional centrifuge tests and numerical analyses will be reported, including the influence of the location of the existing tunnel, sand density and retaining wall stiffness. Design implications of these two types of interaction mechanisms will be highlighted and explained.

BIODATA: **Professor Charles W.W. Ng** is currently the CLP Holdings Professor of Sustainability, Chair Professor in the Department of Civil and Environmental Engineering and Associate Vice-President for Research and Graduate Studies at the Hong Kong University of Science and Technology (HKUST). He is a Chartered Civil Engineer (CEng) and Fellow of The Institution of Civil Engineers (FICE), United Kingdom (UK). He is the President of International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). Professor Ng obtained his MSc and PhD degrees from the University of Southampton and the University of Bristol in the UK in 1987 and 1993, respectively. After carrying out a period of post-doctoral research at the University of Cambridge between 1993 and 1995, he returned to Hong Kong and joined HKUST as Assistant Professor in 1995 and rose through the ranks to become Chair Professor in 2011. Professor Ng has supervised 46 PhD and 41 MPhil students to graduation and mentored dozens of postdoctoral fellows and visiting scholars. Professor Ng was elected an Overseas Fellow from Churchill College, Cambridge University, in 2005 and was elected Changjiang Scholar (Chair Professor in Geotechnical Engineering) by the Ministry of Education in China in 2010. Also he was elected as a Fellow of the Hong Kong Academy of Engineering Sciences in 2008. Currently, he is an Associate Editor of the Canadian Geotechnical Journal. Professor Ng has published some 270 SCI journal articles and 230 conference papers and delivered more than 50 keynotes and state-of-the-art reports in five continents. He is the main author of two reference books: (i) Soil-structure Engineering of Deep Foundations, Excavations and Tunnels by Thomas Telford and (ii) Advanced Unsaturated Soil Mechanics and Engineering by Taylor & Francis. He has received many awards including the 2017 Telford Premium Prize from the Institution of Civil Engineers, the Henry Adams Award from the Institution of Structural Engineers, the first Tan Swan Beng Award from the

Southeast Asian Geotechnical Society, and the R. M. Quigley Award from the Canadian Geotechnical Society three times for his three best papers published in 2007, 2012 & 2017. He was conferred the Mao Yisheng Youth Award by the Chinese Institute of Soil Mechanics and Geotechnical Engineering for his significant contributions in Geotechnical Engineering over the years. He was one of the recipients of the 2nd Prize of 2015 Scientific Technological Advancement Award by the State of China. Recently, he has delivered the 2017 Huangwenxi Lecture on "Atmosphere-plant-soil-interactions: theories and mechanisms", which is the most distinguished named lecture in geotechnical engineering in China.

A Leap in Tunnel Boring Technology; the Variable Density Slurry TBM

By: Gus Klados

SYNOPSIS: The author describes the complex geology of the Sungai Buloh – Kajang (SBK) MRT Line tunnels mostly located under and around the most expensive real estate in downtown KL, where significant subsidence induced by tunnelling were just not acceptable. The stringent demands of circumstances forced the development of a new tunnel boring technology to be used, more suitable to handle mixed face conditions in karst and remain usable in the Kenny Hill Formation, the other prevailing ground condition in the alignment. The new machine configuration allowed five different operational modes, only one of them requiring a 'simple' physical conversion to EPB configuration since some of the planned drives in the SBK Line had to pass the transition area from KL Limestone to the Kenny Hill Formation, where the EPB method is the obvious choice. The designated supplier of the TBMs, Herrenknecht, together with the contractor MMC Gamuda JV developed the new technology and named it the Variable Density Slurry or Mixshield TBM. Notable of the cooperation and trust of the partners that MMC Gamuda took the risk of ordering six Variable Density Slurry TBMs (VD TBMs) of the drawing board for the project. The author demonstrates the success of the said VD TBMs in use on the KVMRT SBK Line. The selection of the right technology allowed the contractor to complete the tunnels within budget and on schedule.

