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OCTOBER 2022

INFRASTRUCTURE TUNNELLING WORKS IN MALAYSIA

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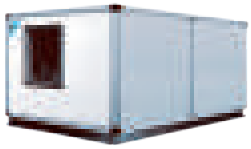

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by Ir. Ong Sang Woh
Chairman, Tunnelling & Underground Space Engineering Technical Division

COVER NOTE

Future of Underground Infrastructure Development in Malaysia

The frequent flash floods occurring in low-lying areas of Kuala Lumpur and other towns in the country are of grave concern to all Malaysians. We need a holistic approach to address and contain the ever-recurring flooding and we can start by educating the masses on waste and garbage disposal, caring for rivers and preventing soil erosion from uncontrolled land clearing and unplanned developments.

Infrastructure and other development must take into account the increase in rainy weather which is the result of changes in global climate. Besides providing caverns and temporary underground reservoirs for flood water storage, excess water should be drained in a timely and progressive manner via small viaducts and tunnels to the river downstream.

Underground structures and tunnels for water drainage should also be enhanced for transportation schemes, especially the ongoing ECRL project and planned Kuala Lumpur MRT Circle line transport projects. Besides the proposal for a new highway bypassing Menora Tunnel in Perak to cater to increased volume in traffic, MRT transportation schemes should also be developed for all major cities besides Kuala Lumpur.

The goal is to construct tunnels as part of the infrastructure transportation development as well as water supply and waste disposal underground network for the future. ■

EDITOR'S NOTE

Tunnelling Through Challenges

by Ir. Dr Siow Chun Lim
Principal Bulletin Editor

As a developing nation, infrastructure development is one of the key propulsion factors needed to power us on the road towards becoming a developed nation. What we all expect to see are skyscrapers, roads, highways, railways, bridges as well as telco and power transmission towers.

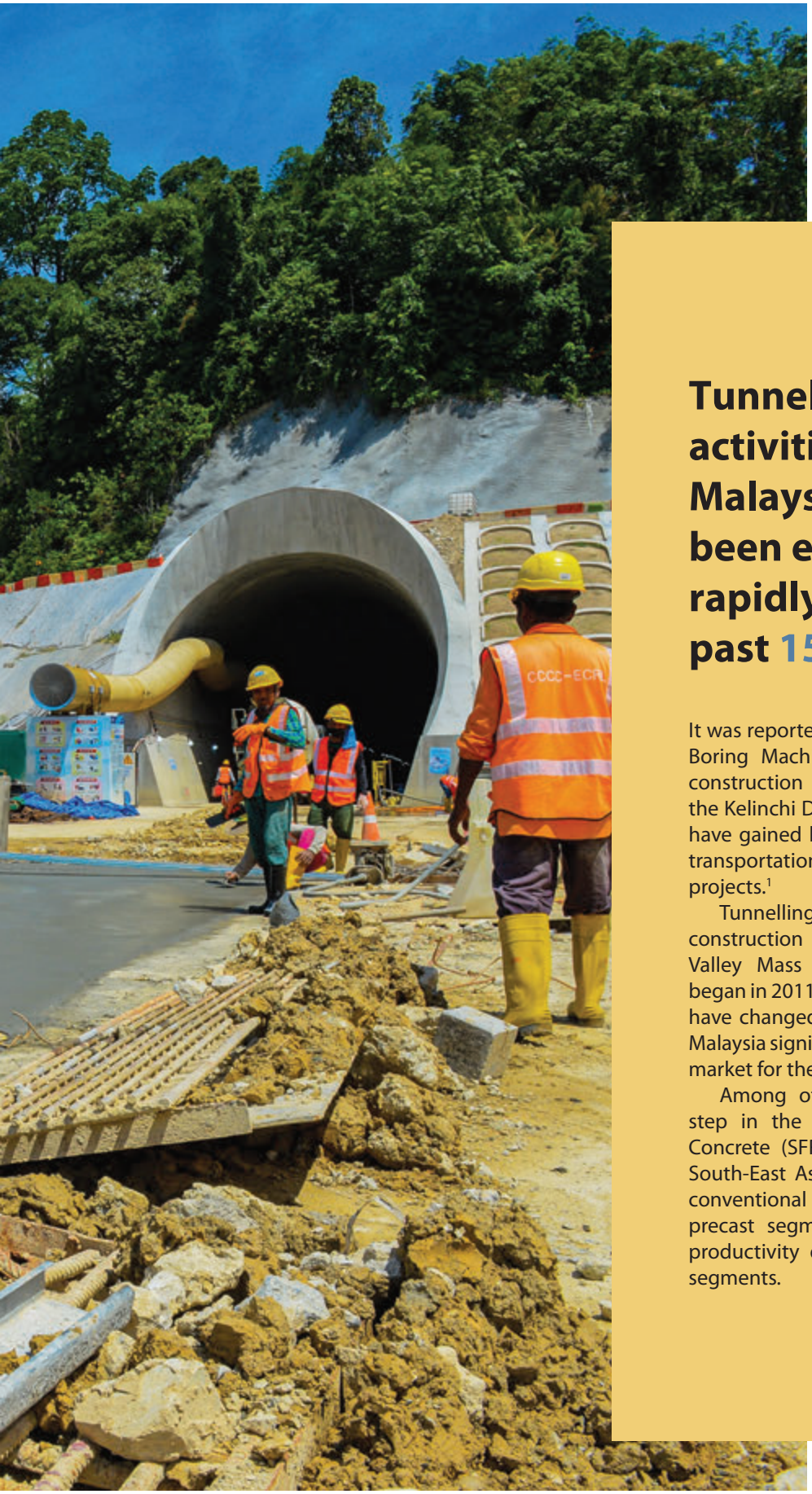
However, we usually "unintentionally ignore" structures lying underground though these serve as essential foundations for the massive structures standing above ground. The other slightly more obvious structures which we may miss unless we drive or ride through one, are tunnels.

Tunnelling works are critical in various infrastructure development and this alone amplifies the complexity and challenges that await the engineering personnel involved. So let us read through what the Tunnelling & Underground Space Technical Division has prepared for us in this issue of *JURUTERA*. Lastly, I would like to wish our members "Happy Deepavali". ■

Infrastructure Tunnelling Works in Malaysia

Mr. Kong Qi

Managing Director of China Communications Construction (ECRL) Sdn. Bhd. An expert with a Master's Degree from Beijing Jiaotong University, Mr. Kong started his career with North Xiangfan Railway and has spent over 30 years working in the railway and construction industry. Prior to coming to Malaysia, he was senior advisor at International Union of Railway and the CEO of Chinese Hungarian Railway Nonprofit Company Ltd.



Tunnelling activities in Malaysia have been expanding rapidly over the past 15 years.

It was reported that from the first time Tunnel Boring Machines (TBMs) were used in the construction of the water transfer tunnel of the Kelinchi Dam in 1994, tunnelling activities have gained huge momentum, specifically in transportation, energy and water infrastructure projects.[1]

Tunnelling works are still on-going for the construction and completion of the Klang Valley Mass Rapid Transit (KVMRT) which began in 2011. Tunnelling works on the KVMRT have changed the landscape of tunnelling in Malaysia significantly, generating a sustainable market for the tunnelling industry.

Among others, it marked an important step in the use of Steel Fibre Reinforced Concrete (SFRC) tunnel segmental lining in South-East Asia which eliminated the use of conventional reinforcement using concrete precast segments and switched instead to productivity during manufacturing concrete segments.

In the TBM Control Room, the Site Manager for Genting Tunnel, Mr. Yin Tonghua, checks CCTV footages of the inside of the tunnel to ensure a smooth operation

A locomotive operator transporting materials to the Tunnel Boring Machine, Genting TBM1

The setting up the world's first tunnelling school – also known as Tunnelling Training Academy (TTA) – in December 2011, also paved the way to a brighter future in tunnelling developments in Malaysia.

ECRL Project Using TBM

More recently, tunnelling work using TBMs for the planned 665km East Coast Railway Link (ECRL), which includes a total of 50km of tunnels and underground alignment, is being carried out along the Gombak-Bentong portion (also known as Genting tunnel) where the single-longest twin hill-tunnel spanning 16.39km is being built under the Titiwangsa mountain range. Tunnelling will also be carried out in several underground lines, including one in the heavily populated Gombak area near the Kuala Lumpur city centre.

With regards to the Genting ECRL Tunnel, this will be the first time a TBM is used for excavation in the area instead of the blasting and drilling methods used in the past. Mr. Kong Qi, the Managing Director of China Communications Construction (ECRL) Sdn. Bhd. (CCCERL), the Engineering, Procurement, Construction & Commissioning (EPCC) contractor for the project, said two TBMs are being used to excavate the twin-bore Genting Tunnel portion of the ECRL alignment.

"Equipped with 4 torque cylinders and weighing 900 tonnes each, the TBM cutter heads from China are 25m long and have an excavation diameter of almost 9 metres," he said. "Together with a back-support system which houses the control room and substation, the TBMs weigh a massive 1,600 tons and measures 266m in length each, making them amongst the largest TBMs for rail tunnel excavation in Malaysia."

He added that the TBMs were custom-made for use in hard rock conditions, explaining that each machine had a maximum digging capacity of 700m per month at the 16.39km twin-bore Genting Tunnel between Bentong and Gombak.

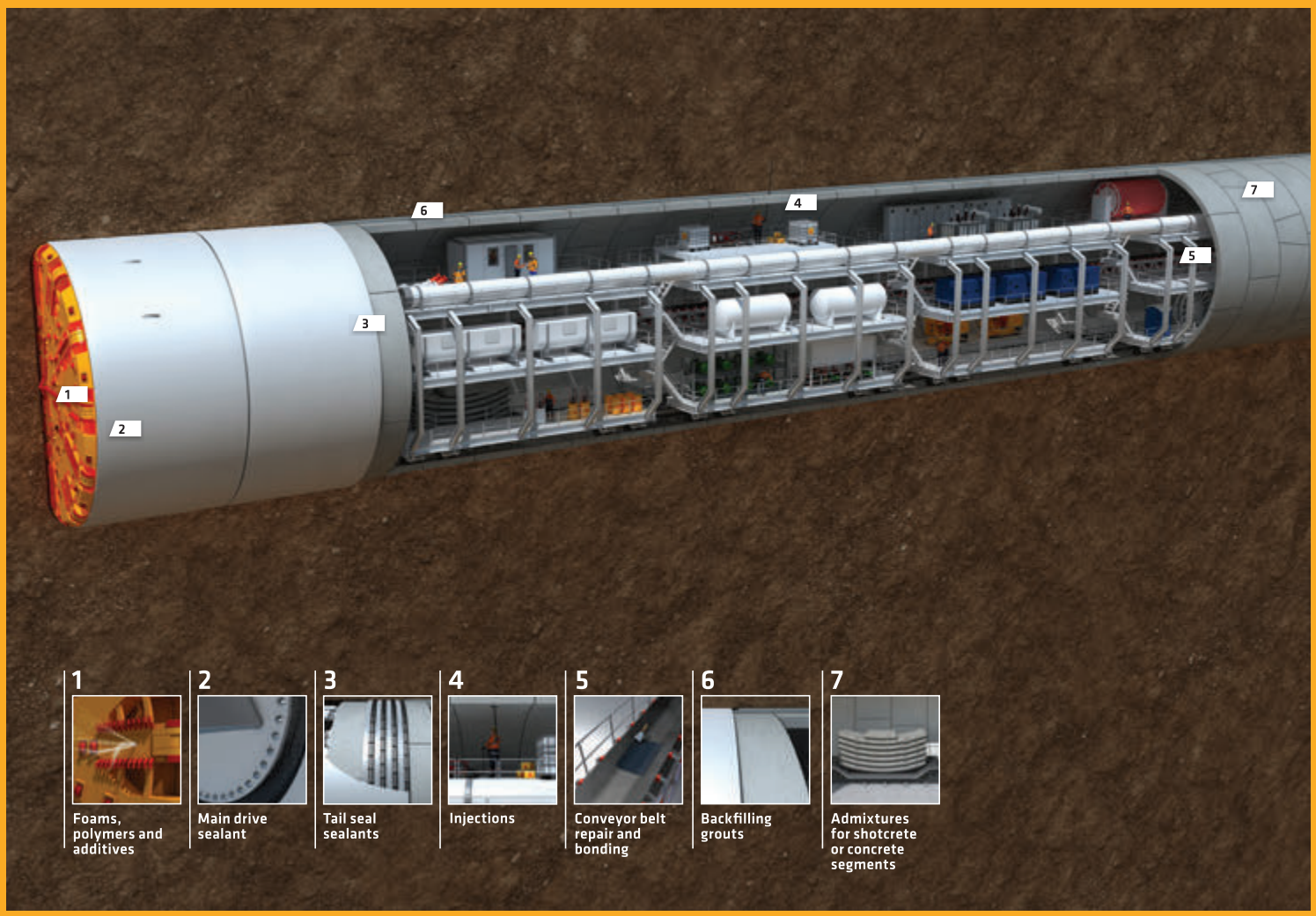
Mr. Kong said the machines, manufactured by CCCC's Tianhe Machinery & Equipment Manufacturing Co Ltd in Shanghai, had cleared the Factory Acceptance Test (FAT) before they were dismantled into 286 packages and shipped from Shanghai to Port Klang in July last year.

"The Forward Main Beam was the largest package to be transported; it measured 9.3m in length, 3.7m in width, 4.6m in height and weighed 135 tons," he added.

The TBMs are used for three main tasks: Tunnel excavation, removal of excavation waste to the surface and installation of concrete walls in the tunnel, which will take up to three years to complete.

According to Mr. Kong, the advantage of using the TBM instead of blasting and drilling is that it limits disturbance to the surrounding ground while producing a smooth tunnel wall. It is also more efficient and shortens the project time period.

"With these proven advantages and the significantly improved TBM technology, the use of TBMs should be a preferred choice for major infrastructure projects, site conditions permitting," he added. "Excavating the Genting Tunnel could have been a challenging feat but CCCC officials were equipped with the proper knowledge to handle the TBM. We have vast experience in handling TBM work. Although this is the longest rail tunnel in South-East Asia, the job is not as difficult as jobs we've had elsewhere."



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It has been reported that even though the Genting Tunnel construction site spans over seven hectares and involves nearly 200 workers, Malaysia Rail Link Sdn. Bhd. (MRLSB) is optimistic that the high-technology TBMs are able to take on the geological and engineering challenges in excavating through the Titiwangsa mountain range.

Regardless of whether they are working inside the tunnel or outdoors, CCCECRL welders always wear personal protective equipment (PPE) and helmets as safety is a top priority

MRLSB is the project and asset owner of ECRL. This special purpose vehicle (SPV) company is wholly owned by the Minister of Finance Incorporated (MOF Inc.), while CCCECRL, a subsidiary of China Communications Construction Company Ltd. (CCCC), is the Engineering, Procurement, Construction & Commissioning contractor for the ECRL Project.

The project is scheduled for completion in December 2026. As of mid-July 2022, the ECRL project has achieved 31.93% completion.

Northern vs Southern Alignment

The overall alignment of the ECRL rail network is designed to provide a much-improved connectivity throughout the East Coast region, as well as to connect it to the West Coast and, at the same time, take into consideration the potential growth of industrial, commercial and tourism sectors along the ECRL corridor. Running at speeds of up to 160km per hour, the ECRL passenger trains will significantly cut travel time from Kota Baru to ITT Gombak down to approximately 4 hours. It is also expected to spur commercial activities, drive investments, increase job opportunities and boost tourism activities along its rail network.

