

# SUSTAINABLE AND SAFE APPROACHES FOR DEEP EXCAVATION AND TUNNELLING IN SINGAPORE'S URBAN ENVIRONMENT

It is vital to have sustainable and safe deep excavation and tunneling works in Singapore. In this seminar, there will be presentations on innovative construction methods used in the Sydney Metro project, a case study on Jakarta Mass Rapid Transit (MRT) system, Cologne Metro Collapse, Geophysical surveys in civil and geotechnical projects for the non-invasive, speedy, and comprehensive capabilities, along with upcoming challenges and technologies.

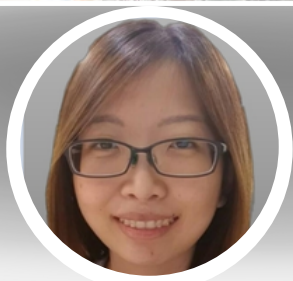
The seminar also delved into advanced technology adoption in Singapore's tunneling projects, with emphasis on risk mitigation in existing buildings. Innovative underground infrastructure technologies from Japan will be presented as adaptable solutions.



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# SYNOPSIS AND SPEAKERS PROFILE

## ADOPTION OF ADVANCE AND INNOVATIVE TECHNOLOGY IN TUNNELLING WORKS

With the rapid expansion of the rail network and other underground infrastructure projects in the densely built-up city, more tunnelling works will be carried out close to existing buildings. With the advancement of tunnelling technology, large Tunnel Boring Machines (TBMs) have been successfully adopted in various projects overseas. Such intricate tunneling operations pose a significant risk to neighboring buildings, especially in challenging ground conditions. Such tunnelling risks can be minimized by leveraging advanced and innovative tunnelling technologies.

BCA-GeoSS has organized a joint learning trip to Japan in May 2023 to study innovative underground infrastructure projects. This presentation highlights some key innovative technologies and construction methods adopted in major Japan underground infrastructure projects and how these technologies can be adopted in upcoming tunnelling projects in Singapore.

**DR POH TEOH YAW** is a Director with Building and Construction Authority which oversees and administers the regulatory framework on building structure safety in Singapore. He is a geotechnical specialist with over 25 years of practical experience. He has authored over 50 publications in geotechnical design and construction including those published in international peer-review journals, conferences and local seminars.

**ER. CHAI KUI FHEN** is presently a senior engineer in the Building and Construction Authority (BCA) of Singapore. She is a registered Professional Engineer in Singapore. She has more than 10 years of experience in the planning, design, and construction of underground infrastructure projects.



## EXCAVATION AROUND HERITAGE BUILDINGS

In a sustainable built environment industry, it is inevitable to carry out development around heritage buildings and conserved structures. It is crucial for engineers to apply their technical knowledge and experience in design and construction to protect the safety, health and welfare of the public and the legacy of the past.

In this presentation, the typical procedures for engineering design to or around conserved buildings will be discussed and case study will be included to illustrate the design of excavation works around conserved buildings.

**ER. LOO JIN JIE** graduated from Nanyang Technological University with Bachelor of Civil Engineering in 2013 and obtained his Master of Science in Soil Mechanics from Imperial College London in 2016.

He is Geotechnical Technical Director from PH Consulting Pte Ltd and has more than 9 years of technical experience in geotechnical engineering and involved in major building and infrastructure projects such as Punggol Digital Districts (PDD), North-East Line Extension, ARC at Changi, Finger 2 at Tuas Terminal, Kim Chuan Depot Extension (C821A) and etc.



## GEOPHYSICAL SURVEYS IN CIVIL AND GEOTECHNICAL PROJECTS

Geophysical surveys have potential advantages such as non-invasiveness, fast coverage, and large coverage. However, feedback from civil engineering suggests geophysical surveys may not always be successful due to unsatisfactory accuracy. This may be due to differences in context and scale between geotechnical site investigation and petroleum exploration and earth science seismology, and a lack of expertise in geotechnical and civil engineering communities.

This presentation shares different geophysical surveys conducted for different purposes and discuss areas for improvement. It will also introduce upcoming technologies. The seminar will highlight the potential capabilities of geophysical surveys and their advantages, while addressing the lack of confidence in their accuracy.

**DR ZHANG YUNHUO** has 14 years' experience as geotechnical engineer. He obtained his PhD degree from the National University of Singapore, where he conducted research on geophysical surveys for geotechnical site investigation.

Dr. Zhang is currently working as a senior manager in the Geotechnical & Tunnel division of Land Transport Authority, where he leads a team of engineers primarily focused on providing technical support for the Cross Island Phase 2 (CRL2) projects. He is also involved in overseeing other engineering studies of existing tunnels and collaborating with the IHL on research and development (R&D) projects.