BIODATA: **Mr. Gus Klados** is the Director, Tunnels for the Underground Works Package Contractor MMC Gamuda KVMRT (T) Sdn. Bhd. for the Sungai Buloh – Serdang – Putrajaya (SSP) Line and has been the Project Manager for the Sungai Buloh – Kajang (SBK) Line in Kuala Lumpur. Gus has forty-five years' experience in tunnelling and related construction worldwide on major infra-structure projects out of which twenty-four years in South- and South-East Asia. He started his professional life in Budapest on the M2 and M3 metro lines. His first foreign assignment was in Belgrade, then in Yugoslavia on the Vračar rail tunnel. Gus spent altogether 7 years in India on the Calcutta- and Delhi Metros. Later Gus worked in England on the Channel Tunnel, in South Africa on the Lesotho Highlands Water Project, in Greece on the Athens Metro Lines 2 & 3, in Singapore on the Deep Tunnel Sewer System, in Malaysia on the SMART project, always as contractor in managerial positions. For a real change Gus returned to Hungary, his native country, after 28 years of absence as project director of the Client on the Budapest Metro M4 Line. He was recalled to Kuala Lumpur in March 2011 to assist the MMC Gamuda JV to tender for, win and construct the underground works contract for the SBK Line and recently for the SSP Line, the first and second MRTs or heavy metro lines in the Klang Valley in Malaysia.

Review of Interfaces between Railway Infrastructures and Adjacent Developments, Singaporean and Malaysian Perspectives

By: ONG Chee Wee, Victor

SYNOPSIS: This age of rapid urban growth calls for the need of rapid transit systems. In the past decades, Singapore had seen major developments in its rapid transit system interconnectivity, with Kuala Lumpur gaining quickly on Singapore with its cutting-edge construction techniques. In light of that, shrewd land and property owners are jumping on the rapid transit bandwagon to develop "rail-linked projects" which interfaces with the rapid transit systems. Therefore, it is essential to understand the requirements and challenges in carrying out the design and construction in order to comply with the Railway Authority requirements and ensuring the safety of the public. This presentation will discuss the requirements of the railway protection codes of Singapore and Malaysia, and present on various case histories. Myriads of challenges are overcome in order to successfully integrate the rail infrastructures and buildings. Hence, this presentation will also highlight the various challenges encountered and how these challenges were resolved.

BIODATA: **Ir. Er. Dr. ONG Chee Wee, Victor** is the Managing Director of ONE SMART Engineering (Malaysia & Singapore) Sdn. Bhd. He is a PE (Civil) registered with the Board of Engineers Malaysia, ASEAN Chartered Professional Engineer, APEC International Professional Engineer (APEC Eng), and Fellow of The Institution of Engineers Australia (FIEAust). He is also a Specialist PE (Geotech) as well as PE (Civil) registered with Professional Engineers Board (PEB), Singapore. Dr Ong is registered with the Institution of Engineers Singapore (IES) as a qualified Active, Beautiful, Clean (ABC) Waters Professional, and also as a Design for Safety (DfS) Professional. He obtained his PhD in Geotechnical Engineering from the National University of Singapore (NUS). Dr. Ong is currently serving on two International Technical Committees for International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE) - Technical Committees TC 207 on Soil-Structure Interaction and Retaining Walls and TC 212 on Deep Foundations. Dr. Ong is also serving as Technical Committee of Asian Technical Committee (ATC-6) "Urban GeoEngineering". He was recently elected as SPRING Singapore Technical Committee for The Standards Council (Civil & Geotechnical Works). Dr Ong is also serving as the 2nd Vice President & Fellow of Singapore Institute of Building. Dr. Ong is a recipient of Best Contribution Award in Asian Young Geotechnical Engineers Conference.

Challenging Geological Conditions in Kuala Lumpur and Its Impact to Underground Space Developments

By: Ng Chew Chiat, David

SYNOPSIS: The karstic limestone of Kuala Lumpur is notorious for its erratic profile, strength and uniformity. It has posed great challenges to the design and construction of foundation to buildings, deep excavation projects, and in the recent "gold rush" of rapid transit infrastructure developments, underground train stations and tunnelling works. It is therefore very important for engineers and asset owners alike to understand the karstic limestone conditions and thus exercise due diligence in the design and construction. In this paper, the nature and engineering properties of limestone will be shown and the challenges due to the karstic limestone for geotechnical problem will be discussed. In particular, tunnelling in limestone can be a nightmare if control measures are not implemented properly. This presentation will also show the various case histories of tunnelling in Kuala Lumpur and the lessons learned.