Initially the ECRL project was to go through Karak and tunnel through the Titiwangsa main range, ending at Port Klang. The change in the Malaysian government in May 2018 resulted in a re-negotiation to save costs with a realignment which would have avoided tunnelling through the Titiwangsa main range. Then in February 2019, the collapse of the Pakatan Harapan government and subsequent change in government to Perikatan Nasional led to the reverting of plans back the original alignment with tunnelling at the Titiwangsa main range.

Mr. Kong said there were many benefits to this change in realignment. "The original alignment, or Northern Alignment, was meant to strengthen the viability of the ECRL project and to provide additional economic, environmental and social benefits.

"The estimated overall benefits of the Northern Alignment are better than those of the Southern Alignment (ECRL 2.0) which passes through Negeri Sembilan. The Northern Alignment offers 'value for money' by extending rail connectivity to existing cargo hubs and increasing capacity in the transfer of cargo via the rail network," he said. "The implementation of the Northern Alignment will steer the ECRL to be a viable infrastructure with a revenue ratio of 70% freight and 30% passenger."

According to Mr. Kong, research has indicated that the ECRL may transport approximately 26.12 million tonnes of freight via the Northern Alignment in its first year of operation, which is significantly more than the 9.0 million tonnes of freight forecasted for the Southern Alignment during the same period. According to the same research, the Northern Alignment is also capable of attracting 5.03 million passengers in its first year of service, compared to 4.07 million passengers via the Southern Alignment.

He added: "The Northern Alignment will serve as a land-bridge from Kuantan Port to two terminals in Port Klang, namely Northport and Westport. With the Northern Alignment, ECRL will also provide more organised cargo and passenger transport services between the east and west coasts of the peninsula, attract investments along the alignment corridor and generate many opportunities for businesses and employment. In short, implementing the Northern Alignment is a better option because it provides greater long-term benefits to the national rail network."

As to whether the ECRL will be linked to the China-Laos high speed rail which has been successfully completed and operational, Mr. Kong said it is better to wait and see how things develop in the future, after the ECRL is completed by the end of 2027.

"After all, both ECRL and China-Laos rail projects are key elements of China's Belt & Road Initiative," he said.

Challenges

Mr. Kong said that from the project management point of view, the 655km ECRL alignment alone was a huge challenge as it involved 1,712 work locations from Kota Baru to Port Klang at the peak of its construction.

As a brand-new railway route, it will require the building of a multitude of temporary access routes, bridges and facilities. "From the environmental point of view, minimising the impact of the project on the environment is another challenge and this has always been a top priority. There will be approximately 60 tunnels, 130km of viaducts and 20 wildlife crossings to help in the conservation of forests and wildlife," he added.

With the ECRL cutting across the Titiwangsa mountain range via the Genting Tunnel, the construction of the Genting Tunnel is not easy and involves a high element of risk.

"Taking into account the safety and environmental factors, the TBMs were brought in. For other tunnels in the project, we adopted very strict safety standards because of the poor geological conditions and shallow-buried limitations," said Mr. Kong. "About 180km or 41% of the ECRL alignment passes through swamp areas and this requires a huge amount of foundation treatment to mitigate the soft foundation. To control embankment settlement in swamp areas, we had to implement rigid treatments like pile-plank structure and Deep Soil Mixing (DSM) processes."

He said that the ECRL alignment also passes through large areas in the east coast which are prone to flooding, so mitigation works and other requirements are needed to ensure the ECRL is able to withstand the most extreme flood situations as per the requirements from the local authorities. Many drainage channels have to be constructed along the ECRL routes to meet the flood control requirements. To add to that, the COVID-19 pandemic was another unexpected challenge.

Workers installing dust collector filter elements inside the TBM1

Impact of COVID-19 Pandemic

Mr. Kong said several strategies had been undertaken to mitigate the impact of the COVID-19 pandemic (including post-pandemic impact) on the construction progress of ECRL project.

"Even before the outbreak in Malaysia, the management had taken precautionary measures while keeping our staff informed on the latest development of COVID-19 around the world," he said.

> **When Malaysia was put under strict restrictive measures to contain the spread of COVID-19, the ECRL project came to a halt and staff members had to work from home. The smooth resumption of construction of the ECRL was only possible due to the strict precautionary measures that CCCECRL had taken, especially in the early days of the outbreak.**

According to Mr. Kong, the strict measures taken included compartmentalisation of office space, with regular sanitisation, social distancing and health tracking every day as well as regular COVID-19 testing of the staff members. Along with that, CCCECRL set up industry vaccination centres (PPVINs) at the ECRL Dungun and Chukai base camps in Terengganu, and CIDB Kuantan to vaccinate its management personnel, staff members and sub-contractors. He said CCCECRL attached equal importance to the resumption of work and the precautious measures against the outbreak.

As for initiatives or support rendered by CCCECRL to promote an inclusive and sustainable local rail industry, specifically the tunnelling industry, Mr. Kong said there were several already in place as well as in the pipeline.

"One of these is the Program Latihan Kemahiran Industri or Industrial Skills Training Programme (PLKI) of the ECRL Project, which is a platform to produce more workers for the growing rail industry following the Malaysian Government's decision to focus on rail infrastructure development to enhance the public transport system," said Mr. Kong.

On 23 June 2022, Prime Minister Dato' Sri Ismail Sabri Yaakob launched the East Coast Rail Link Project's first TBM which will be used to excavate the 16.39km twin-bore Genting Tunnel in Bentong, Pahang

He said the programme will benefit up to 5,000 local trainees to be involved in the project from the construction phase to the operation and maintenance phases. CCCECRL is allocating RM23 million in sponsorship under its corporate social responsibility (CSR) initiative for the programme.

"All graduates of the PLKI-ECRL programme will be offered jobs with either Malaysia Rail Link Sdn. Bhd. (MRL) or China Communications Construction (ECRL) Sdn. Bhd.," he said.

Transforming Malaysian Tunnelling Industry

Mr. Kong said the ECRL Project will help transform the Malaysian tunnelling industry into a more resilient environment. He said the tunnelling industry can support sustainable infrastructure development in Malaysia by creating the right ecosystem.

"Rising urbanisation continues to create demand for space. A workshop of the Working-Group 20 of the International Tunnelling Association (ITA-AITES) confirmed recently that if more than 50% of the planet's population already live in cities, an estimated 61% will be urbanised in 2030 and 70% in 2050," he said.

Therefore, he said, the tunnelling industry can provide relief by extending itself to beyond transport tunnels and utilities to underground construction and underground space expansion.

"The use of TBMs for tunnel construction has proved to be more friendly to the environment by reducing site operations and truck trips, thus preserving water and cutting down on energy consumption and carbon emissions. With the advancements in TBM technology, larger diameter TBMs and non-circular shaped TBMs are available to support the industry," said Mr. Kong. "However, it will take the whole industry, from designers and engineers to contractors to make it more sustainable." ■

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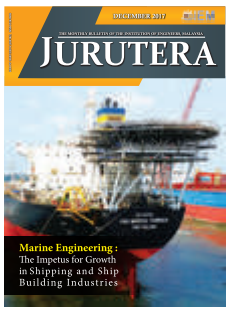

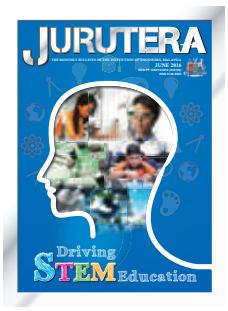

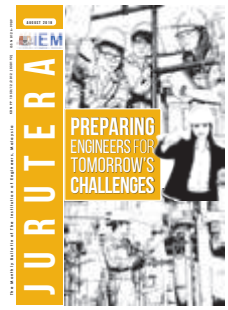

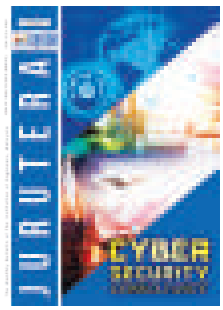

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Challenges in the Construction of Sewer Network in Urban Area Using Trenchless (Pipe Jacking) Method

Written and Prepared by:

Narendran Maniam

The Chief Executive Officer of IWK, Mr. Narendran has over 24 years of experience in strategic planning, business development, planning of water and wastewater infrastructure and operations of water and wastewater services. He was appointed Council Member of the Malaysian Water Association (MWA) 2021/2023 Session.

The Greater Kuala Lumpur/Klang Valley (GKL/KV) National Key Economic Area (NKEA) is one of the 12 NKEAs under Malaysia's Economic Transformation Programme and the goal is to transform it into one of the 20 most liveable metropolises globally.

Under this initiative, Jabatan Perkhidmatan Pembetungan (JPP) and Indah Water Konsortium Sdn. Bhd. (IWK) were given the humongous task of carrying out major sewerage construction works to transform the Klang and Gombak rivers into vibrant, liveable waterfronts of high economic value. To achieve this, all old sewer systems, including multi-point sewage treatment plants, within this catchment had to be rationalised and the sewage diverted to new treatment plants via new gravity sewers, force mains and pumping stations. Under this programme, IWK was appointed the project management consultant to study, plan and execute the construction of major sewerage projects in the following areas:

1. Batu, Jinjang Kepong (construction value estimated at RM400 million)
2. Bunus (construction value estimated at RM400 million)
3. Damansara (construction value estimated at RM118 million)
4. Petaling Jaya Utara (construction value estimated at RM277 million)
5. Petaling Jaya Selatan (construction value estimated at RM140 million)
6. Kajang (construction value estimated at RM365 million)
7. Puchong (construction value estimated at RM236 million)
8. Upper Kerayong (construction value estimated at RM96 million).

The benefits of implementing these projects are reducing pollutant loadings into the Gombak and Klang rivers (including their tributaries), removing non-performing multi-point old sewage treatment plants, unlocking land areas for future developments and spurring the country's economic growth.

Major works are associated with the laying of new sewer pipes to convey the sewage from old treatment plants to new pumping stations and modern treatment plants which are capable of treating sewage to the River

Figure 1.0(a): Sheet pile Cofferdam Shaft construction at Langat Cheras, Kajang

Figure 1.1: Concrete Caisson Shaft construction at Hulu Langat, Kajang

Figure 1.2: Cast-in-situ concrete shaft construction at Hulu Langat, Kajang

Class B Discharge of sewer pipes using trenchless method i.e. pipe jacking.

Major Challenges & Action Plans for Shaft Construction

Listed below are some major challenges that contractors faced during the implementation of the projects and the action plans that were taken to overcome the problems:

1. **Poor sub-soil conditions (soft clay, very loose soil and high-water table).** Concrete grouting was applied to eliminate these problems. A stabilising fluid was injected into the soil under high pressure and high velocity. This liquid concrete hardened to form cemented columns; this would solidify the soil and increase the friction by strengthening the soil.

Figure 2.0: Shaft bottom soil collapsed. Concrete grouting was applied to stabilise the soil at Hulu Langat, Kajang

2. **Presence of hard ground stratum (rock):** In some areas, hard stratum was encountered along the pipe alignment. Studies were carried out to change the alignment to avoid the hard stratum. In cases where the pipe alignment could not be shifted, a rock cutter machine was deployed to jack through the hard layer.

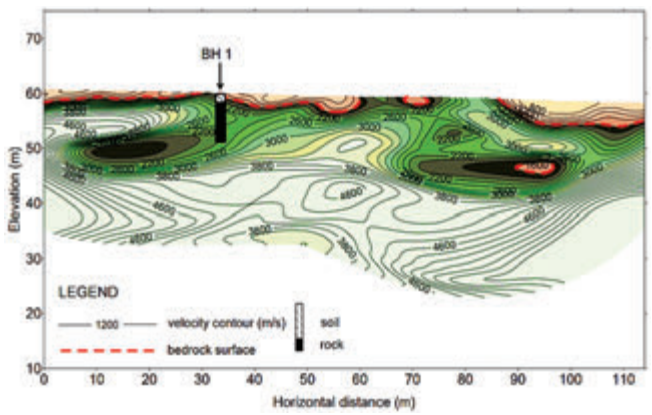

Figure 2.1: Seismic refraction survey at Cheras Batu 11, Kajang

Figure 2.2: Hard ground was cored and used as a shaft wall in Langat, Kajang

3. **Sinkholes:** Concrete grouting was applied to eliminate the problem of sinkholes. In this method, a stabilising fluid was injected into the soil under high pressure and high velocity. This liquid concrete hardened into cemented columns. These columns were grouted in numerous numbers to stabilise the soil. It would solidify the soil and increase the friction by strengthening the soil.
4. **High concentration of utilities:** This problem at many locations was resolved by relocating the utilities or protecting them. To protect the utilities during the construction of shafts, the Sheet Piling Cofferdam method was employed. The sheet piles were installed very carefully by avoiding the locations of utilities and the gap areas were filled with timber piles.

Figure 2.3 (a): Road settlement at manhole N-19, Jalan Bintulu, Taman Beringin

Figure 2.3 (b): Road settlement at manhole N-19, Jalan Bintulu, Taman Beringin

Figure 2.3 (c): Sinkhole at manhole N-17 (Zone 3B) along Jalan Kapit, Taman Beringin

Figure 2.3 (d): Rectification of the settlement road with backfilling, concrete and pressure grouting at manholes along Jalan Kapit, Taman Beringin

5. **Narrow corridor or small working space:** Rapid development within the catchment area resulted in very small working spaces. To tackle this problem, the designers looked into placing the shafts at strategic locations where long jacking construction could be carried out. The initial planning of the sewer alignment was critical to ensure successful implementation of the works.

Figure 2.4(a): Shaft next to the office building installed by using silent piler at Pakej D49, Kajang

Figure 2.4(b): Shaft next to highway pier installed by using silent piler at Pakej D49, Kajang

6. **Traffic congestion:** The contractor had to come up with a comprehensive traffic management plan and diversion routes with the help of adequate signages as well as the Media to spread information on traffic diversion plans.
7. **Public complaints:** The public was well informed of the impending projects and the inconveniences encountered via the Media such as radio and newspaper so that they could take the necessary actions. Hotlines were created to receive and resolve public complaints immediately.
8. **Compliance with local authority requirements:** Most of the shaft issues were related to the location of the shafts. Instructions from local authorities such as Lembaga Lebuhraya Malaysia, Jabatan Kerja Raya and KTMB required all the utilities to be placed at the road right of way (ROW). So designers incorporated shaft locations in their designs which were in compliance with the authority requirements.
9. **Interfacing with the other ongoing construction projects (interfacing and coordination):** The consultant and IWK worked with all other parties involved in the on-going construction work to plan and execute the works. Construction drawings were exchanged and detailed corridors of working areas established with work schedules to avoid work disruption.