# COLOGNE METRO COLLAPSE – ROOT CAUSES AND LESSONS LEARNED FOR SAFE URBAN EXCAVATION AND TUNNELLING IN SINGAPORE

This seminar revisits the 2009 Cologne Metro Collapse, delving into its root causes, lessons learned and the practices adopted in Singapore to avert similar incidents. The collapse of the Cologne City Archive building on 3 March 2009, resulting in two fatalities, loss of invaluable historical documents, and over a billion euros in damages, was attributed to the construction of the Cologne Metro line.

Specifically, a flaw in a diaphragm panel led to the infiltration of water, sand and gravel beneath the archive building, ultimately causing the building's foundations to erode and collapse. The seminar will provide an overview of the Cologne North South Metro Line, details of the Cologne Archive collapse, the rescue operation through a rescue pit, possible triggers for the collapse, the subsequent investigation through an investigation pit, identification of the root cause, final resolution, the lessons assimilated, and the current preventive measures undertaken in Singapore to avert the recurrence of similar incidents.

**DR AN XINMEI** earned both her bachelor's and master's degree from Xi'an Jiaotong University China, and her PHD degree from Nanyang Technological University, Singapore. She has over 17 years of research and practical experiences in rock engineering and underground space development, including involvement in the NTU PTRC-DSTA joint UTRC programme for the development of underground space for civilian and military uses, Thomson East Coast Line deep excavation and tunnelling, ground improvement of soft clay for JRL depot, and JRL elevated viaduct projects.

She has authored over 40 papers and was awarded Best Presentation Award for 'Controlled Rock Blasting for Underground MRT Station Construction in Bukit Timah Granite' by the Society for Rock Mechanics & Engineering Geology (Singapore) in 2018. She is currently serving as the Senior Project Manager in Land Transport Authority, Singapore.



## LESSONS LEARNT FROM DEEP EXCAVATION AND TUNNELLING WORKS IN SINGAPORE

Construction of major underground infrastructures such as metro stations and tunnels, road tunnels, underpasses, underground basements etc requires various excavation and tunnelling methods. As these major infrastructure developments are mostly in the high-populated urbanized areas it is inevitable that they have to be constructed next to/under existing structures.

In addition, construction of these underground structures faces lots of challenges due to unfavourable ground conditions, site constraints, limited construction timeline etc. This presentation will highlight some of the lessons learnt from deep excavation and tunnelling works for major infrastructure developments in Singapore.

**DR JEYATHARAN KUMARASAMY** graduated from University of Peradeniya, Sri Lanka with B.Sc. (Eng.) First Class Honours in 1985 and obtained Ph.D. in Soil Mechanics from Cambridge University, UK in 1992. He is a registered Professional Engineer (Civil) in Singapore.

Jeyatharan is currently a Deputy (Civil Design & Lands) with Land Transport Authority (LTA), Singapore. Prior to that, he worked in few consulting companies such as Parsons Brinkerhoff and Arup Singapore Pte Ltd on various major infrastructure projects for about 10 years.

Jeyatharan has over 25 years of practical experience in planning, design and construction of major infrastructure projects. He also has several years of experience in soil investigations, geotechnical instrumentation and monitoring, and preparation of Geotechnical Baseline Interpretative Reports (GIBR).

He is currently the President of the Tunnelling and Underground Construction Society, Singapore (TUCSS) and was a member of the executive committee of the International Tunnelling and Underground Space Association (ITA) from 2019 to 2022.



# RAIL INFRASTRUCTURE ENGINEERING DESIGN AND CONSTRUCTION CHALLENGES FOR MECHANICAL & CIVIL ENGINEERS

For a successful completion of Light Rail Transit (LRT) rail infrastructure and for it to be operational and functional, it involves multidisciplinary professionals such as Architecture, Mechanical engineering, electrical engineering, civil engineering, system engineering, trackwork engineering and signaling engineering.

In the design and construction of rail infrastructure at the design and construction phase, there is especially intensive integration and interfacing of mechanical engineering design and civil engineering design to ensure the mechanical engineering consideration for the rail operation can be incorporated efficiently into the civil engineering structures.

A recent case study of design and construction of a rail infrastructure project with twin 2km underground bored tunnels, four numbers of cross passages and a ventilation and intervention shaft will be presented to illustrate the process of integration and interfacing between Mechanical Engineering and Civil Engineering as well as how such infrastructure looks like.. This case study will demonstrate the importance of immense coordination between the civil engineers and the mechanical engineers.