BIODATA: **Er. Ng Chew Chiat, David** is the Executive Director of ONE SMART Engineering Pte Ltd which has offices operating in Singapore and Malaysia. He is a Specialist Geotechnical PE registered with Singapore PEB. He graduated in 1999 with a Master's Degree in Geotechnical Engineering from NUS where he received the Innovation Award and NSTB Gold Award for his outstanding academic results and research work. In 2000, he was awarded the First Prize of the prestigious Hulme's Competition by the Tunnelling & Underground Construction Society of Singapore for his technical paper in tunnelling. In 2013, he has received the Young Consulting Engineer Award 2013 by the Association of Consulting Engineers of Singapore (ACES). He has published more than 50 technical papers in the field of geotechnical engineering. He has been involved in the design, supervision and project management of major infrastructure projects in Singapore with deep excavation, mined tunnels and bored tunnels in Deep Tunnel Sewerage System, Kallang Paya Lebar Expressway, North East Line, Circle Line, Downtown Line and Thomson East Coast Line during his past 20 years of working experience. Er. David Ng is the Qualified Person (Civil) and Qualified Person (Geotechnical) of Supervision for Thomson East Coast Line (TEL) Contract T220 Great World City Station and Tunnels and Contract T221 Havelock Station. Under Er. Ng's leadership, ONE SMART Engineering was conferred by the Institution of Engineers, Malaysia (IEM) the prestigious IEM Award for Contribution to Engineering Industry in Malaysia 2018 for its contribution to Consulting Engineering Practice.

The Challenges of Diaphragm Wall Construction in Complex Geology

By: Ooi Lean Hock

SYNOPSIS: The Sungai Buloh-Serdang-Putrajaya (SSP) Line traverses through a stretch of highly complex geology. The complex geology for the purpose of this paper is deemed to be the interfaces between geological boundaries, faults, weathering patterns and lithology that deviates from common expectations. The depth to limestone bedrock for some of the stations located in the complex geology section is found to be relatively deep. Hence the option of using diaphragm walls as the retaining structures both under temporary and permanent conditions become plausible and an attractive options.

However, it is not uncommon that most designers will avoid the use of diaphragm wall in limestone in view of the variability and uncertainties normally associated to limestone. This talk presents the challenges associated to the construction and design of diaphragm wall construction in complex geological conditions. The dynamic nature of the subsurface conditions and the influence of probing and investigation methods including pre-treatment works prior to diaphragm wall construction are briefly discussed. Some of the possible measures that have been undertaken to complete the diaphragm wall with the intention to ensure safety and to minimise the potential impacts of the works to third party properties will also be presented.

BIODATA: **Ir. Dr Lean Hock OOI**, graduated with PhD from University of Sydney, Australia. In the past he has worked as a geotechnical consultant and a specialist contractor. He is currently the lead geotechnical engineer in the Design and Technical Department of MMC GAMUDA KVMRT (T) Sdn Bhd for the second line of Klang Valley Mass Rapid Transit from Sg Buloh-Serdang- PutraJaya (SSP) line. He has extensive experience in ground treatment works, more recently in deep excavation and tunneling works. He also has a keen interest in geotechnical instrumentation and testing. He has been involved in many interesting infrastructural projects such as railways, runways, highways, tunnels and hydropower both locally and abroad.

Ground Response Due to Underground Construction and Impact to 3rd Party Structures

By: Boon Chia Weng

SYNOPSIS: The construction of underground works consisting of station excavations and tunnelling in an urban environment requires the impact to 3rd party structures located within the influence zone to be assessed and, if required, protected. Methods of impact assessments are discussed, including insights obtained from finite element analyses and recent theoretical developments based on load transfer analyses for structures founded on piled foundations, made jointly with Dr Ooi Lean Hock. Furthermore, the type of risks to 3rd party structures varies with the geological formations through which these underground works have to be constructed. Discussions are largely based on the Kenny Hill Formation and the Kuala Lumpur Limestone Formation in Kuala Lumpur. Appropriate preventive measures to minimize impact to 3rd party structures are discussed.