Figure 3.0: Pressurised slurry removal method for curve drive (nominal diameter 250-700mm narrow pipe driving method), ACEMOLE

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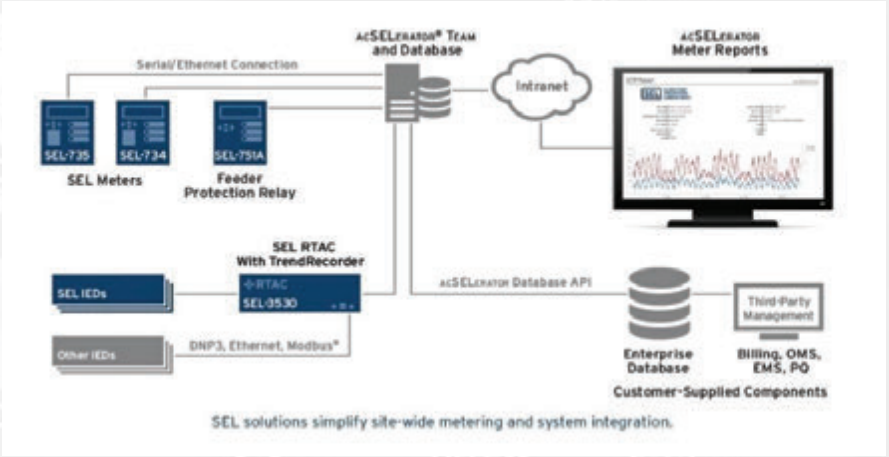

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Major Challenges & Action Plans for Pipe Jacking Works

Listed below are the major challenges that the contractors faced and the action plans taken:

a) **Poor sub-soil conditions (soft clay, very loose soil and high-water table):** Bentonite solutions were widely used to stabilise the sub-soil conditions mentioned above. In pipe jacking, reduction of jacking forces could be achieved by injecting bentonite, polymer solutions or other additives into a thin overcut annulus excavated around the pipes. Physicochemical interactions, including clay swelling inhibition and filter-cake formation at or near the cavity boundary, were believed to alter the process of cavity contraction. This could help reduce radial effective stresses on the pipe and, in turn, the jacking forces. Other than geological and hydro-geological conditions, other factors such as the pipe diameter, installation depth, over-cutting ratio, installation rate and pipeline misalignment as well as, to some extent, the surface coating of the pipes affected the jacking rate and construction time.

b) **Presence of hard ground stratum (rock):** This was a major challenge when jacking works were being carried out at Pakej D43, D44 and D49 sites. To alleviate this problem, contractors carried out soil profiling of the pipe alignments and, based on the data, proper cutter heads were installed into the jacking machines prior to the jacking works. The length of jacking was also calculated to ensure that the pressure exerted by the jacking force would not damage the jacking pipes. In some cases, manual jacking (manshield) was done to resolve the problem but this was time-consuming.

c) **Sinkholes:** Should sinkholes appear at the alignment of the jacking routes, it would be already too late most of the time to carry on the jacking activities since the jacking head would have sunk in the void areas created by the sinkholes. Rescue pits had to be constructed to remove the jacking head and the excavated area filled with cement grouts to stabilise the base. Once the area was stabilised, the jacking head was installed so that the jacking process could continue.

d) **High concentration of utilities:** Utilities such as Syabas (water), TNB (electricity), telcos and gas pipes occupied most of the available space within the corridor of the road ROW. The long jack method was used in some areas to reduce the construction of jacking and receiving shafts. The long jack was introduced at Kampung Baru to avoid the relocation of utilities. By employing the jacking method, the contractor was able to avoid damaging the utilities at the site.

e) **Narrow corridor or availability of small working space:** The curve jacking method was utilised at the project site to ensure that jacking routes were within the approved jacking corridor. Curve jacking was carried out in Kampung Baru to install a 1,500mm diameter pipe to convey sewage flow to a pumping station. Although it was designed initially as a straight jacking route, the density of utility services in the area encouraged the contractor to suggest curve jacking as an alternative. A detailed study of obstacles along the route indicated that the drive would need to be curved. Such was the complexity of these obstacles that the precise alignment had to be modified several times.

f) **Traffic congestion:** To tackle this problem, alternate jacking routes were selected to reduce traffic congestion. Roads were widened at the shaft areas so that jacking equipment could be placed at the jacking pit areas without traffic issues. Diversion routes were also recommended to road users at strategic locations to minimise the problem. Blinkers were installed at night to warn them of hazards at the jacking area.

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g) **Public complaints:** Flyers were distributed to the local community to create awareness of the benefits of the ongoing project. Dilapidation surveys were carried out to protect property owners from damages arising from the works.

h) **Compliance with local authority requirements:** Major local authorities required the use of the pipe jacking method for installing pipes at depths greater than 3 metres. The major challenge faced was the transportation of jacking pipes from the designated storage area to the jacking shaft.

i) **Interfacing with other on-going construction projects (interfacing and coordination):** Many extensions of time applications from the contractors were related to interfacing problems with authorities like LLM, local authorities, JPS and other government agencies. Even though coordination meetings were conducted to seek a solution, these were not always successful.

Lessons Learnt

The challenges faced were good learning experiences and advanced methodologies were developed during the implementation of the projects. Some of the measures/ methodologies taken during the construction stages helped to improve or minimise the environmental impact. Sharing and learning together among the project stakeholders via technical site visits, seminars and conferences were good ways to develop new methodologies and served as guidelines for upcoming projects. ■

Upcoming Activities

Webinar Talk on Recent Experience on Precision Farming for Oil Palms

Date : 1 October 2022 (Saturday)
Time : 9.00 a.m. – 11.00 a.m.
Venue : Digital Platform
Approved CPD : 2
Speaker : Dr Chen Zi

Webinar Talk "After Thought of a Climate Change Case Study: Impact of El Niño on Oil Palm Yield in Malaysia"

Date : 1 October 2022 (Saturday)
Time : 11.30 a.m. – 1.30 p.m.
Venue : Digital Platform
Approved CPD : 2
Speaker : Ir. Dr Lloyd Ling

Technical Talk on Ground Improvement Solutions (Vibro Stone Columns, Soil Mixing and Drilling & Grouting) - Execution, Quality Control & Case Studies

Date : 5 October 2022 (Wednesday)
Time : 5.30 p.m. – 7.30 p.m.
Venue : Wisma IEM
Approved CPD : 2
Speaker : Mr. Sreenivasa Raju P.

One-Day Course on "How to Be Persuasive Engineers"

Date : 6 October 2022 (Thursday)
Time : 9.00 a.m. – 5.30 p.m.
Venue : Wisma IEM
Approved CPD : 7
Speaker : Ir. Al-Khairi Mohd Daud

Innovation Day: Accelerating & Sustainability Through Innovation

Date : 6 October 2022 (Thursday)
Time : 9.00 a.m. – 6.00 p.m.
Venue : Hilton Kuala Lumpur
Approved CPD : 7
Speakers : Mr. Anthony Yeok
: Mr. Thilagam Govindasamy
: Mr. Johnathan Yau
: Mr. Kok Soon Yeh
: Mr. Ch'ng Eng Yong
: Mr. Alvin Lim
: Mr. John Chin
: Mr. Frankco Nasarino Nainggolan
: Mr. Ahmad Farhan Ahmad Khairi

Workshop (Physical) on Dispute Avoidance No.6 - Postponed from 11 June 2022

Date : 8 October 2022 (Saturday)
Time : 9.00 a.m. – 12.00 p.m.
Venue : Wisma IEM
Approved CPD : 2.5
Speakers : Ir. Zafrul Mahmood
: Ir. Dr Ooi Teik Aun
: Ir. Leon Weng Seng

Virtual Half-Day Course on "Life Cycle Cost on Green Project"

Date : 8 October 2022 (Saturday)
Time : 9.00 a.m. – 1.00 p.m.
Venue : Digital Platform
Approved CPD : 0
Speaker : Ir. Noor Iziddin Abdullah bin Ghazali

MMC-Gamuda Upholds Track Record with Another Win at ITA 2021

Written and Prepared by:

Adam Row

A technical writer with years of experience in managing communications across multiple industries. He holds a degree in Biotechnology from New York State University. He is a key member of the MMC-Gamuda Public Relations & Stakeholder Management team delivering the mega MRT lines.

Joyce Shamini Rajendran

Graduated with a Civil Engineering Honours Degree majoring in Sustainable Development & Construction from University Teknologi Petronas. She is Communications & Engagement Lead with Gamuda Excellence Transformation.

While many purport to embrace innovation and promote change, no Malaysian construction outfit walks the talk better than MMC Gamuda which continues to drive the fields of tunnelling and construction operations forward by harnessing the power of numerous homegrown and in-house technological advancements.

These innovations, developed over the course of the construction of the MRT Putrajaya Line project, one of the most important national infrastructure rail projects in the country, culminated in the project itself being accorded Major Project of the Year (over €500 million) at the ITA Tunnelling Awards 2021. Combined with other recent impressive wins, including being named International Project of the Year at the Ground Engineering (GE) Awards 2021 and Tunnelling Project of the Year at the New Civil Engineer (NCE) Tunnelling Festival 2021, it solidifies the company's status as an established international industry leader in the tunnelling construction space.

These awards become even more impressive when you consider the scope of the MRT Putrajaya Line, a mega-infrastructure rail project in the heart of Kuala Lumpur. As part of a 3-line network known as the Klang Valley Mass Rapid Transit (KVMRT) system, it was aimed at raising the existing public transport modal share of the city from 20% to 40% as part of the National Economic Transformation Programme. The project alignment itself spanned 52.2km, serving a population corridor of 2 million people. Snaking through the city centre, the underground package comprised 13.5km of twin-bored tunnel with 11 stations and tunnel portal structures up to depths of 60m, valued at US$3.13bil.

Throughout the project, 12 multi-mode Variable Density Tunnel Boring Machines (VDTBM) were utilised, 8 of which were refurbished from the construction of MRT Kajang Line, and deployed over 16 tunnel drives, a scale uncommon for a single contractor.

They were used to advance the project alignment through at least 4 distinct and highly variable geological conditions including abrasive granite, the Kenny Hill formation, alluvium and KL's notoriously difficult Class 5 extreme karstic limestone, with over a dozen interfaces between them. This presented unique challenges for each of the 11 underground stations as there was no one-size-fits-all solution.

Above the ground, the project proceeded through highly built-up areas with residential high-rises, heritage sites and under busy arterial roads, necessitating comprehensive building protection works, traffic diversions and utility relocations, with the project scope naturally including the removal of obstructions, underpinning and additional ground treatment works. Twelve major structures had to be demolished, including a 16-storey high police quarters. Other noteworthy works included the construction of cross passages and adits in risky areas, like the use of box-jacking to construct an underpass beneath the city's busiest primary road with no interruption to the traffic flowing above.

These challenges notwithstanding, MMC Gamuda surpassed the contractual requirements of the project by delivering various in-house construction innovations such as the world's first autonomous TBM system and novel applications of Building Information Modelling, Augmented Reality, Geospatial Information Systems and drone surveying to manage the mega project, as well as upskilling initiatives including pioneering institutions like the Tunnel Training Academy, BIM Academy and KVMRT Training Centre.

Throughout the MRT Putrajaya Line project, MMC Gamuda rose above trying circumstances and unimaginable challenges to demonstrate construction excellence in the region with timely delivery of tunnels, award-winning innovations and exemplary COVID-19 response. The strategic vision of the management team

to embrace technology in construction paved the way for in-house solutions such as the use of Augmented Reality in BIM and the Autonomous TBM (A-TBM) which were developed on the ground by young engineers in synergy with experienced seniors to overcome the challenges of conventional tunnelling. The AI system grants TBMs unprecedented capabilities to drive themselves with minimal human input, using AI driven algorithms to ingest data and make decisions in real-time. Deployed and proven effective across 4 distinct geological formations of Line2 with over 10km of tunnelling in both EPB and VD modes, this system won international acclaim as the ITA Technical Product/Equipment Innovation of the Year 2019.

The company is also one of the few globally to implement Building Information Modelling Level 2, certified by British Research Establishment, for a project of this scale and complexity. BIM is a 3D model-based process that cuts across civil, mechanical, electrical and architectural disciplines to produce a single source of truth, thus greatly enhancing design reviews in identifying potential clashes early and preventing abortive works. All these were only possible with the backing and active involvement of the client to achieve a transparent and collaborative work environment for all parties, from the design phase to operations reporting at site.

BIMAR (Augmented Reality for BIM) meanwhile, is a mobile app developed in-house at MMC Gamuda, that overlays a 3D BIM model in an actual built environment through camera feed. This allows for clashes and errors to be spotted instantly and prevents costly reworking. Monthly drone surveying offers 3D visual presentation of up-to-date progress at all sites. These photomosaics are accurate enough to be overlaid into BIM models and made accessible via a Cloud GIS portal. Driven by this data, the company adopted a paperless system to track and analyse information such as progress claims, quality inspections and safety reports.

However, fate dealt one more card against the project when the entire globe was gripped by the COVID-19 pandemic and all human activities ground to a halt worldwide. With the threat of a prolonged lockdown impacting construction progress, numerous preemptive measures were taken to protect the 16,000 strong project workforce and to ensure business continuity.

The early establishment of emergency preparedness and trauma care provisions was critical to the success of MMC Gamuda's COVID-19 crisis management response and it enabled the project to be granted special permission from the government to proceed with work at full capacity throughout the various imposed lockdowns, thanks to successful strategies in managing COVID-19 risks. The aforementioned internationally-accredited in-house laboratory now has a team of 40 technologists and pathologists who conduct over 90,000 free RT-PCR tests monthly for project staff members and workforce, with an average test result time of 4 hours.

MMC Gamuda's Centralised Labour Quarters (CLQ) were also revamped to incorporate "new norm" standards and to further redistribute workers, a new CLQ with an additional capacity for 2,800 people was built in less than 3 months. This facility is now touted as a model COVID-resilient worker accommodation with reduced living occupancy and segregation of common facilities.

Each CLQ comes with isolated quarantine blocks for positive cases while specially allocated quarantine hotels are available for the rest of the workforce which results in a clear divergence between rising national infection trends and the company's relatively low infection trend, thus securing the confidence of the authorities to gain work approval.

So effective are these initiatives that they have since become the gold standard for industry partners and government agencies alike. MMC Gamuda continues to work closely with the government to facilitate mass vaccination drives to supplement the national vaccination programme. To date, over 50% of project members had been inoculated, far exceeding the national average of 10% as of end June 2021.

Despite all these hurdles, the tunnelling package was delivered on schedule with the overall project remaining firmly on track, thanks in part the company's large-scale adoption of digital innovations and in-house solutions. Effective BIM implementation in particular, helped enhance project-wide collaboration in the proper coordination and integration of complex civil, electrical, mechanical and rail systems. These virtual design reviews helped manage construction progress by ensuring accuracy, preventing potential design clashes and costly reworks. MMC Gamuda's novel autonomous TBM system also brought tangible benefits with faster response times, improved accuracy and productivity gained from prolonged cutting tool life and shorter cycle times.

Its role as design and build contractor for the MRT Putrajaya Line also allowed the company to make strategic programme changes when necessary. When a slump zone was discovered in a particular site during construction for example, many plans were developed to tackle the worse-than-anticipated ground conditions and potential delays in the launch of two TBMs. A combination of a bespoke ground treatment scheme, redesign of the station deep foundation to a buried soil-bearing "floating" structure plus further optimisation of the temporary strutting systems enabled an earlier TBM launch of 75m from the head of the station box instead of the initial 200m. In another instance, a delay was imminent when an unexpectedly abrasive granitic region was encountered while mining, which ultimately required the teams to blast through a 100m stretch within the cutterhead before regular mining could be resumed.

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Also notable was the innovative application of geophysical principles of parallel seismic and magnetometry readings to identify potential obstructions in the tunnel envelope where as-built data was unreliable. In one particular location, 55 left-in piles were accurately evaluated and ruled out using this method. The completion of all tunnelling drives with minimal incidence validated the effectiveness of the novel methods employed.

Another impactful area which MMC Gamuda spearheaded was the adoption of material-efficient steel fibre reinforced concrete for tunnel linings, which led to further optimisation in the project to use less steel while exceeding specified requirements. Also recognising the huge demand for water in tunnelling operations, the company specifically set out to target 50% of the total water demand to be met by treated construction effluent. Industrialised Building System (IBS) was also adopted in the permanent structure of select shafts over 40m to yield the benefits of safer (less exposure to working at heights) and greener construction.

Applying the principles of a circular economy, a local TBM Refurbishment Facility was set up in collaboration with MMC Gamuda's technology partner, Herrenknecht AG, with a facility based in a neighbouring state, roping in local SME partners and suppliers in the steel industry and crews from the company's tunnel training academy. Eight TBMs from Line1 were refurbished and recommissioned for Line2, resulting in savings of over US$100 mil. These efforts further reduced the carbon footprint by eliminating the need to procure new TBMs or having to ship or source for materials between countries.