**ER. DAVID NG** is a Professional Engineer (Civil) and Specialist Professional Engineer (Geotechnical) in Singapore. He has been involved in the publication of more than 70 technical papers in field of geotechnical and environmental engineering. He has more than 20 years of experience in management, planning, design and construction of major infrastructure and transportation projects in Singapore, Malaysia and India. Having worked in the Land Transport Authority for several years, he is now co-founder of One Smart Engineering Pte Ltd which has design offices in Singapore and Malaysia.

Er David Ng has been IES Council Member and Honorary Treasurer since the year 2020. He has also been elected as TUCSS Council Member from 2010 to 2016. He is also serving as the Chairman of IES C&S Technical Committee. Er David Ng has also been invited to serve as technical committee member by Building and Construction Authority (BCA) on various development of guidelines and technical references for geotechnical design. He is also the Adjunct Lecturer for NUS, BCA Academy and IES Academy teaching deep excavation and tunneling design and construction supervision.



## DESIGN OF SEISMIC LOADING FOR MRT UNDERGROUND, CASE OF JAKARTA MRT

It is well known that Indonesia is located within “the ring of fire”, where 3 (three) majors faults exist. As such, seismic design plays a major influence on structural design in the country. The seismic design has become even more interesting when dealing with underground metro structures such as underground train stations and tunnels. Jakarta MRT has been successfully built, and now a new phase is under construction to be followed by the other East – West Line shortly.

There have been many discussions about the seismic design for these underground structures that are to be undertaken. It has become important that the methodology adopted is safe and can be well accepted considering various available approaches. In this opportunity, the author will describe best-practiced approaches used by engineers in considering the seismic effects in the design of underground structures. The seismic design of underground structures is unique in several ways when compared with those used in the design of highrise buildings. In the underground structures, the inertia of the surrounding soil is relatively large compared to the inertia of the structures.

Some approaches have been proposed for the seismic design of the underground structures e.g. Response Displacement Method and Racking Method. A case study on the seismic design of one of the underground stations and tunnels will be presented following the abovementioned approaches.

**DR IRAWAN TANI** graduated with his PhD in Structural domain from France University, has more than 25 years of experience in multi-international projects in a wide range of projects including metro, seismic design, mining transportation, maritime and infrastructure, industrial, oil and gas, buildings from every stage from Pre-FS, Basic Design, FEED, DED and project execution including supervision work.

His experience includes managing diverse technical teams in design, management, supervision, and training for large-scale, multidisciplinary projects including infrastructure development, building construction, and transportation. Dr Tani also specialized in structural design skills including those for underground structures, bridges, industrial structures, buildings, and dynamic/seismic design, as well as for earthworks, jetties, ports, and temporary construction.

He currently serves as an Acting Director of Mott MacDonald Indonesia and leads a Transport Sector related to major Transportation Project in Indonesia. He is also involved in Technical Excellence in Mott MacDonald Group

## A FIRST OF ITS KIND FULLY PRECAST UNDERGROUND METRO STATION – DESIGN EXPERIENCE

The Sydney Metro Northwest project, which is Australia's largest public transportation project, was carried out by a joint venture between Mott MacDonald (MM), SMEC, and KBR.

The project was to deliver 36km of new metro rail for Sydney's growing Northwest using a new generation of fully automated metro trains. The project includes eight new stations which include 3 underground stations and five upgraded stations. The common denominator of the PPP infrastructure design was the extensive use of precast concrete. The vast experience in underground metro projects made MM Sydney choose the Singapore office due to its extensive experience in underground metro projects.

Underground MRT stations involving deep excavation with props are commonly constructed with cast in situ reinforced concrete with limited opportunities for the use of precast concrete elements. The presentation aims to share the experience on the design and construction of a fully precast metro station as per the client's requirements.

**ER. DR. KANNAN** is a Professional Engineer in the field of Civil Engineering with 27 years of experience. He obtained his PhD degree in Structural Engineering from National University of Singapore and bachelor's degree in civil engineering from University of Peradeniya, Sri Lanka.

He has proven track record in handling mega infrastructure projects such as MRT stations and road tunnels in Singapore, Malaysia, Indonesia, Hong Kong and Australia. He was involved in the detailed design of MCE, Air side road tunnel in Changi and number of MRT projects in Singapore in DTL 1, DTL 2, North south line extension, and five stations in the eastern stretch of Thomson East Coast Line. He also involved in the Phase 1 and 2 of the Jakarta Metro. He played a key role in the feasibility study of North South Corridor (NSC) project and advanced engineering works in North South Cable tunnel. He is currently QP(D) for two of the underground section of NSC contracts and contract P102 Punggol Extension of Cross Island Line. One of his remarkable projects completed in the year 2019 is the first of its kind fully precast underground metro station for Sydney Metro.