BIODATA: **Dr Boon Chia Weng** is now working with MMC-Gamuda KVMRT(T) Sdn Bhd on the underground works package of the Sungai Buloh-Serdang Putrajaya Line of the Klang Valley Mass Rapid Transit Project (KVMRT), and previously on the Sungai Buloh-Kajang Line. Boon is experienced in deep excavations, tunnelling, ground improvement, site investigation and building impact assessment for underground works in both residual soil and rock, where recent theoretical developments are made jointly with Dr Ooi Lean Hock. Boon read civil engineering at Nanyang Technological University and graduated in 2009, after which he pursued a career in geotechnical engineering. In 2016, he was awarded the Rocha Medal Award by the International Society for Rock Mechanics (ISRM) for his doctoral thesis at Oxford University submitted in 2013, and he has given invited lectures at Turkey (EUROCK 2016), Spain (GEORAMP), Korea (Seoul National University) and the Geological Society of Malaysia. He was nominated and elected as a future leader member of the American Rock Mechanics Association (ARMA) in 2017. In 2009, he was awarded the Lee Kuan Yew Gold Medal and Professional Engineers Board Gold Medal in Singapore. Boon is now a member of the Geotechnical Engineering Technical Division of The Institution of Engineers, Malaysia.

Challenges and Advances in Tunnelling in Malaysia

By: Ooi Teik Aun

SYNOPSIS: Tunnelling in Malaysia can be attributed to the successful implementation of the SMART project started in 2003 by Dr Mahathir administration to solve the problem of frequent flooding of the Kuala Lumpur Business District. Kuala Lumpur also faces traffic congestion which is made worse each time there is a heavy downpour. In order to solve the flooding and traffic problems a dual purposes tunnel was adopted together with a holding basin to contain the water from upstream catchment. This water during heavy rainstorm is diverted from the City Centre using the SMART Tunnel as a by-pass. The challenges faced by the construction of the tunnel is in the treacherous Kuala Lumpur Limestone Formation where sinkhole formation poses great threat to the roads above the route of the tunnels. The other factor that spur the growth of tunnels in Malaysia is the shortage of water supply in Kuala Lumpur and the Klang Valley areas which is undergoing rapid urbanization. The construction of an interstate water transfer tunnel from Karak in Pahang and Ulu Langat in Selangor through the Main Mountain range of Titiwangsa in the granite formation also faces great challenge due the rock burst and ground water issues. This project started soon after the completion of the SMART tunnel. The commencement of the SBK MRT line 1 in 2011 marked the start of major tunnelling activities in Kuala Lumpur city centre. This paper will discuss the challenges and advances achieved in the course of planning, design and construction of tunnellling related to railway transport in Malaysia and the impact of China's Belt and Road initiatives in the tunnelling activities in Malaysia.

BIODATA: **Ir. Dr. Teik Aun Ooi** obtained his Bachelor of Civil Engineering and Master of Engineering from Auckland Universiity in 1966 and 1968 respectively. He obtained his PhD from University of Sheffield in 1980. He was the Co - Organizing Chairman of the recently concluded SEAGC2016. He is the immediate Past President of the Southeast Asian Geotechnical Society (SEAGS), Founder Chairman of the Association of Geotechnical Societies in Southeast Asia (AGSSEA).