Apart from active participation in industry conferences and exhibitions, MMC Gamuda also runs in-house capacity building initiatives like the region's first Tunnel Training Academy (TTA), a BIM Academy and the KVMRT training centre (KTC), a one-stop centre for project-wide SHE trainings in partnership with local authorities. KTC provides hands-on specialist training for crane operators, scaffolders and other high-risk professions; to date it has upskilled over 50,000 personnel. Other internal efforts include ChaiTime, informal town halls on site with senior management staff, Women@Work, a workplace support and learning platform to empower women in construction.

The TTA has created job opportunities in the highly specialised field of tunnelling for over 1,000 personnel, many of them school-leavers who come from underprivileged backgrounds and supported the global talent pool by welcoming trainees for other international tunnelling projects. TTA graduates were also instrumental in the company's TBM refurbishment efforts, a first in the region.

With a high concentration of communities located along the project alignment, an extensive public engagement strategy was implemented to facilitate hundreds of interfacing works involving the public. A project hotline was also maintained 24/7 while case-to-case public engagement was handled by a dedicated team in sync with the site operation team. Community initiatives were often education-based, with STEM activities, sponsorship for schools in need and the upkeep of a long-standing project Info Centre which hosted a multitude of guests from all over the world to promote underground construction. Since the pandemic, site visits have been transformed into a 360° virtual reality experience inside a TBM or walking through a station box.

Recognising the amplified risk of construction in urban, underground environments, MMC Gamuda strives for industry excellence, gleaning from the best practices of the ITA and British Tunnelling Society and it bravely takes the lead where there is no local precedence. The company had since developed numerous guidelines and competency ranking systems to fill the gaps in local skillset and regulations, such as the standardised Construction Skills Certification Scheme which was first mooted in the project but had since been mandated nationwide and was a direct legacy of the project that would long remain. Other pioneering establishments by MMC Gamuda included the project's underground specialist Fire & Rescue Department (also a first in the country), created opportunities for knowledge transfer on a larger national scale and continued to support local agencies with its expertise in these areas, offering intensive specialist courses such as sinkhole emergency drills and flashover instructors' courses without cost.

The safety commitments made by the company throughout its implementation of the MRT Putrajaya Line project saw the project not only achieve but also maintain its British Safety Council 5 Star Rating for 3 consecutive years with 2 Swords of Honour and a 3rd pre-qualified. These, together with various UK recognitions bestowed, such as the International Best in Construction Sector award, validated the success of MMC Gamuda's step-change policies which consequently had a far-reaching industry impact.

With so many accolades and achievements under its belt, one would expect MMC Gamuda to be happy and rest easy but instead, the company has continued to push the boundaries of technology application in construction, with an eye on moving the entire industry forward. Going beyond Malaysian shores, its focus has now expanded to possible projects in Singapore and even Australia which, if its track-record is anything to go by, will bring forth even more innovations in the future. Goh Chee Young, the Deputy Project Director of MMC-Gamuda KVMRT(T) Sdn. Bhd. (Underground Works Package), says its senior management has already established a dedicated in-house unit to promote technological engineering solutions development, called the GET Innovation Hub. This unit will support and sustain the culture of innovation which has become synonymous with the MMC Gamuda corporate culture from top to bottom. Based on the winning formulas developed working on the MRT Line projects, it is foreseen to have tangible benefits on projects the company is already involved in overseas and moving forward. ■

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IEM 63rd Annual Dinner & Awards Night 2022

The Institution of Engineers, Malaysia (IEM) held its 63rd Annual Dinner & Awards Night 2022 at the Grand Lagoon Ballroom, Sunway Resort, Bandar Sunway, Selangor, on 23 July 2022. The event, themed G.R.O.W., was pursuant to the 63rd Annual General Meeting held on 16 April 2022 which saw the installation of its first woman President, Ir. Prof. Dr Norlida binti Buniyamin and the election of the new Council Members and Executive Committee line-up for Session 2022/2023.

The guest of honour was Y.Bhg. Dato' Ir. Nor Hisham bin Mohd Ghazali, Director-General of National Water Research Institute of Malaysia (NAHRIM). Also present were distinguished local and foreign personalities and senior government officials in the engineering field. Malaysia's Queen of Ballads, Dayang Nurfaizah and The Solianos, provided entertainment for the evening.

Picture 1: Ir. Prof. Dr Norlida (left) with NAHRIM Director-General Dato' Ir. Nor Hisham (right) and his wife, Datin Noriah Abu Bakar prior to the start of the Annual Dinner at Grand Lagoon Ballroom

Picture 2: Ir. Prof. Dr Norlida accompanies Dato' Ir. Nor Hisham into the Grand Lagoon Ballroom

Picture 3: NAHRIM Director-General Dato' Ir. Nor Hisham delivering his speech

Dato' Ir. Nor Hisham said that G.R.O.W aptly depicted the sentiment of the country on its way to recovery after the pandemic. Representing Growth, Reinforcement, Opportunity & Worth, it summarised the essence of IEM's aspirations as listed below:

- Growing need for local engineering talent
- Reinforcing the masterplan for national development
- Opportunities for local engineering players and
- Worth of the engineering-related industries as a whole

As the first woman president, after 63 years, of one of the largest professional bodies in the country, Ir. Prof. Dr Norlida paid tribute to her predecessors, recognising their selfless contributions to IEM and the nation and said this was something she would find very difficult to emulate. Touching on the Covid-19 pandemic, she said "we might not be out of the woods yet as new variants continued to appear now and then but, being engineers, we would find the solution and learn to cope like we had done for the last two years".

More than 1,200 members and guests comprising representatives from professional bodies and government agencies as well as guests from regional engineering organisations, witnessed the presentation of various awards to worthy recipients (individuals and companies) as follows:

IEM Distinguished Honorary Fellow Award
Y.Bhg. Academician Tan Sri Dato' Ir. Prof Emeritus Dr Chuah Hean Teik – IEM Past President
IEM Honorary Fellow
Ir. David Lai Kong Phooi – IEM Past President
IEM Young Engineer Award
Dr Ong Chong Yong
IEM Top Mentor Award
Ir. Lau Eng Kee
Ir. Juares Rizal bin Abd Hamid
Ir. Hj. Jamaludin bin Hj. Takei
Top Membership Drive Award
Ir. Dr Kwong Kok Zee: Individual for Graduate Member Category
Ir. Lim Kim Ten: Individual for Corporate Member Category
Tenaga Nasional Berhad: Organisation for Graduate Member Category
Tenaga Nasional Berhad: Organisation for Corporate Member Category
IEM Presidential Award of Excellence
Champion: Tunnelling and Underground Space Technical Division (TUSTD)
1st Runner-Up: Mechanical Engineering Technical Division (METD)
2nd Runner-Up: Electrical Engineering Technical Division (EETD)
3rd Runner-Up: Project Management Technical Division (PMTD)
4th Runner-Up: Geotechnical Engineering Technical Division (GETD)
Most Improved: Electronic Engineering Technical Division (eETD)

Award for the Highest Numbers of Virtual Activities Conducted
Champion: Electrical Engineering Technical Division (EETD)
1st Runner-Up: Project Management Technical Division (PMTD) and Information & Communication Technology Special Interest Group (ICTSIG)
2nd Runner-Up: Oil, Gas & Mining Technical Division (OGMTD)

Award for the Highest Paid Numbers of Participants of Virtual Activities Conducted
Champion: Civil & Structural Engineering Technical Division (CSETD)
1st Runner-Up: Electrical Engineering Technical Division (EETD)
2nd Runner-Up: Geotechnical Engineering Technical Division (GETD)

Contribution to Engineering Industry Award
Digital Industry: BIM Engineering Solution & Technology Sdn. Bhd .
Asset Management – Materials & Production: Inari Amerton Berhad
Asset Management – Industries: OPUS Consultants Sdn. Bhd.
Engineering Consultancy Practice: M.E.I. Consultants Berhad
Power Energy & Green Technology Industry: Samaiden Group Berhad

Outstanding Engineering Achievement Award
Ken Holdings Berhad for the design and construction of Menara Ken TTDI

The following 14 top engineering students from local universities also received IEM Gold Medal Awards in recognition of their excellent performance in their studies.

No	Student's Name	University
1	Leong Khai Yuann	Asia Pacific University of Technology & Innovation
2	Gan Rui Xin	Universiti Pertahanan Nasional Malaysia
3	Tieh Zhe Xuan, Daniel	AMIST University
4	Micheal Ong Tse Yuen	Heriot-Watt University Malaysia
5	Ho Chee Hong	Inti International University
6	Leong Jie Sheng	UOWN KDU UC
7	Chan Jun Kang	Monash University
8	Chua Xin Yi	University of Nottingham Malaysia
9	Chwa Li Anne	SEGi University
10	Jayne Tan Zhia Ne	Swinburne University of Technology
11	Lim Jin Xiang	Tunku Abdul Rahman University College
12	Ryan Adler Tan	Universiti Malaysia Sarawak
13	Chong Ying Hai	UCSI University
14	Genee Koh Jing Ying	Universiti Putra Malaysia
15	Ng Yee Jie	Universiti Tunku Abdul Rahman
16	Abdul Haziq bin AbdulYazid Muhammad Adham Mohd	Universiti Teknologi Petronas
17	Alias	Universiti Teknologi Mara

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Picture 4: Past Presidents of IEM. Left to right: Dato' Ir. Dr. Gue Sew Sew, Dato' Paduka Ir. Prof. (Dr) Haji Keizrul bin Abdullah, Tan Sri Datuk Ir. (Dr) Haji Ahmad Zaidee bin Laidin, Dato' Ir. (Dr) Lee Yee Cheong, Ir. Prof. Dr Norlida Buniyamin, Ir. David Lai Kong Phooi, Dato' Ir. Lim Chow Hock, Tan Sri Dato' Ir. Prof. Emeritus Dr Chuah Hean Teik, Ir. Dr Tan Yean Chin and Ir. Ong Ching Loon

Picture 6: IEM Gold Medal recipients: Engineering students from 14 local universities pose with the IEM President after receiving their medals

Picture 5: Left to right: IEM Vice President Ir. Hj. Mohd. Aman Hj. Idris, Vice President Ir. Yau Chau Fong, Vice President Ir. Mohd Khir Muhammad, Deputy President Ir. Prof. Dr Jeffrey Chiang Choong Luin, President Ir. Prof Dr Norlida Buniyamin, Vice President Ir. Chen Harn Shean, Vice President Ir. Prof. Dr Tan Chee Fai, Vice President Ir. Abdul Razak Yakob, Honorary Secretary Ir. Prof. Dr Zuhaina Zakaria and Honorary Treasurer Ir. Dr Lee Yun Fook

Picture 7: Winners of Awards for Contribution to Engineering Industry. Left to right: Ts. Edward Han Liang Kwang (BIM Engineering & Solution), Encik Noorazizi Che Adib (Inari Amerton), Dato' Ir. Lim Kok Khong (MEI Consultants), Ir. Prof Dr Norlida Buniyamin, Ir. Chow Pui Hee (Samaiden) and Ir. Dr Tony Chan Tuck Leong (OPUS Consultants)

Picture 8: Ir. Prof. Dr Norlida Buniyamin presenting the Outstanding Engineering Achievement Award 2022 to Dato' Kenny B.K. Tan, Chairman of KEN Holdings Berhad

Application of Space-borne Technologies for Ground & Structural Deformation Monitoring

Written and Prepared by:

Ir. Assoc. Prof. Dr Rini Asnida Abdullah

Ir. Frankie Cheah

On 27 January 2022, the Tunnelling & Underground Space Technical Division (TUSTD) of The Institution of Engineers, Malaysia (IEM) organised a webinar titled Application of Space-borne Technologies for Ground & Structural Deformation Monitoring. There was a total of 63 participants at the webinar which was moderated by Assoc. Prof. Ir. Dr Rini Asnida Abdullah, a technical committee member of TUSTD.

Three speakers from Kokusai Kogyo Co. Ltd. (KKC) of Japan, delivered talks from 4.00 p.m. to 6.00 p.m. These experts in various fields relating to ground and structural deformation using space-borne technologies were Dr Sasakawan Tadashi, Mr. Mitsutomo Nakamura, and Mr. Dipendra Sunuwar.

Dr Tadashi started the webinar with a talk on the principle and fundamental overview of the satellite system for remote sensing. He briefly described the different types of remote sensing and wavelengths and touched on satellite positioning, navigation and timing (PNT) services on a global or regional basis.

The second speaker, Mr. Nakamura, introduced remote sensing technology for holistic deformation using Interferometric SAR (InSAR). He highlighted some case studies on InSAR application in monitoring ground and

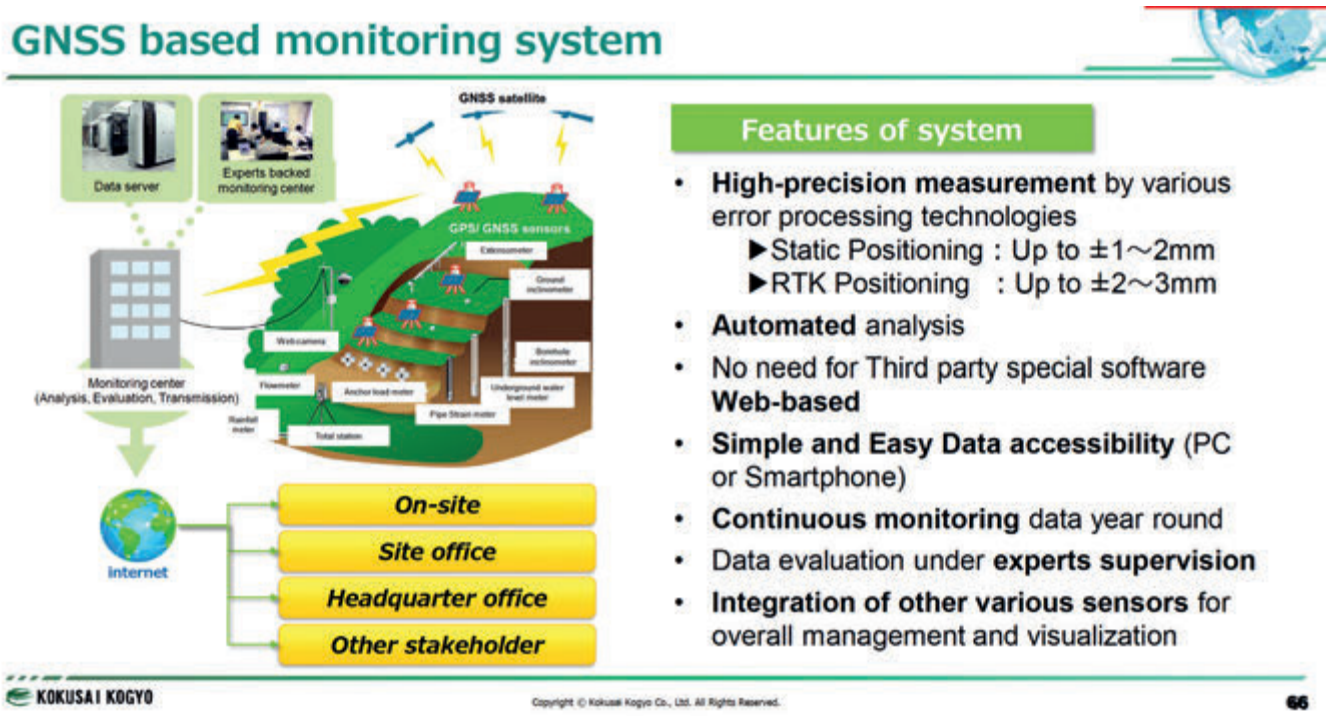

Figure 1: GNSS-based monitoring system

structural deformation which included:

1. Land subsidence trend
2. Detection of deformed building and dam structure
3. Ground surface displacement during underground construction work.

