UNDERGROUND TUNNELLING IN THE KLANG VALLEY AND THE PURSUIT OF AN AUTONOMOUS TUNNEL BORING MACHINE

by Dr Boon Chia Weng

The Tunnelling & Underground Space Technical Division (TUSTD) organised a technical talk on Underground Tunnelling in the Klang Valley and The Pursuit of an Autonomous Tunnel Boring Machine at the Malakoff Auditorium, Wisma IEM on 19 December 2019. A total of 60 participants attended.

Ir. Nanthakumar, the Technical Director of AECOM, presented the general scope of design works on the KVMRT Project, i.e. Sungai-Buloh Serdang Putrajaya (SSP) Line Underground Works Package, which consisted of 13.5 kms of underground tunnels and the construction of 10 new underground stations.

The alignment intersected with the 1st MRT line, i.e. the Sungai Buloh-Kajang (SBK) Line at Tun Razak Exchange (TRX) Station. The design management structure consisted of a lead design consultant and several detailed design consultants as well as a design-and-technical team from the main contractor.

According to Ir. Nanthakumar, there were many design aspects to consider in the underground works package project, such as safety, constructability, durability, maintainability, environmental, aesthetics, line identity, station planning and architecture, some of which include interfacing with transit-oriented developments.

He talked about the different geologies with regards to the construction method adopted for each station, as well as their respective tunnel interfacing sequences, such as launching, retrieval and pull-through or bore-through. He also highlighted the various risks associated with tunnelling before ending his part of the talk.

Then Mr. Justin Chin, Acting General Manager of MMC-Gamuda KVMRT (T) Sdn. Bhd. and Project Lead

Dr Boon Chia Weng (left), presenting tokens of appreciation to the three speakers, Ir. Nanthakumar, Mr. Justin Chin and Mr. John Lim (left to right)

in the research and development of the autonomous TBM, talked about the challenges of underground tunnelling in karstic limestone and the development of the Variable Density Machine which was used in the 1st MRT Line.

The density of the slurry could be increased to prevent blowout at the same applied face pressure. The viscous slurry would fill up cavities and solution channels, thereby minimising losses. The number of sinkholes was drastically reduced as compared with the Stormwater Management And Road Tunnel (SMART) project which was completed in 2007. Furthermore, the Variable Density Machine had afforded flexibility to the tunnelling programme, allowing TBMs to mine across various geologies in Kuala Lumpur by changing to either earth-pressure-balance or slurry mode. This success spurred the team to innovate further.

According to Mr. Justin Chin, the autonomous TBM was developed during the 2nd MRT Line to minimise reliance on TBM operators who would otherwise need to monitor a data screen for extended hours. The auto-steering function was tested on two pilot drives of 1.9 km long each in karstic limestone. He also showcased the intelligent adaptive control capability in the autonomous TBM which was particularly useful for traversing varying geologies to optimise advance speed and minimise wear-and-tear of cutter discs. The success was then replicated on other drives and to date, had mined 5 km length of tunnels.

The team's efforts and results were duly acknowledged and it won two coveted international awards for MMC-Gamuda KVMRT (T) Sdn. Bhd., namely the International Tunnelling Association (ITA) Technical Product/Equipment Innovation of the Year Award 2019 and the New Civil Engineer (NCE) Innovation in Tunnel Excavation Award 2019.

Mr. John Lim, the lead developer for the autonomous TBM and research engineer with MMC-Gamuda KVMRT (T), shared his experience working as a tunnel engineer. He talked about how he made use of his programming skills to automate routine tasks in his daily job, while attending to numerous responsibilities as site engineer. Both his job exposure and his past knowledge on artificial intelligence (AI) algorithms were recognised by the organisation and he was later tasked to work with a team on the autonomous TBM project.

The project also benefitted from the contribution of two other colleagues, an electrical manager experienced in TBM control and a senior electrical engineer, Mr. Liew Kit Shen, who was skilled in PLC programming. Mr. John Lim further briefed the audience on the various types of AI algorithms, as well as the background of both data communication and control for the TBM.

He shared useful tips on how to get started in programming and suggested a few programming languages to be used, depending on the purpose and landscape of development. He also showed an example of a program with intelligent functions which he developed for the autonomous TBM. Lastly, he presented ongoing innovation efforts to further improve on tunnelling operations before ending the talk. ◼