He is a Past President of the Malaysian Institute of Arbitrators (MIArb). He is the Immediate Past ICE Country Representative for Malaysia (2000 - 2015), Founder Chairman of IEM Tunnelling and Underground Space Technical Division (TUSTD), Founder Chairman of IEM Consulting Engineering Special Interest Group (CESIG), He is an Honorary Fellow of The Institution of Engineers, Malaysia (Hon. FIEM), Fellow of the Institution of Civil Engineers (CEng FICE), Fellow of the MIArb (FMIArb), Fellow of Malaysian Society of Adjudicators (FMSA) and Fellow of Asean Academy of Engineering and Technology (FAAET). Dr. Ooi has fifty years of experience in the Construction Industry. He spent his initial fourteen years with the Public Works Department Malaysia before leaving to work in the private sector where he spent seventeen years working in the construction sector. He play major role in the Johore Baru Causeway widening and the design and construction of Senai Airport in 1970s. He was the Project manager for the Wisma Saberkas Building Project in Kuching in 1980s. He was Project Director for the Design and Construction supervision of the New Kuching Deep Water Port at Kampung Senari in 1990s. He started his consultancy practice in 2000 specialising in Civil and Geotechnical Engineering works. Dr. Ooi is a practicing Consulting Engineer, An Expert Witness in Court and in Arbitration, An Accredited Checker, An Arbitrator and An Adjudicator. He is a member of the Accredited Checker Committee of the Board of Engineers, Malaysia. Dr. Ooi devoted much of his time in honorable public service in continuing education of engineers and development of Malaysia Annexes for Eurocode 7 and 8. He is an independent executive director of IEM Training Centre Sdn Bhd since 1992. In 2013 he was appointed executive director of the IEM Academy Sdn Bhd. He has been Organizing Secretary and Chairman of numerous IEM Workshops, Seminars, and Conferences since 1970s. He was responsible for forming five active ICE Student Chapters in Universities in Kuala Lumpur. Dr Ooi conducted touring lectures in geotechnical engineering to Malaysia, Vietnam, Thailand, Cambodia, Laos, Myanmar and Philippines. In Malaysia he was invited to deliver the prestigous 19th Professor Chin Fung Kee Memorable Lecture in 2009. He frequently delivered lectures to the final year University engineering students. He is currently the Organizing Chairman of WTC2020 and Executive Council Member of ITA. He is also the Deputy Chairman of TUSTD.

How Innovative Engineering Equipment Promotes Underground Space Development

By: Zhiguo Zhang

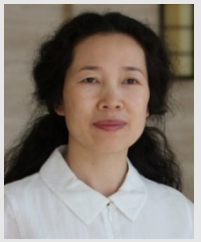
SYNOPSIS: With the rapid development of urban underground space, integration of above-ground and underground space development faces new challenges. Public focus now shifts to innovative technology and engineering equipment that fits the environmentally-friendly, safe and cost-effective development trend. The presentation will discuss the application of innovative engineering equipment on the ground of case studies of underground space development. The future prospects of these technologies and innovations are also touched upon in this presentation.

BIODATA: **Mr. Zhiguo Zhang** is the Deputy General Manager of China Railway Engineering Equipment Group Co., Ltd. (CREG) as well as the Senior Engineer and Chief Economic Manager. He graduates from Southwest Jiaotong University and his major is Mechanical Engineering and Automation. Mr. Zhang has been the Chief Mechanical Engineer of Fourth TBM Company of China Railway Tunnel Stock Co., Ltd. during which period he accumulated rich tunneling construction experience. While he was serving as the Chief Engineer of CREG, Mr. Zhang was in charge of the R&D and manufacture of different types of TBMs. He is a well-known TBM expert with nearly 20 years of professional experience. Mr Zhang has published numbers of technical papers & writings on TBM tunnelling journals at national levels.

Key Components and Comprehensive Information System of Tunnel Construction

By: YAN Jinxiu

SYNOPSIS: Ground, action (construction) and response (deformation) are three key components of tunnel construction, which are interacting each other during construction. The informatization of these components and the establishment of comprehensive information system are important for better tunnel construction in the future. At present, the automatic geological prediction system, the application of BIM to tunnel design and construction as well as the monitoring and measuring system have been applied in some major tunnelling projects. However, only by establishing the comprehensive information system which contains three key components can the relevant analysis be carried out and the effective information management of tunnel construction be realized. The comprehensive tunnel construction information system can not only achieve data sharing, greatly improve the efficiency and quality of construction management, but also form a comprehensive and systematic raw data for documentation. In recent years, the development of GIS and BIM technology facilitate the establishment of comprehensive tunnel construction system. The presentation introduces the three key components and their interaction during tunnel construction, geological prediction system, BIM application to design and construction, monitoring system as well as the establishment of comprehensive information system of tunnel construction in the future.



BIODATA: **Professor YAN Jinxiu** is currently the Vice President of the International Tunnelling and Underground Space Association(ITA); Vice President of the Chinese Tunneling and Underground Works Society and Deputy General Manager of China Railway Academy Co., Ltd. Prof. YAN has worked as consulting engineer for many major tunnel projects for more than 30 years. In the past 5 years, she has delivered nearly 20 international Keynotes or lectures in Asia, Europe, America and Middle East. As research team leaders or experts appointed by the governments or the project owners, she have been involved in the construction of many major railway, highway tunnels and metro projects as well as long subsea tunnels in China. Recently, she has been working on optimization of support structure, information system and application of new material for some major metro projects. Prof Yan has won China Women's Model Awards 2017; the Winner of 2012 China Economic Female Entrepreneur Figures; Expert for enjoyment of China State Council Special Allowance for Outstanding Contribution to Engineering in 2011; Winner for the 5th Talent Prize of China Zhantianyou Development Foundation for Railway Science and Technology in 2008 as well as Winner for Tip-top talent by the Ministry of Railways, P.R. China in 2000.