He said InSAR can help estimate the inundation of water depth and area affected during the flood. InSAR will eliminate fieldwork, global coverage and GIS Ready Georeferenced.

The last speaker, Mr. Dipendra Sunuwar, addressed the Global Navigation Satellite System (GNSS) based monitoring applications and uses (Figure 1). GNSS used satellite positioning for continuous and precise three-dimensional deformation monitoring, with precisions of up to 1mm. The successful installations of GNSS were delivered comprising the application for displacement monitoring underground tunnel below residential area, slope displacement monitoring, viaduct monitoring, etc. It had also been proved that web-based monitoring values from GNSS RTK (real-time kinematic positioning) were more stable, regardless of harsh weather such as heavy rain.

The webinar ended with a Q&A session. The moderator thanked Dr Tadashi, Mr. Nakamura and Mr. Sunuwar for their time taken to deliver the webinar talks (Figure 2). ■

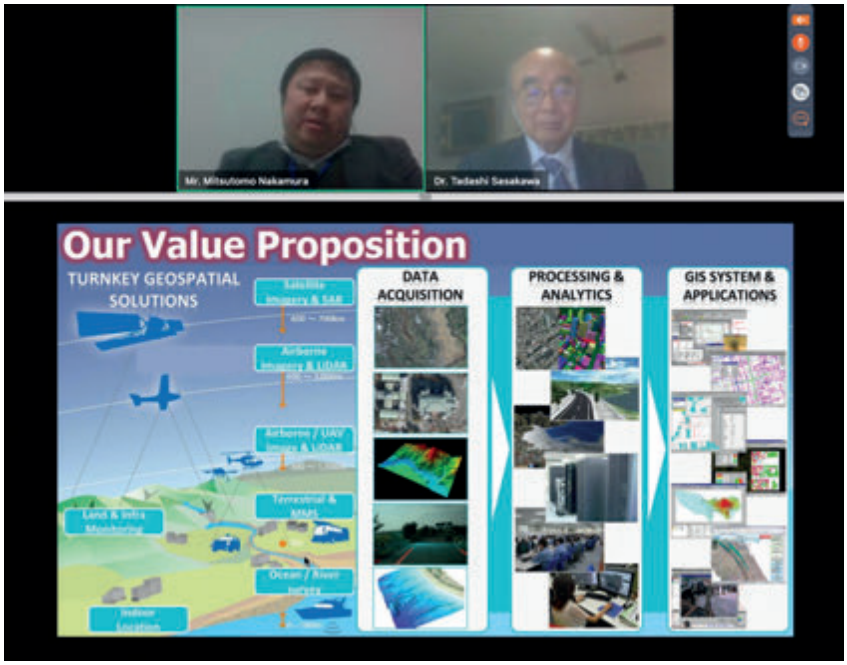

Figure 2: Mr. Nakamura (left) and Dr Tadashi during the Q&A session

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#3

Webinar on Application of Vertical Sinking Machine Method for Shaft Construction

Written and Prepared by:

Mr. Ang Ming Huei

On 23 April 2022, the Tunnelling & Underground Space Technical Division (TUSTD) of The Institution of Engineers, Malaysia (IEM) organised a webinar on Application of Vertical Sinking Machine (VSM) Method for Shaft Construction in conjunction with its AGM from 11.30 a.m. to 1.30 p.m.

The honorary speaker was Mr. Chen Ying Kang, an experienced Tunnel Manager from Shanghai Tunnel Engineering Co. Singapore (STECS). A total of 130 participants attended the webinar which was moderated by Mr. Ang Ming Huei, a committee member of TUSTD.

First, Mr. Chen expressed his appreciation at being invited to speak at the webinar and sharing session for the application of the Vertical Sinking Machine (VSM) method which was successfully executed in a recently completed PUB DTSS-2 project in Singapore.

He gave a brief, informative introduction to the VSM (Figure 1), with its applications in the compact site laydown area. The typically small site laydown area (Figure 2), as compared to the conventional shaft construction method, is an important key element, especially for shaft construction in limited available working spaces such as Kuala Lumpur or Singapore City. Mr. Chen also illustrated all the key components of the VSM (Figure 3) followed by shaft construction methodology of using the VSM.

There was an impressive stimulation video showing shaft construction using the VSM method which involved the setting up, excavation profiles on various ground conditions, installation of the precast segment shaft, controlled self-balancing and sinking of the shaft concurrently with the shaft excavation activity. Upon completion of shaft precast segment and excavation to the designated level, the in-situ casting method was adopted at tunnel eye followed by the construction of the shaft base.

Mr. Chen also presented remedial/repair measures for the shaft in the event of basal heave or excessive shaft wall leakage as well as operations and temporary work aspects such as ground improvement, lifting consideration, formworks for in-situ casting, strand hydraulic jacks and wires strand.

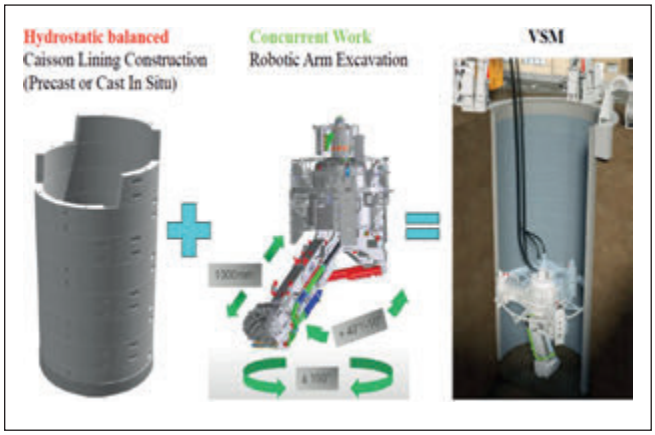

Figure 1: Schematic illustration of Vertical Sinking Machine construction method

Next, he showed the actual work time-frame for using conventional shaft excavation and construction in comparison to using the VSM pre-cast segmental lining; this clearly illustrated savings in terms of time/manpower which is another important key element in the construction industry today with regards to carbon footprint and labour shortage.

In addition, using the VSM is also safer as this construction method can significantly reduce the need for humans to work at heights and in confined spaces.

Then Mr. Chen mentioned some of the limitations and constraints of using VSM, such as high preliminary and utility diversion costs, inability to achieve optimal performance for strata harder than 120MPa and being limited to a circular shape only.

He reiterated that extensive operation monitoring, instruments monitoring and periodic maintenance were

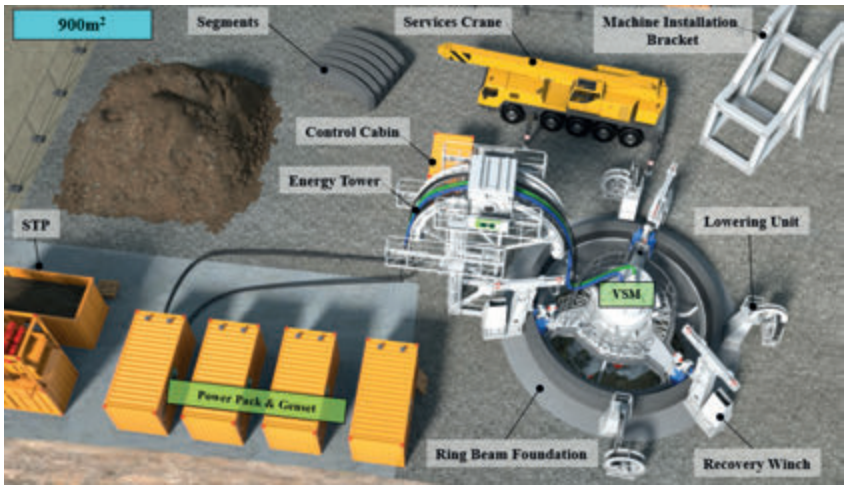

Figure 2: Typical compact site laydown using VSM construction method

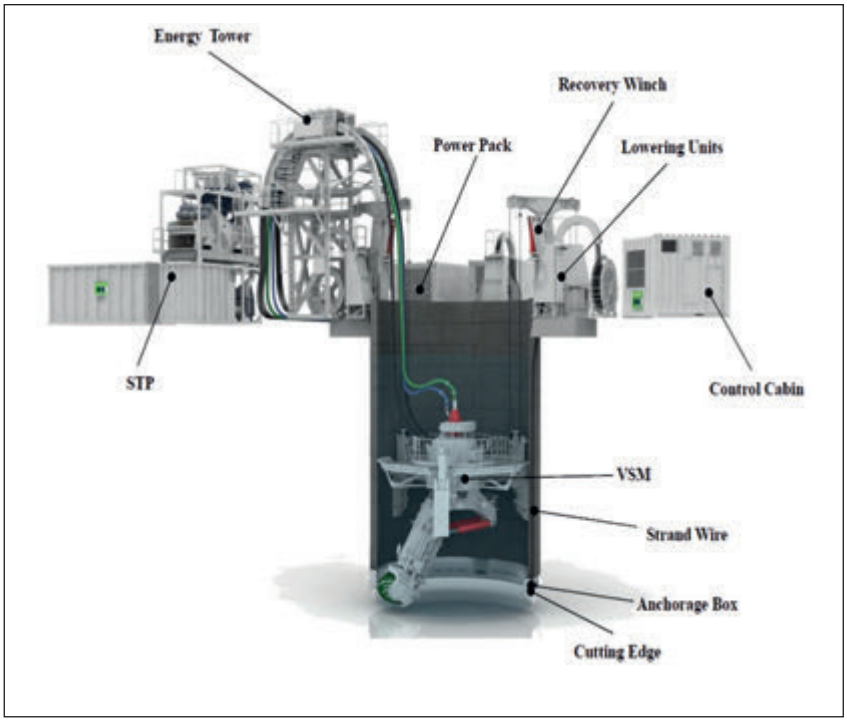

Figure 3: Key components elements of Vertical Sinking Machine

required at all times during the construction period in order to overcome and control the series of challenges, such as segment erection quality, cutter head drop, shaft unable to self-sink, drum unable to work due to sticky and clay soil condition, VSM breakdown, etc. He then presented various preventive measures and solutions to each of the respective major challenges mentioned.

Mr. Chen finished his presentation by showing the possibility of using VSM for other applications in various advanced engineering techniques and innovative solutions as it always ensured a high level of safety during construction and effective time-cost balance.

After a Question & Answer session, the moderator thanked Mr. Chen and STECS for their time and efforts. The webinar ended at 1.30 p.m. ■

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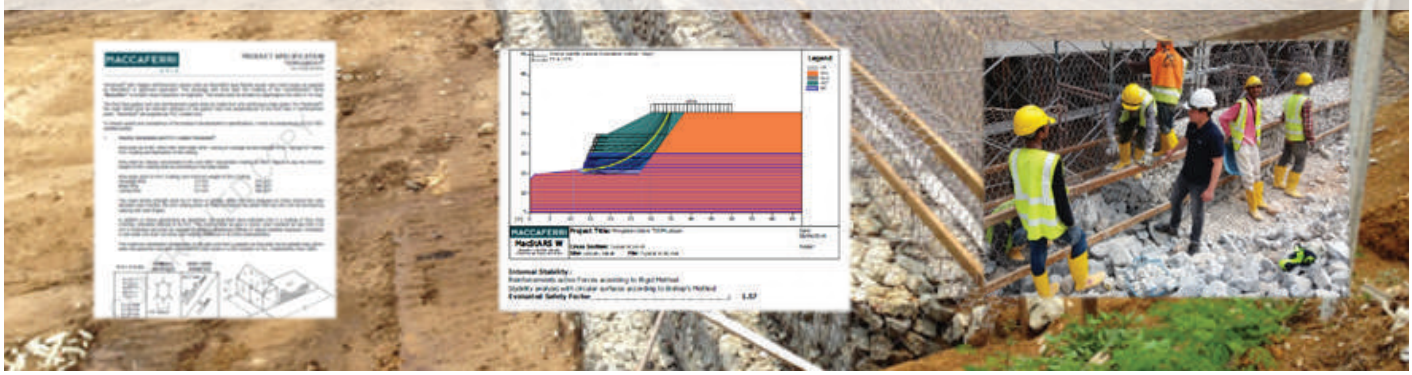

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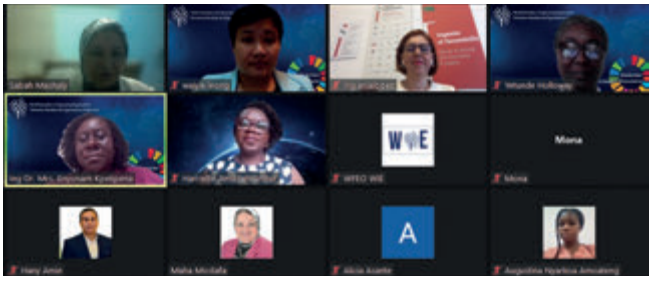
International Women in Engineering Day 2022

Written and Prepared by:

Ir. Prof. Dr Leong Wai Yie

In conjunction with International Women in Engineering Day 2022, INTI International University and The World Federation of Engineering Organisations (WFEO) Women in Engineering, invited the winners and recognised nominees of Women in Engineering to speak on Innovation Leadership For Engineering. The award to recognise outstanding woman engineers was first introduced at the 50th Anniversary of WFEO at UNESCO in Paris in March 2018. The speakers – Prof. Rosalind Archer, Ing. Harriet Amissah-Arthur, Magali Anderson, Sabah Mohamed Mashaly and Ir. Prof. Dr Leong Wai Yie – shared their experiences and contributions in their respective fields.

1. Prof. Rosalind Archer presented traits which can be taught to university students to cultivate them into innovative professionals.
2. Ing. Harriet Amissah-Arthur shared tips on giving a voice to sub-represented groups such as indigenous people, which can be turned into innovative solutions.
3. Magali Anderson talked about her experiences in cultivating innovation among employees in an organisation as well as her vision on how innovation and sustainability can walk together.
4. Sabah Mohamed Mashaly spoke on the importance of innovation in the energy sector to help achieve climate change goals in her country, Egypt, this year.
5. Ir. Prof. Dr Leong Wai Yie stressed on the importance of women participation in research and innovation which can provide solutions to problems such as climate change, clean energy, environmental sustainability and appropriate technology.



Each prominent speakers shared their experiences and contributions in their respective fields

International Women's Day and World Women Engineer Day are avenues for promoting female participation in the development of science and innovation. Women are expected to become more conscious of their potentials and to explore their abilities and interests in research and innovation because these are the key to building an advanced nation.

Boosting women's participation requires the following:

- Support, investment and acceptance of women in the world of industrial engineering.
- Promoting science through role models and mentoring programmes to inspire young women.
- Developing digital economy to encourage women in entrepreneurship.

The speakers left the following pieces of invaluable advice that the audience can reflect on: "Be an engaged team member. Celebrate team success but do not forget to recognise the contributions of the individual. Find good mentors along the way and, in turn, share your knowledge and become a mentor yourself. Be willing to take on new assignments and roles, even if (perhaps, especially if) these are outside the scope of what you typically do. This will expand your network and give you different perspectives. Appreciate what others do to make the business successful. ■

Success Factors for Sustainable Product Design

Written and Prepared by:

Ir. Dr Oh Seong Por

On 28 May 2022, IEM Negeri Sembilan Branch (IEMNS), IEM Melaka Branch and Technological Association of Malaysia (TAM), Negeri Sembilan Branch, organised a talk on Success Factor for Sustainable Product Design. The talk, delivered by Ir. Dr Oh Seong Por, the Immediate Past Chairman of IEMNS, had 18 participants who included engineering consultants, industry operational engineers and lecturers (Figure 1).

Figure 1: Co-organisers IEMNS, IEMM and TAM

First, Dr Oh introduced sustainable product design as one of the affirmative actions to protect the environment and then touched on the roles of the government, industry and university (research centres) as success factors of sustainable product designs (Figure 2).