Construction Technologies for Gaoligongshan Tunnel on Dali-Ruili Railway

By: Hong Kairong

SYNOPSIS: With a total length of 34.5km, Gaoligongshan Tunnel on Dali-Ruili Railway is currently the first ultra-long single-track railway tunnel under construction in China, using hard rock Tunnel Boring Machine (TBM) and drilling-blasting method for construction. This tunnel has a special geographical location and complex geological conditions, i.e., high ground temperature, high ground stress, and high seismic intensity, as well as active neotectonic movement, active geothermal water environment, active externally-driven geological conditions, and active bank slope surface reconstruction. Base on the comprehensive analysis of difficulties in construction, the in-depth analysis of the key technologies for tunnel construction will be made in this presentation, mainly including adaptability of key TBM parameters to different grounds, technologies for excavation of weak and variable cross-section tunnels with large deformation by TBM, technologies for prevention and control of high ground stress and rockbursts, technologies for adaptability of fast tunneling by TBM in fractured ground, technologies for TBM tunneling environment protection in ground with high ground temperature, construction technologies of deep shaft and treatment technologies for water Inrush.

BIODATA: **Mr. Hong Kairong**, graduated from Beijing Jiaotong University, majoring in Bridge and Tunnel engineering, with a Ph.D. degree and a professor-level senior engineer. Currently, he is Chief Engineer of China Railway Tunnel Group Co., LTD, Director of State Key Laboratory of Shield Machine and Boring Technology, Standing Director and Secretary General of China Civil Engineering Society Tunnel and Underground Engineering Branch, Standing Director of China society of rock mechanics and engineering, Deputy Director of editorial Committee of Tunnel Construction journal. Mr. Hong Kairong is mainly engaged in the research and practice of various types of tunnel engineering construction technology, has participated in the construction of nearly 100 tunnels of more than 10 railways in China, and has undertaken and completed a number of national scientific research projects, such as, " National High-Tech Research and Development Program of China (863 Plan) ", " Supported by the Major State Basic Research Development Program of China (973 Program) t". He has published 8 monographs and published more than 40 papers. He has many patents for inventions, 1 first prize and 2 second prize for scientific and technological progress of the state, 2 first prize for scientific and technological progress of Henan province, 1 second prize and 1 third prize for scientific and technological progress of China railway society, and 1 first prize for scientific and technological progress of China construction. In 2015, he was selected as the "young and middle-aged expert with outstanding contribution" of the national millions of talents project, and in 2016, he was named the leader of the national special support plan for high-level talents and the national labor model in 2012. Also won the seventh national Zhan Tianyou youth award, the ninth Zhan Tianyou achievement award, the thirteenth Zhan Tianyou prize. Since 2007 to enjoy the special allowance of the government of the state Council.

Construction Experience of Long Large Tunnels under Complex Geological Conditions in Southwest Mountainous Area in China

By: Chen Debin

SYNOPSIS: Infrastructure construction in China has been developed greatly since the beginning of this century. China has a vast territory, mountainous area and complicated geological conditions. As the adoption of higher technical standards in traffic engineering and water conservancy and hydropower projects, the proportion of tunnel projects has greatly increased. We now have successful experiences in construction of the complex and difficult tunnel projects that has been a huge challenge in the past. Some technologies are the key factors in the long, large, complex and difficult tunnel construction. It is necessary to share the successful experience and hope that it could be used for reference in the future. China Railway No.5 Engineering Group Co., Ltd. (CR5) has accumulated rich successful experiences during completion of 1340km tunnel in the past ten years, including 20 complex difficult tunnels with a length of more than 10km each. This presentation will discuss successful completed tunnel projects under complex geological conditions， such as karst, large deformation, and harmful gases. Hopefully these experiences could be helpful in the construction of tunnels under similar complex geological conditions in Asia.

BIODATA: **Prof. Er. Chen Debin** is the Chief Engineer of China Railway No.5 Engineering Group Co., Ltd. He obtained his bachelor's degree in engineering from the Southwest Jiaotong University of China in 1984. Since then, he has been working in CR5 in tunnel engineering technique and management. In the 1980's, as one of the earliest participants, he engaged himself in promotion of NATM in China. In the 1990's, he participated in construction of two famous railway projects in China: Nanning-Kunming Railway and Neijiang-Kunming Railway. These two railway projects, featuring with tremendous complicated tunnel works outstood other projects in China at that time. During construction of these tunnels, Pro. Chen perfectly solved a series of technical and management problems, and achieved remarkable results, and was recommended to be the young science and technology talent of the former Ministry of Railways of China because of his contributions. Since the beginning of this century, Pro. Chen has participated in construction of many complicated tunnels in famous railway projects, as well as hydropower and water conservancy projects, urban metro projects, and other engineering fields in China. In the past ten years CR5 has undertaken construction of tunnels 1340km, including 20 complex difficult tunnels with a length of more than 10km each, some of them are very famous in China because of technical and construction difficulties. As the Chief Engineer of CR5, Pro. Chen has led and presided over construction of these projects, and solved many difficulties in technology and management, and made positive contributions. Pro. Chen is now one of the directors of Tunnel and Underground Works Branch of China Civil Engineering Society, and has rich experiences in the field of tunnel engineering construction.

Geotechnical Challenges in the Design and Construction of Singapore Land Transport Underground Infrastructure

By: Jeyatharan Kumarasamy

SYNOPSIS: Due to the limited land space in the small island state of Singapore most of the land transport infrastructure are increasingly being planned and built underground. Unfortunately, the geology varies significantly within this small land mass which poses more difficulties for the underground construction in Singapore. All major Mass Rapid Transport (MRT) structures and road structures such as underground expressways and underpasses designed and constructed for the last 20 years in almost all different types of geology experienced several challenges during the design and construction. In order to understand and appreciate the major geotechnical challenges, the paper first highlights the various geological formation in Singapore and their various stages of weathering as well as their geotechnical characteristics. However, the most importance aspect in preventing major risks is to conduct adequate site investigation to characterise the ground condition. The challenges and difficulties in providing adequate ground information are also highlighted and how they were overcome. Construction challenges would differ depending on the construction methods as well as the construction sequences. Various construction methods such as cut and cover methods, mechanised and mechanised tunnelling methods, etc. are being adopted for the construction of Singapore underground land transport infrastructures depending on the size of the structure, ground condition and constraints at site. Typically, most of the MRT stations and wide tunnels, such as road tunnels, are constructed using cut and cover methods whereas most of the MRT tunnels are constructed using the tunnel boring machines. Several smaller length tunnels such as cross passages are constructed by conventional tunnelling methods such as NATM method. Challenges in both tunnelling as well as deep excavation works are presented in this paper. The paper also provides the adopted mitigation measures in the design and construction to minimise and mitigate the identified risks in different construction activities.

BIODATA: **Dr. Jeyatharan Kumarasamy (Jeya)** obtained his bachelor degree in Civil Engineering with First Class Hons from Peradeniya University, Sri Lanka in 1985 and a PhD degree in Soil Mechanics from Cambridge University, UK in 1991. He has over 25 years of research, design, construction and teaching experience in Sri Lanka and Singapore in the field of geotechnical engineering, including deep excavations, soil improvement, deep foundations, numerical analyses, slope stabilisation, instrumentation and monitoring, and site investigation works. Jeya has been working with design consultant firms including Parson Brinckerhoff Pte. Ltd and Arup (Singapore) Pte Ltd for more than 10 years on major infrastructure including MRT North-East Line, and commercial projects such as Marina Bay Sands. Over the last 15 years he has been working with Singapore's Land Transport Authority (LAT) in the planning, design and construction of several major rail and road projects including MRT Circle Line, Downtown Line and Thomson East Coast Line. He is currently the President of the Tunnelling and Underground Construction Society of Singapore (TUCSS). He is also the Chairman of the Technical Committee for Site Investigation under the Singapore Accreditation Council (SAC).