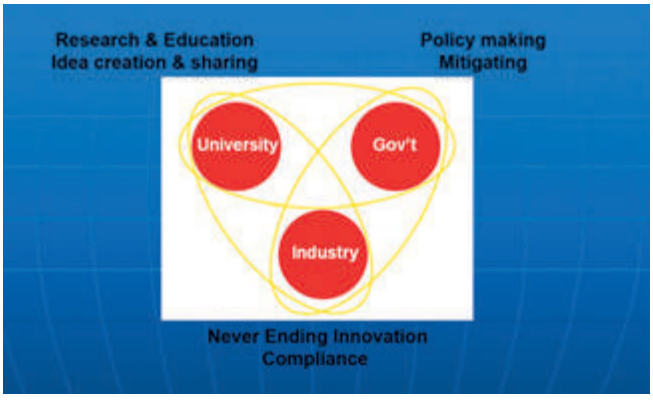


Figure 2: Joint effort by the government, industry and university

The discussion on a case study involving the electric car as a sustainable product design attracted active participation in the Q&A session.

Success Factor

Government: According to Dr Oh, the government, empowered with executive and legislative powers to dictate policies and perform mitigation roles, can set the right conditions to encourage the development of sustainable products. For example, many signatories of the Paris Climate Agreement 2016 are committed to reducing carbon dioxide emission, especially from fossil-fuelled internal combustion engine vehicles. Various incentives including tax exemption, free toll, free parking, loan and grant have been introduced. These boosted the demand for electric cars from 2017 and, by 2020, over 10 million vehicles had been sold.

Industry: It has two main roles:

1. To enshrine sustainable product development and protection of the environment into the corporate business philosophy.
2. To continuously innovate products or services to optimise usage of resources (material, energy and water) and to cut down waste generation.

For example, car makers such as Toyota, Ford, Geely and Volkswagen, have announced plans to collaborate with battery manufacturers (such as CATL, Panasonic and Samsung SDI) to develop high performance batteries at lower costs.

University: As a place for cultivating minds and creating new knowledge, the university can become an important platform to develop green technology. Besides the lithium-ion battery developed by Dr John Goodenough at Oxford University in 1980, many researchers have been relentlessly developing new active materials and electrolytes to improve power density and charging speed. These have contributed to longer travel distances of 500-700km between charges and shorter recharging times of under 30 mins.

In conclusion, Dr Oh said that the key determinant to drive the successful implementation of sustainable product designs is carefully-thought-out strategies with active participation by government, industry and university. ■

Tarikh: 14 September 2022

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Berikut adalah senarai calon yang layak untuk menduduki Temuduga Profesional bagi tahun 2022.

Mengikut Undang-Undang Kecil IEM, Seksyen 3.8, nama-nama seperti tersenarai berikut diterbitkan sebagai calon-calon yang layak untuk menjadi Ahli Institusi, dengan syarat bahawa mereka lulus Temuduga Profesional tahun 2022.

Sekiranya terdapat Ahli Korporat yang mempunyai bantahan terhadap mana-mana calon yang didapati tidak sesuai untuk menduduki Temuduga Profesional, surat bantahan boleh dikemukakan kepada Setiausaha Kehormat, IEM. Surat bantahan hendaklah dikemukakan sebulan dari tarikh penerbitan dikeluarkan.

Prof. Ir. Dr Zuhaina binti Zakaria
Setiausaha Kehormat, IEM

PERMOHONAN BARU / PERPINDAHAN MENJADI AHLI KORPORAT

Nama	Kelayakan
KEJURUTERAAN AWAM	
KUEK SHEOW LIN	BE HONS (MALAYA) (CIVIL, 2005)
NURUL DIANA BINTI RAUZAN	BE HONS (UiTM) (CIVIL, 2009) MSc (UiTM) (CIVIL (CONSTRUCTION), 2013)
KEJURUTERAAN ELEKTRONIK	
FAUZIYAH BINTI SALEHUDDIN	BE HONS (UiTM) (ELECTRICAL, 2001) MSc (UKM) (MICROELECTRONICS, 2004) PhD (UNITEN) (2012)
KEJURUTERAAN KIMIA	
LAI SHIOU POH	BE HONS (UTM) (CHEMICAL, 2009)
KEJURUTERAAN MEKANIKAL	
MOHD IZZAT BIN MOHD THIYAHUDDIN	BE (MINNESOTA) (MECHANICAL, 2009) PhD (QUT) (2014)

PERMOHONAN BARU / PERPINDAHAN MENJADI AHLI KORPORAT

Nama	Kelayakan
KEJURUTERAAN MEKANIKAL	
SURESH A/L TAREMELINGGAM	BE HONS (UNITEN) (MECHANICAL, 2014)
KEJURUTERAAN PERLOMBONGAN	
PRAKASH TEOH	BE HONS (USM) (MINERAL RESOURCES, 2004)

PERPINDAHAN AHLI

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
48071	JILL FLUER C BENSING	BE HONS (UTM) (CIVIL, 2006)
20597	LEE CHUI HOON	BE HONS (UTM) (CIVIL, 2005)
97332	NADIA JASWINE JAMES	BE HONS (UiTM) (CIVIL, 2010)
72623	SWEE YENN PERNG	BE HONS (BRADFORD) (CIVIL, 2010) ME (BRADFORD) (CIVIL AND STRUCTURAL, 2010)
KEJURUTERAAN ELEKTRIKAL		
24099	CHUNG GHI HENG	BE HONS (CURTIN) (ELECTRICAL, 2006)
43775	MUKHZANIM HELMI BIN MOHAMAD	BE (KYUSHU INSTITUTE OF TECHNOLOGY) (ELECTRICAL, 2009)
116700	TIANG TOW LEONG	BE HONS (USM) (ELECTRICAL, 2009)
88446	TOMMY SILVESTER	BE HONS (UMS) (ELECTRICAL & ELECTRONICS, 2013)
KEJURUTERAAN GEOTEKNIKAL		
48481	KHOO LAI PENG	BE HONS (UMP) (CIVIL, 2010)
KEJURUTERAAN PEMBUATAN		
50906	NUR AMALINA BINTI MUHAMMAD	BE HONS (USM) (MANUFACTURING WITH MANAGEMENT, 2012) MSc (USM) (MECHANICAL, 2014) PhD (USM) (2020)
KEJURUTERAAN MEKANIKAL		
45779	MOHD FAIZ BIN AHMAD SHAHROM	BE HONS (UTP) (MECHANICAL, 2009)
94128	MUHAMMAD SYAKIRIN BIN RAZAKI	BE HONS (UNITEN) (MECHANICAL, 2008)
108262	NG TIAN YI	ME HONS (MANCHESTER) (MECHANICAL, 2018)
105648	SIVANES A/L SINGARAVELU	BE HONS (UTHM) (MECHANICAL, 2013)

PERMOHONAN BARU / PERPINDAHAN MENJADI AHLI KORPORAT

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
38048	CHONG EU MEE, ELIZABETH	BE HONS (UTM) (CIVIL, 2005) ME (UTM) (CIVIL - TRANSPORTATION AND HIGHWAY, 2007) PhD (SWINBURNE) (2020)
49870	MUHAMMAD RIZAL BIN RAZALI	BE HONS (UTM) (CIVIL, 2010) ME (UPM) (WATER, 2013)
112192	PANG TZE CHIN, PANG	BE (KARLSRUHE UNIVERSITY OF APPLIED SCIENCE) (CIVIL, 2012) ME (BEUTH UNIVERSITY OF APPLIED SCIENCE) (CIVIL, 2014)
64649	TENGKU AMIR SHAH BIN TENGKU ALIM SHAH	BSc (LOUISIANA AT LAFAYETTE) (CIVIL, 2012) MSc (UTP) (OFFSHORE, 2017)
KEJURUTERAAN ELEKTRIKAL		
44150	EZWAN ARDIE BIN ZAIS	BE HONS (UTM) (ELECTRICAL, 2004)
37780	MANURAAJ A/L KUNASEGARAN	BE HONS (UNITEN) (ELECTRICAL POWER, 2012)
KEJURUTERAAN ELEKTRONIK		
95825	SYAMSUL BAHREEN BIN MOHD SATAR	BE HONS (UTM) (ELECTRICAL - ELECTRONIC, 2006)
108002	TAN XIAO JIAN	BE HONS (UniMAP) (BIOMEDICAL ELECTRONICS, 2016) PhD (UniMAP) (2020)
KEJURUTERAAN KIMIA		
23311	TAN JULLY	BE HONS (UTM) (CHEMICAL, 2005) ME (UTM) (ENVIRONMENTAL, 2007) PhD (MALAYA) (2018)
KEJURUTERAAN MEKANIKAL		
109233	KAVILAN SADACHARAMANI	BSc (IOWASTATE) (MECHANICAL, 2010)
17900	PRABAKARAN A/L MANOGARAN	BE HONS (OXFORD BROOKES) (MECHANICAL, 1996)

Pengumuman yang ke-167

SENARAI PENDERMA KEPADA WISMA DANA BANGUNAN IEM

Institusi mengucapkan terima kasih kepada semua yang telah memberikan sumbangan kepada tabung Bangunan Wisma IEM. Ahli-ahli IEM dan pembaca yang ingin memberikan sumbangan boleh berbuat demikian dengan memuat turun borang di laman web IEM http://www.iem.org.my atau menghubungi secretariat di +603-7968 4001 / 5518 untuk maklumat lanjut. Senarai penyumbang untuk bulan Ogos 2022 adalah seperti jadual di bawah:

NO.	NO. AHLI	NAMA
1	30536	MR. MOHD DALIAS BIN AWI
2	81063	MR. KWONG JEE KONG
3	15288	MR. LAI KUAN PIN, DONNY

Upcoming Activities

Webinar on 'Structural Analysis, Design and Detailing Using Digital Technology'

Date	:	12 October 2022 (Wednesday)
Time	:	3.00 p.m. – 5.00 p.m.
Venue	:	Digital Platform
Approved CPD	:	0
Speakers	:	Ir. Wong Sik Kwang
	:	Mr. Raymond Chow
	:	Mr. Hong Ming

One Day Short Course on Recent Developments in Soft Soil Improvement Methods (In conjuction with GEESS2022)

Date	:	17 October 2022 (Monday)
Time	:	9.00 a.m. – 5.00 p.m.
Venue	:	Wisma IEM
Approved CPD	:	6
Speaker	:	Professor Chu Jian

CONTINUATION FROM MAY ISSUE 2022

PERMINDAHAN KEPADA AHLI SISWAZAH

No. Ahli	Nama	Kelayakan
KEJURUTERAAN MEKANIKAL		
51947	ALBERT NELSON ANAK ROBERT	BE HONS (UNIMAS) (MECHANICAL & MANUFACTURING, 2015)
90309	ANAS TAZZ BIN MOHAMMAD	BE HONS (UiTM)(MECHANICAL, 2021)
87091	ARJUN RVAN RAVINDRAN	BE HONS (MONASH UNI.) (MECHANICAL, 2018) ME (THE UNI. OF MELBOURNE) (MECHANICAL, 2020)
76540	CHIA CHIN SENG	BE HONS (UTHM)(MECHANICAL, 2018)
94730	CHONG CHEE HAO	BE HONS (UTAR)(MECHANICAL, 2020)
86414	CHUAH ZHUO WEI	BE HONS (UPNM)(MECHANICAL, 2019)
95788	DARYL IAN PALIATH	BE HONS (UNITEN) (MECHANICAL, 2018)
60954	FADHILAH BINTI SUTAN IBRAHIM	BE HONS (UMP)(MECHANICAL, 2016)
40451	FUAD SHAKIR BIN ABDUL AZIZ	BE HONS(UTM)(MECHANICAL - MARINE TECH., 2011)
79879	JONATHAN JOHNNY RAJATIN	BE HONS(UNITEN) (MECHANICAL, 2019)
63587	JOSHUA PAULRAJ A/L NALLATHAMBI	BE HONS (UTHM)(MECHANICAL, 2017)
94080	KABILASHEN READDYI A/L MUNUSAMY	BE HONS(UTP)(MECHANICAL, 2020)
44832	KAM JIA LIQ	BE HONS (UTM)(MECHANICAL, 2012)
91117	KEE CHUN WEI	BE HONS (UMP)(MECHANICAL, 2020)
101891	KHAIRUL MUHAMMAD AKMAL BIN KHAIRUL AZHAR	BE HONS(UNITEN) (MECHANICAL, 2019)
69385	KOH JIAN XIANG	ME HONS (NOTTINGHAM) (MECHANICAL, 2017)
52730	LAI JIA JIUN	BE HONS(CURTIN UNI.) (MECHANICAL, 2013)
77769	LEE ZHENG FUK	BE HONS (UNIMAS) (MECHANICAL & MANUFACTURING, 2018)
76492	MOHAMAD AZARUDDIN BIN MOHD ZAIN	BE HONS (UTHM)(MECHANICAL, 2018)
97765	MOHAMMAD HIRZAN BIN MD ZAHAR	BE HONS (CURTIN UNI) (MECHANICAL, 2019)
99681	MOHAMMAD SAFIBIN ISLAM	BE HONS (UOW M'SIA KDU UNI. COLLEGE)(MECHANICAL, 2020)
61329	MOHD NADRIE HASFUAN BIN HASANUDDIN	BE HONS (UiTM)(MECHANICAL, 2016)
69963	MOHD SHAUQI BIN ISA	BE HONS (UNIMAS) (MECHANICAL & MANUFACTURING, 2017)
79963	MUHAMAD NUR AKMAL BIN ROSLAN	BE HONS(UNITEN) (MECHANICAL, 2019)
87775	MUHAMMAD DANIEL BIN POAT	BE HONS (UNITEN) (MECHANICAL, 2019)
32795	MUHAMMAD KHAIRIL ANUAR BIN MOKHTAR	BE HONS (UTP)(MECHANICAL, 2009)
67671	MUHAMMAD TAUFIQ B. MOHD HANAFIAH	BE HONS (UiTM)(MECHANICAL, 2017)
82732	NUR ATHIRAH BINTI SHAHRUDIN	BE HONS (UTHM)(MECHANICAL, 2019)
67716	NURUL AIMI BINTI MOHD FAUZY	BE HONS (UTP)(CIVIL, 2019)
85039	PRASATH RETNAM	BE HONS (UTAR)(MECHANICAL, 2020)
95767	SHAILENDRA A/L MANOHARAN	BE HONS (UNITEN) (MECHANICAL, 2018)
89856	SIEW TZE HUNG	BE HONS (UTAR SG LONG) (MECHANICAL, 2021)
47798	SITI ZAHARAH BINTI MOHD. IBRAHIM	BE HONS (UNIMAS) (MECHANICAL & MANUFACTURING, 2013)
64689	TEOH LIK YANG	BE HONS (UNITEN) (MECHANICAL, 2013)
70003	THADDEUS SENABONG ANAK RENJAN	BE HONS (UNIMAS) (MECHANICAL & MANUFACTURING, 2017)
102139	TING SIEN KIONG, CLEMENT	BE HONS (UTAR)(MECHANICAL, 2020)
84491	WILVER ANAK PHILIP	BE HONS (UTM)(MECHANICAL - MANUFACTURING, 2019)
99642	WONG CHOONG YI, JUSTIN	BE HONS (MONASH UNI.) (MECHANICAL, 2019)
42076	WONG YIK HOE	BE HONS(UCSI UNI.) (MECHANICAL, 2013)
KEJURUTERAAN MEKATRONIK		
52582	MOHD YUSRI BIN AZIZAN	BE HONS (UNIMAP) (MECHATRONICS, 2012)
KEJURUTERAAN PEMBUATAN		
50356	ZULFADZLI BIN MAZLAN	BE HONS (UiTM)(MECHANICAL - MANUFACTURING, 2016)
KEJURUTERAAN PETROLEUM		
75182	MUHAMMAD ILHAM BIN ABDUL KARIM	BE HONS (UiTM)(OIL & GAS, 2016)
113159	THEVARUBAN RAGUNATHAN	BE HONS (UTP)(PETROLEUM, 2018) MSc (UTP)(PETROLEUM, 2020)

PERMOHONAN MENJADI AHLI SISWAZAH

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AERONAUTIKAL		
115254	MAHENDRAN A/L APPADURAI	DCAM PART 66 CATEGORY C HOLDER (CAAM)(2018)
115283	LOH KIM SING	DCAM PART 66 CATEGORY C HOLDER (CAAM)(2021)
KEJURUTERAAN AEROANGKASA		
114963	ABDUL RASHID BIN HAJI SERAKAWI	BE HONS (USM)(AEROSPACE, 2007) MSc (USM)(AEROSPACE, 2012)
KEJURUTERAAN PERTANIAN		
115188	MOHD HAFIZZ BIN WONDI	BE HONS (UPM)(AGRICULTURAL & BIOSYSTEMS, 2016)
KEJURUTERAAN BIO-KIMIA		
115217	NOR MARINA BINTI OMAR	BE HONS (IIUM)(BIOCHEMICAL - BIOTECHNOLOGY, 2005)
KEJURUTERAAN KIMIA		
115161	ADAM HARITH BIN ZAFRUL FAZRY	BE HONS (UNSW)(CHEMICAL, 2020)
115134	PATMASHINI SAII A/P K. NITHYANANTHAN	BE HONS (UTAR) (PETROCHEMICAL, 2021)
115147	TOH JIAN HENG	BE HONS (UTP)(CHEMICAL, 2020)
115260	VOO WEI XIN	BE HONS (UTAR)(CHEMICAL, 2020)
114784	MOHAMAD IDLAN BIN MOHAMAD IZHAR	ME HONS(HERIOT-WATT UNI)(CHEMICAL - OIL & GAS TECHNOLOGY, 2019)
115286	LALIDHAMBIGAI CHANTHARAN	BE HONS (TAYLOR'S UNI.) (CHEMICAL, 2020)
115221	RAHINEE A/P NAGAPPAN	BE HONS (UPM)(CHEMICAL, 2019)
114788	CHIA KAM HWANG	BE HONS(UPM)(CHEMICAL, 1999)
114934	MUHAMMAD AKMAL BIN MOHD SHAHAR	BE HONS (UiTM)(CHEMICAL WITH ENVIRONMENTAL, 2018)
114955	TEE ZU YAN	ME HONS (IMPERIAL COLLEGE LONDON, 2019)
115185	SHALINI D/O MANIARASAN	BE HONS (UMP)(CHEMICAL, 2017)
114978	MOHD FARID FAHMI BIN SUKRI	BE HONS (USM)(CHEMICAL, 2015) MSc (USM)(CHEMICAL, 2018)
115191	TAN SO CHUAN	BE HONS (UTAR)(CHEMICAL, 2016)
114956	OMAR BIN AHMAD FAUZI	BE (UNI. OF MINNESOTA) (CHEMICAL, 2014)
115177	NAJEEB BIN ABDUL KHALID	BE HONS (UNIMAP) (BIOPROCESS, 2014) MSc (UPM)(PROCESS SAFETY & LOSS PREVENTION, 2017)
115236	B. ANANDHADHASAN A/L BALASANDRAN	BE HONS (UTAR)(CHEMICAL, 2012)
115290	CHAN SUE CHING, GERALDINE	BE (UMP)(CHEMICAL, 2013) ME (UMP)(CHEMICAL, 2016)
115287	Dr ARMAN BIN SIKIRMAN	BE HONS (UiTM) (CHEMICAL, 2012) PhD (UiTM)(CHEMICAL, 2017)
114795	SYED HAFIF NAJADBUDIN BIN SYED HAMDAN	BE HONS(UTM)(CHEMICAL, 2020)
114932	CHIN KAI KEAN	BE HONS (UTM)(CHEMICAL, 2009)
115272	CHAN BOON SAN	BE HONS (UMS)(CHEMICAL, 2007)
117110	NOORSURIA BINTI SURADI	BE HONS (UTM) (CHEMICAL, 2006) ME (UPM)(ENVIRONMENTAL, 2014)
115193	JOHAN @ EDDY LUARAN	BE HONS (USM)(CHEMICAL, 2001)
115150	FARHANAH BINTI AHMAD SHAH	BE HONS (UTM)(CHEMICAL, 1996) ME (UM)(SAFETY, HEALTH & ENVIRONMENT,
KEJURUTERAAN AWAM		
114823	TAN ZI JIE, KEVIN	BE HONS (UTAR SG LONG) (CIVIL, 2021)
114823	TEE RAY THERN	BE HONS (MONASH UNI.)(CIVIL, 2020)
115061	AINA SYAHIRAH BINTI AHMAD ISHAK	BE HONS (UPNM)(CIVIL, 2020)
115237	CHONG ZHI LIANG	ME HONS (HERIOT-WATT UNI.) (CIVIL, 2020)
115250	CHUNG KA YIE, GABRIEL	BE HONS (MONASH UNI.)(CIVIL, 2021)
115284	LIM CHENG ZHOU	BE HONS (INTI INTERNATIONAL UNI.)(CIVIL, 2020)
115253	MUHAMMAD AFIQ AMMAR BIN MUHAMMAD HIJAZ	BE HONS (UTP)(CIVIL, 2020)
114918	LEE JIA SHENG	ME HONS(IMPERIAL COLLEGE LONDON)(CIVIL, 2019)
114924	LIEW CHEW YEE, NATALIE	BE HONS (CURTIN UNI)(CIVIL & CONSTRUCTION, 2019)
114919	MOHD. ISHAQ BIN SELAMAT	BE HONS (UMS)(CIVIL, 2019)
114949	WEI ZHE WONG	BE HONS (UTAR)(CIVIL, 2021)
115170	ROLAND CHILDS JR	BE HONS (UM)(CIVIL, 2019)
115229	CHAN CHUN KHAI	BE HONS (UKM)(CIVIL, 2020)
115218	LAM CHIN CHEN	BSc Hons (NCKU)(CIVIL, 2020)
114771	SARVESH SIVALINGAM	BE HONS(UTP)(CIVIL, 2019)
114959	MUHAMMAD ANAS BIN MOHD FIRDAUS SUGUMAR	BE HONS (UiTM)(CIVIL, 2018)
114959	NIK MOHD NADZRIN BIN ZALIZAN	BE HONS (UiTM)(CIVIL, 2019)
115182	MUHAMMAD IMRAN HISHAM BIN RUSLAN	BE HONS (UiTM)(CIVIL, 2020)
115239	AMIRA NATASHA BINTI OTHMAN	BE HONS (UiTM)(CIVIL, 2019)
115267	LEE CHEE KIAT	BE HONS (UTAR)(CIVIL, 2018)
115245	LEE EE YERN	BE HONS (INTI INTERNATIONAL UNI.)(CIVIL, 2020)
115294	LIM LI SHAUN	BE HONS (MONASH UNI.)(CIVIL, 2021)
114917	MOHAMAD ROFANDDI BIN RAHMAD	BE HONS(UTM)(CIVIL, 2019)
114818	MOHAMMAD AIMAN BIN MAHMAD SUHAIMI	BE HONS(UNITEN)(CIVIL, 2019)
114969	MOUREN MORIS	BE HONS (SWINBURNE UNI) (CIVIL, 2018)
115148	TEY MING WANG	BE (HUAQIAO UNI.)(CIVIL, 2017)
115126	WONG YEW CHEONG, CHARLES	BSc HONS (WEST VIRGINA UNI.) (CIVIL, 2017)
115231	CHUA SAY LIANG, ERIC	ME HONS (UCL)(CIVIL, 2018)
115213	FAIZUL BIN ZURAIMI	ME HONS (THE UNI. OF MANCHESTER)(CIVIL, 2018)
115232	MOHD ARSHAD KHAN BIN RAFE QUE	BE HONS (UTM)(CIVIL, 2018)
114775	FITRI BIN MAHAMAD MUDZRABI	BE HONS(USM)(CIVIL, 2017)
114790	TAN IK TYNG	BSc HONS (NATIONAL TAIWAN UNI.)(CIVIL, 2016)
115220	KOAY FENG JIN	BE (THE UNI. OF MANCHESTER)(CIVIL, 2016) MSc (CITY, UNI. OF LONDON)(CONSTRUCTION MANAGEMENT, 2017)
115233	LIM TECK THONG	BE HONS (UTM)(CIVIL, 2017)
114779	EVANGELINA LINNIS	BE HONS(UiTM)(CIVIL, 2017)
114810	GOH KAH SHENG, JASON	BE HONS(UNIMAP)(CIVIL, 2016)
115149	BENJAMIN TAN WUN-KING	BE HONS (SWINBURNE UNI. OF TECH)(CIVIL, 2017)
115176	SYURAFARINA BINTI ZULKIPLY	BE HONS (UTHM)(CIVIL, 2015)
115174	ZAL HAZMI BIN ABDUL HAMID	BE HONS (UTM)(CIVIL, 2019)
115219	HANIF IHSAN BIN ALI	BE HONS (UiTM)(CIVIL, 2017)
114770	LIM JIA YIN	BSc HONS(NATIONAL TAIWAN UNI.)(CIVIL, 2013)
115180	LEE JIE SHENG	BE HONS (INTI INTERNATIONAL UNI.)(CIVIL, 2017)
115160	MOHAMAD AMIRUL HAFIZ BIN ABD HAMID	BE HONS (UMP)(CIVIL, 2015)
115196	MOHAMMAD FIRDAUS BIN ISMAIL	BE HONS (UTM)(CIVIL, 2018)
105484	SITI KHADIJAH BINTI PONIMIN	BE HONS (IUKL)(CIVIL, 2019)
115230	LISHYUAN CHUO	BE HONS (SWINBURNE UNI. OF TECH.)(CIVIL, 2015)
114769	RUVINDRAN MUTHUSAMY	BE HONS(UNITEN)(CIVIL, 2017)
114925	NUR ANITA BINTI HASAN BASRI	BE HONS (UPM)(CIVIL, 2016)
114925	SYAHRUL NAZRAIN BIN ABDUL RAHMAN	BE HONS(UTM)(CIVIL, 2013) ME (UTM)(GEOTECHNICS, 2020)
115173	Dr. MOON WEI CHEK	BE HONS (USM)(CIVIL, 2014) PhD (USM)(EARTHQUAKE, 2019)
115216	SHARIFAH NUR AZUREEN BINTI WAN OSMANI	BE HONS (SWINBURNE UNI. OF TECH.)(CIVIL, 2013)
114802	MOHAMAD FARID BIN ABDUL RASHID	BE HONS(UTM)(CIVIL, 2013)
114774	MOHAMMAD HIRZARUL AIZAT BIN MOHD TAHIR	BE HONS(UiTM)(CIVIL - INFRASTRUCTURE, 2014)
114916	NUR DIYANA SYAHIRAH BINTI ROSDI	BE HONS(UTM)(CIVIL, 2012)

114813	TAN BOON CHEIK	BE HONS (UTM)(CIVIL, 2012) PhD(UTM)(CIVIL, 2019)
114929	MUHAMMAD ZULHILMI BIN ROSLI	BE HONS (UiTM)(CIVIL, 2012)
114977	ROMEO ROGER	BE HONS (UTP)(CIVIL, 2012)
114980	NOR FARHANA BINTI MOHD ARIS	BE HONS (UiTM)(CIVIL, 2012)
114935	NURFITRI BINTI RALI	BE HONS (UNIMAS)(CIVIL, 2014)
115265	MOHAMAD SHAHRUL AMRIE BIN SHAFEHARDIN	BE HONS (UTM)(CIVIL, 2018)
114809	MOHAMAD ROMZIE BIN MOHAMMAD ALI ADAHA	BE HONS(UTHM)(CIVIL, 2014)
115273	STEWARD ANAK LUDAN	BE HONS (UTM)(CIVIL, 2009)
114776	WONG YEE HOO	BE (UNI. OF TASMANIA)(CIVIL, 2010)
114922	TANG KIOK NGEE, TERENCE	BE HONS (UNISEL)(CIVIL, 2008)
114952	Dr. ZUL-ATFI BIN ISMAIL	BE HONS (UTM)(CIVIL, 2012) PhD (UKM)(CIVIL & STRUCTURAL, 2017)
114928	MOHD ANAS BIN IDERIS	BE HONS (UTM)(CIVIL, 2018)
115262	MUHAMMAD OSMAN BIN AINUDIN	BE (UMP)(CIVIL, 2010)
114964	ANIDA SUHARTI @ AMI RONIDA BINTI BASIRON	BE HONS (UTM)(CIVIL, 2003) MSc (UTM)(CONSTRUCTION MANAGEMENT, 2009)
115264	BELINDA ANAK MASON	BE HONS (UNIMAS)(CIVIL, 2010)
115280	NOR MASLINA BINTI MOHSAN	BE HONS (UiTM)(CIVIL, 2002)
114927	YEO WEE LIONG	BE HONS (THE UNI. OF NEW SOUTH WALES)(CIVIL, 1999) Mes (THE UNI. OF THE NEW SOUTH WALES)(CIVIL, 2000)
114766	SHIN KOK YEE	BE HONS (THE UNI. OF LEEDS)(CIVIL - CONSTRUCTION MANAGEMENT, 1997)
115172	KUMAR A/L MARIAPPAN	BE HONS (UTM)(CIVIL, 2019)
114990	CHOON WEE KIM	BE HONS (UTM)(CIVIL, 2020)
115130	KOO ZHIXIAN	BE (MONASH UNI.)(CIVIL, 2018)
115178	LAU YI HONG, VINCENT	BE HONS (UCTS)(CIVIL, 2018)
114954	NUR SYAQEERA BINTI MISMAN	BE HONS (UKM)(CIVIL & STRUCTURAL, 2017)

KEJURUTERAAN ELEKTRIKAL

114808	TAY YE CHEE, DAPHNE	BE HONS(SWINBURNE UNI. OF TECH.)(ELECTRICAL & ELECTRONICS, 2019)
114821	YEOW ZONG HUI, DOMINIC	BE HONS (UTAR SG LONG)(ELECTRICAL & ELECTRONIC, 2021)
114803	SING CHOON LOCK ANDREW	BE HONS(APU)(ELECTRICAL & ELECTRONIC, 2020)
114930	MUHAMMAD AMIR FAIQ BIN ZAKARIA	BE HONS(UTP)(ELECTRICAL & ELECTRONICS, 2020)
115056	HOON JIAN WEN	BE HONS (UCSI UNI.)(ELECTRICAL & ELECTRONICS, 2020)
114807	CHIN TSHUN FAN, HENRY	BE HONS(TAYLOR'S UNI.)(ELECTRICAL & ELECTRONICS, 2018)
114780	MUHAMMAD DANIAL BIN TAIB	BE HONS(UNIKL)(ELECTRICAL, 2019)
115194	MUHAMAD FARHAN BIN ZAKARIA	BE HONS (USM)(ELECTRICAL, 2019)
115234	DEVARAJ PILLAI	BE HONS (UNITEN)(ELECTRICAL POWER, 2020)
114920	LIM ZE QI	BE HONS (THE UNI. OF LEEDS)(ELECTRONIC & ELECTRICAL, 2017) MSc (UNI. OF SOUTHAMPTON)(ENERGY & SUSTAINABILITY WITH ELECTRICAL POWER)
114936	MUHAMMAD ANAS BIN SAHABUDEN	BE HONS (UKM)(ELECTRICAL & ELECTRONIC, 2018)
115164	MOHD AZIZUDDIN BIN MOHD AZHAR	BE HONS (UTeM)(ELECTRICAL, 2020)
115242	LEE VUN CHONG	BE HONS (CURTIN UNI.)(EKECTRICAL POWER, 2018)
115243	MUHAMMAD BIN ISMAIL	BE HONS (UiTM)(ELECTRICAL, 2018)
115189	AMEERUL AIMAN BIN JEMAN	BE HONS (UiTM)(ELECTRICAL, 2018)
115293	NIRUBEN KUMAR A/L JAYA KUMAR	BE HONS (UNITEN)(ELECTRICAL POWER, 2017)
115279	PUNITHAN A/L RAVICHANDRAN	BE HONS (UNITEN)(ELECTRICAL POWER, 2018)
115263	WAN NUR AIDA BINTI WAN MARZUKI	BE HONS (UNSW)(ELECTRICAL, 2019)
114817	LEE HUEY JIUN	BE HONS(UTP)(ELECTRICAL & ELECTRONICS, 2015)
114986	MOHAMAD HAZIQ SYAMEER BIN MOHD SHUHAIMI	BE HONS (UNITEN)(ELECTRICAL POWER, 2018)
114939	TANG HUNG PENG, KENNETH	BE HONS(USM)(ELECTRICAL, 2017)
114957	VINOD MAHENDRAN	BE HONS (UNITEN)(ELECTRICAL & ELECTRONICS, 2018)
115246	AMIRUL HAKIM BIN MOHD JAMIL	BE HONS (UiTM)(ELECTRICAL, 2017)
114796	ABU HASSAN B MOHAMMED NAZARI	BE HONS(QUEENSLAND UNI.)(ELECTRICAL, 2016)
114778	GUGARAJAN A/L SELVARAJAH	BE HONS(UNITEN)(ELECTRICAL, 2016)
114768	NUR IKWANI BINTI IZUL	BE HONS(UTM)(ELECTRICAL - INSTRUMENTATION & CONTROL)
114799	MOHD KHAIRUL ANNUAR BIN MAT RAHIM	BE HONS(UiTM)(ELECTRICAL, 2016)
114794	SOON KIAN LUN	BE HONS(UM)(ELECTRICAL, 2015) PhD(MONASH UNI)(ELECTRONIC & COMPUTING, 2020)
57724	MUHAMMAD LUQMAN BIN FAILEI	BE HONS (UTM)(ELECTRICAL, 2015)
115235	ALFIYAN MUBARAK BIN MIDA MYDIN	BE HONS (UNIMAP)(ELECTRICAL SYSTEM, 2016)
115238	KHAIRULANWAR BIN SUHAIMI	BE TECH HONS (UNIKL)(ELECTRICAL, 2017)
114793	KUMARENDRAN A/L KARUPIAH	BE HONS(AIMST UNI.)(ELECTRICAL & ELECTRONICS, 2016)
114987	MUHAMMAD FADHLULLAH BIN ISMUEIN	BE HONS (UTHM)(ELECTRICAL, 2015)
114974	MUHAMMAD HAZIQ BIN AHAMMAD JAIZ	BE HONS (UTHM)(ELECTRICAL, 2012)
114973	MUHAMMAD IZZAT HAZIQ BIN SANIB	BE HONS (UTHM)(ELECTRICAL, 2015)
115163	MUHAMMAD SHUBHI BIN MOHD SAPLI	BE HONS (UTHM)(ELECTRICAL, 2014)
115291	AFDHAL BIN KAMARULZAMAN	BE TECH HONS (UNIKL)(ELECTRICAL, 2013) BEM GRADUATE ENGINEER REGISTRATION BRIDGING COURSE, 2020
115295	CHAN JUN YEE	BE HONS (UTM)(ELECTRICAL, 2014)
115281	NADIAH ATIKA BINTI YAACOB	BE HONS (UNITEN)(ELECTRICAL POWER, 2013)
114970	Dr. NUR DALILAH BINTI NORDIN	BE HONS (UTM)(ELECTRICAL, 2012) PhD (UTM)(ELECTRICAL, 2019)
114941	MOHAMAD ASNAN BIN AHMAD	BE HONS (UNITEN)(ELECTRICAL POWER, 2012)
114967	THIYAGU A/L PERUMAL	BE HONS (UNIMAP)(ELECTRICAL SYSTEMS, 2014)
115169	MOHAMMAD FIKRI BIN MOHD HALIM	BE HONS (UNIMAP)(ELECTRICAL ENERGY SYSTEM, 2014)
114797	MUHAMMAD TARMIZI BIN MOHAMAD ISA	BE HONS(UTM)(ELECTRICAL, 2016)
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114983	YONG HONG CHIEN, KELVIN	ME (UTM)(ELECTRICAL POWER, 2019)
115255	ANDREW BIN GODUK	BE HONS (UTM)(ELECTRICAL, 2019)
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114972	WAN MOHD RIZA BIN WAN MOHMUD	BE HONS (UNISEL)(ELECTRICAL, 2014)
115258	AZRIE BIN OSMAN	BE HONS (UTM)(ELECTRICAL, 2020)
114773	LIEW YEW SHENG	ME (UTAR)(ELECTRICAL, 2019)
114933	KHAIRUL ARIFFIN BIN REZO	BE HONS (UTM)(ELECTRICAL, 2015)
115151	KUANMAS BINTI KIMJUAN	BE HONS (UMS)(ELECTRICAL & ELECTRONICS, 2007)
114962	AZMI MURAD BIN ABD AZIZ @ JUNED	BE HONS (UiTM)(ELECTRICAL, 2006)
115152	SANTERA SEGARAN A/L AVADIAR SELVARAJ	BE HONS (UTM)(ELECTRICAL, 2017)
114782	NUR AZLIN MOHD YUSOFF	BE HONS(UPM)(ELECTRICAL & ELECTRONICS, 2003) MSc(THE UNI. OF LEEDS)(ELECTRICAL & RENEWABLE ENERGY SYSTEMS)
114931	YUZLINA BINTI YUSSOF	BE HONS (UNITEN)(ELECTRICAL POWER, 2010)
115159	MOLLIE ANAK URAI	BE HONS (UTM)(ELECTRICAL - ELECTRONICS, 2002) ME (UTM)(ELECTRICAL POWER, 2019)
115179	MUHAMAD SHAFIE BIN MOHD JUSOH	BE HONS (UPNM)(ELECTRICAL & ELECTRONIC - POWER, 2018)

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115137	NG WEY LONG	BE HONS (UTAR)(ELECTRONIC, 2021)
115133	TAN DER SHENG	BE HONS (UTAR)(INDUSTRIAL - ELECTRONIC, 2021)
115136	ONG CHU SHEN	BE HONS (UTAR)(ELECTRONIC, 2021)
115135	ONG SOON HOE	BE HONS (UTAR)(ELECTRONIC, 2021)
115282	WOO WEN JIE	BE HONS (THE UNI. OF AUCKLAND)(BIOMEDICAL, 2019) ME HONS (THE UNI. OF AUCKLAND)(BIOENGINEERING, 2020)
114979	MOHAMAD HAFIZUDDIN BIN MD ROOSLY	BE HONS (UMP)(ELECTRICAL - ELECTRONICS, 2019)
115131	MUHAMMAD SHAHRIN BIN SHAHAR	BE HONS (UPNM)(ELECTRICAL & ELECTRONIC - COMMUNICATIONS, 2018)
115162	FARAH NUR IZZATI BINTI MORTADHA	BE HONS (UNITEN)(ELECTRICAL & ELECTRONICS, 2019)
115139	LOK SHOU YIN	BE HONS (UTAR)(ELECTRONIC, 2021)
115277	AHMAD BUKHAIRI BIN MD RASHID	BE HONS (UTM)(ELECTRICAL - ELECTRONICS, 2017)
114798	SHAMALA DEVI A/P MUNIANDY	DIPL. OF BACHELOR (MOSCOW AVIATION INST.)(CONTROL IN TECHNICAL SYSTEM)
114945	ONG ZHI YING	BE HONS (UNIMAP)(BIOMEDICAL ELECTRONIC, 2017)
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114968	MOHAMAD SYAHIN BIN ZAINI	ME HONS (THE UNI. OF LEEDS)(ELECTRONIC & ELECTRICAL, 2015)
115274	FATISYFINA BINTI JULAIHI	BE HONS (UiTM)(ELECTRONICS - INSTRUMENTATION, 2016)
115257	MUHAMAD ERFAN BIN ELIAS	BE HONS (UiTM)(ELECTRONICS, 2017)
115129	Dr. HOH WEI SIANG	BE HONS (UNIMAP)(COMPUTER NETWORK, 2014) PhD (UNIMAP)(2018)
115060	TAN JYE LIH, WILSON	BE HONS (SOUTHERN UNI. COLLEGE)(ELECTRONIC, 2020)
115244	NADHIRAH BINTI MUSTAFA	BE (VANDERBILT UNI.)(ELECTRICAL, 2012)
114976	IKLIL KHAIRIYYAH BINTI ABDUL NASIR	ADV. DIPLOMA (MOSCOW AVIATION INS.)(CONTROL SYSTEMS, INFORMATICS & ELECTROPOWER SYSTEM, 2014)
115184	BUKHARY BIN BAKAR	BE HONS (UTM)(ELECTRICAL - ELECTRONIC, 2010)
114804	SHAHRIZAN BIN JAMALUDIN	BE HONS(UTeM)(ELECTRONICS - COMPUTER, 2008) ME(UKM)(COMMUNICATION & COMPUTER, 2011) PhD(UKM)(ELECTRICAL, ELECTRONIC & SYSTEMS, 2017)
114805	TSAI LEE PEI	BE HONS(SWINBURNE UNI.)(ELECTRICAL & ELECTRONIC, 2011)
114938	MOHD ADIL BIN KAMALUDIN	BE HONS (UiTM)(ELECTRONICS - INSTRUMENTATION, 2016)
115127	MOHAMAD AZIZ BIN AHMAD AZHAR	BE HONS (UTM)(COMPUTER, 2007)
115186	MUHAMMAD AMIN CHE HASSAN	BE HONS (KUTTHO)(ELECTRICAL, 2006)
115153	DARMADEVAINDRA A/L MANIAM	BE HONS (UNI. OF LINCOLN)(ELECTRICAL & ELECTRONIC, 2003) ME (UTM)(ELECTRICAL - COMPUTER & MICROELECTRONIC SYSTEM, 2015)
115256	TUAN SAU-WERN	BE HONS (MMU)(ELECTRONICS MAJORING IN COMPUTER, 2001)
114806	NOR HALIZA MD YUSOF	BE(THE UNI. OF QUEENSLAND)(ELECTRICAL & ELECTRONIC, 1998) ME(UM)(BIOMEDICAL, 2014)
115057	LO SU AIUNG @ FELIX LO	BE HONS THE UNI. OF WESTERN AUSTRALIA)(INFORMATION TECHNOLOGY, 1999)
115240	NARISHAH MOHAMED SALLEH	BSc (UNI. OF MISSOURI)(ELECTRICAL, 1996) ME (UTeM)(MANUFACTURING SYSTEM, 2013)
114812	NORHASHIM BIN YACOB	BE HONS(UTM)(ELECTRICAL - TELECOMMUNICATIONS, 2008)

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115138	LOW QUAN HUEY	BE HONS (UTAR)(ENVIRONMENTAL, 2021)
115259	MUHAMAD NAJMI IQBAL BIN CHE MOON	BE HONS (UNIMAP)(ENVIRONMENTAL, 2016)
115132	THIRUVARASU A/L MOHAN	BE HONS (UTAR)(ENVIRONMENTAL, 2021)
114950	HANI MAISARAH BINTI MOHAMAD	BE HONS (THE UNI. OF WESTERN AUSTRALIA)(ENVIRONMENTAL, 2013) MSc (UNESCO-IHE)(WATER - FLOOD RISK MANAGEMENT)

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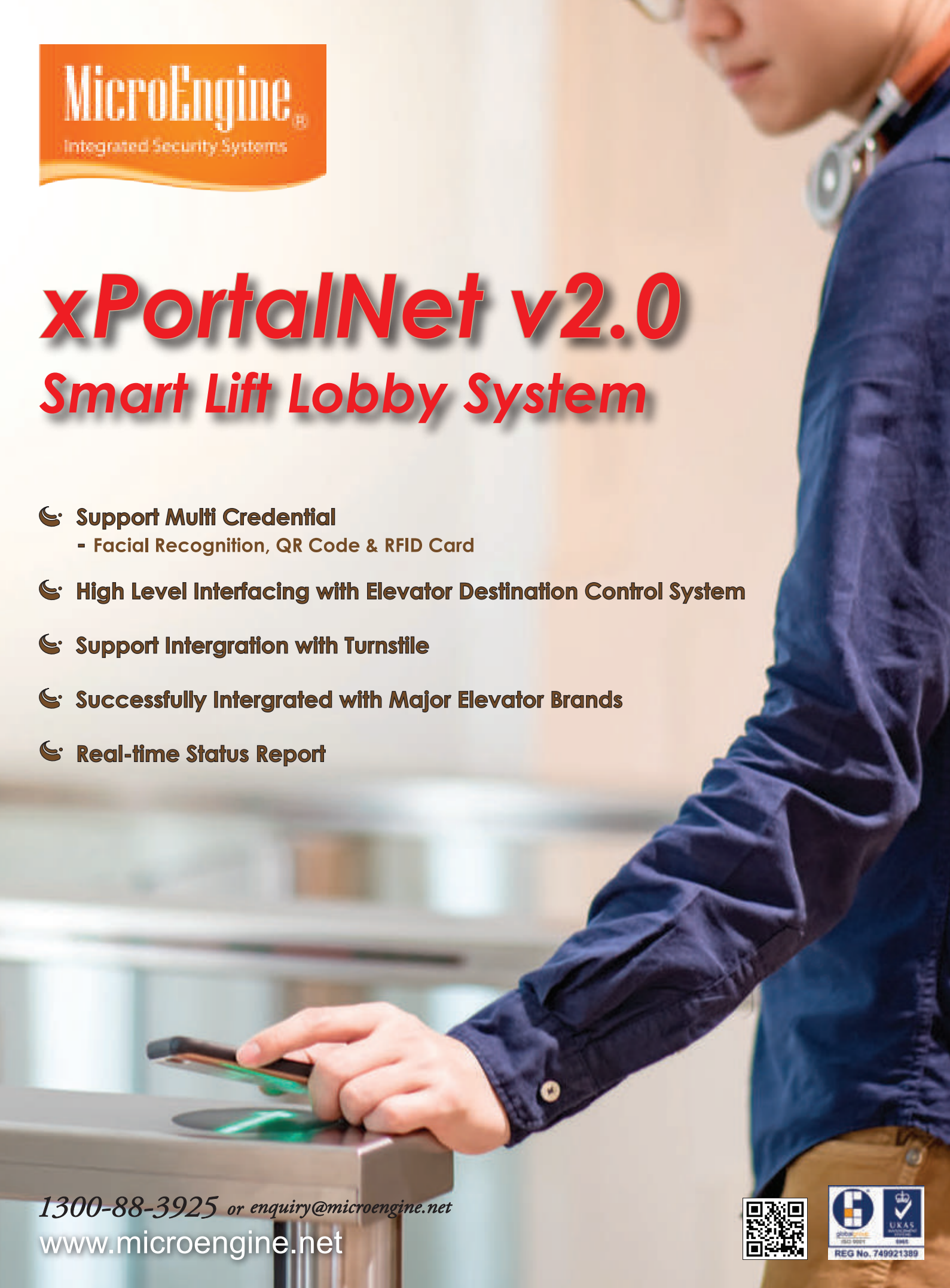

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