Technical Site Visit To Pipe-Roofing Tunnelling At Sungai Bunus Pump Gate Station

by Ir. Chong Chi Koong

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The Tunneling and Underground Space Technical Division, Institution of Engineers Malaysia (IEM) had successfully organised a technical site visit to a pipe-roofing tunneling at Sungai Bunus Pump Gate Station on 26th January 2019. Twenty-three participants comprising 22 of various member grades from IEM and 1 non-IEM member attended this technical site visit.

The participants boarded a chartered bus and departed from Bangunan Ingenieur, Petaling Jaya at 9:00am and arrived at the project site office at 9:45am. After having settled down at the project conference cabin, an overview of the project was delivered by En. Azman Bin Abu Bakar, Principal of Perunding Azman. Ooi & Rao Sdn Bhd. According to En. Azman, this project is implemented by the Department of Irrigation and Drainage (DID), Wilayah Persekutuan Kuala Lumpur as part of the *Rancangan Tebatan Banjir Sungai Bunus*, Wilayah Persekutuan Kuala Lumpur to mitigate the frequent flooding issues in the Sungai Bunus catchment area. For instance, two severe flooding events had occurred in the Jalan Tun Razak area between Years 2011 and 2012. He also highlighted on other earlier major flooding events at the Kampung Baru area in the 1970s and 1980s, where the then Selangor Menteri Besar's resident was located, which was also not spared in the flood events. DID with the help of Japan International Cooperation Agency - JICA, came up with a proposal to do a bypass at Sungai Klang in 1970s. After another flood event in the 1980s, a 3m diameter corrugated metal pipe-tunnel was constructed but it relieved the flooding issue for a while. Then another flood in the 1980s/1990s, part of corrugated metal pipe-tunnel was widened to a double-box culvert of 12ft x 12ft each and the remaining length of 400m to 500m was enlarged. However, in between 2011 and 2012, twenty-two houses were affected with sinkholes and Jalan Tun Razak was flooded four times.

En. Azman added that as the area is already very urbanised, there were very little space left to create retention ponds and detention ponds. Therefore, in order to overcome this lack-of-space issue, DID had decided on a series of on-line and off-line flood mitigation ponds totalling 8 numbers in various parts of the 7 km long Sungai Bunus catchment area stretching from Setapak Jaya Pond, Air Leleh Pond, Polapol, Kg. Boyan Pond, Sri Rampai, Air Panas area, Titiwangsa Air Panas, Kg. Baru area, and so forth consisting of a total of 17 km length of 3 distributaries - Sungai Peras, Sungai Peran and Sungai Bunus. These are mainly on lands still belongs to the Government, though still not gazetted. This also include a piece of Government-owned land previously used as hockey/football field where a series of off-line detention ponds were created measuring 100m x 100m x 6m deep.

En. Azman lamented that in retrospect, there were many previously built detention ponds that had been taken away by private sectors for developments. Owing to this, an occurrence of any one severe storm event in Kuala Lumpur would give rise to widespread flooding as the current river

drainage system would not be able to cater for a massive volume of rain water; no thanks to those greedy developers.

En. Azman mentioned that there are many firsts in this flood detention scheme, for example, in Polapol there is one underground detention pond of about 100,000 cu.m capacity using a series of Bebo Arches to create the detention pond comprising of 5-series of arches of 100m x 100m x 23m span. With regard to the maintenance of the underground storage ponds, there will be inlet structure with a series of 75 to 100 cu.m capacity reservoirs with quick release gates to flush out sediments at a velocity of more than 6m per second, which are generally self-cleansing. If needed, bobcat would be used to clear up any remaining sediments.

En Azman also mentioned that in any one storm event, there would be a need to retain between 1 million to 1.5 million cu.m of water. And the concept of flood control is in the use of a series of collapsible gates controlled by SCADA system, which are capable of reducing the volume of water flow from 250 cu.m per second to less than 70 cu.m per second. To a question from a participant as to why the lake at Titiwangsa was not used for the storage of floodwater in a storm event, En. Azman said that the Kuala Lumpur City Hall (DBKL) had set a condition that after any one storm event, the area must to be reinstated back to its original condition within 2 to 3 hours, which DID finds it hard to fulfil. Where the river was widened for storage, soft engineering was used to stabilise the bank to bring it back to near-nature and adding turfings, green areas and open spaces for the benefit of the community. The river storages were designed for 30 to 50 years ARI (Average Recurrence Interval) with 2 to 3 hours retention period.

En. Azman also touched on the high cost in land acquisitions alone without building the infrastructures. Therefore, DID needed to look for alternatives, such as available areas at both AKLEH Highway and DBKL reserves. It was decided on another diversion, which is skew with two physical modellings using InfoWorks software done for stilling basin and pump gate and for addressing two issues - one at Jalan Tun Razak and the other on “punching” through 2 successive Reinforced Earth (RE) walls which formed a road ramp to the AKLEH Highway. In fact, two critical areas were encountered, i.e. at Jalan Raja Muda Abdul Aziz and at the RE wall road ramp next to Sungai Klang.

En Azman gave a brief description of the procedures on how to maintain the stability of the RE walls during the pipe-roofing construction. For instance, by doing both horizontal and vertical groutings using double-packer grouts and then tying of both RE walls. Once these are done, the pipe-roofing were installed via pipejacking. Finally, the space within the pipe-roofing could be mined to form a tunnel. During the construction stage, high water-table was encountered and this was overcome by installing well points system to keep the area dry. Besides, a floodwall was also in place to control flooding.

After which, a video was played which showcased the construction of a new rectangular opening penetrating the two successive RE walls underneath and through the existing AKLEH Highway bund along Sungai Klang. Dr Esam Ahmads Abdul Rahman ALFaez, Geotechnical Designer and Supervising Engineer from the Consultant provided a running commentary on the video and elaborated that the pipe-roofing tunnelling system through an RE wall road ramp is the first of its kind in the world that was designed and being constructed to form the opening. He added that an assembly of temporary 600mm dia. mild steel pipes were installed contiguously at two opposing sides and at top by hydraulic jacking or microtunnelling; thus forming a rectangular pipe-roofing tunnel. The completed pipe-roofing tunnel is to house a cast-in-situ twin box culvert which acts as a vital connection between Sungai Bunus and Sungai Klang acting as a control-gate structure that hoist force main

drainage pumping system that lifts low water level from Sungai Bunus to high water level of Sungai Klang.

Dr Esam further elaborated that it is of vital importance to further enhance the stability of the RE walls prior to the construction of the opening. As such, certain measures or standard operational procedures are adopted as follows:

1. Prior to the advancing steel pipes, a Cement-Bentonite mixture slurry would be grouted into the granular materials between the RE walls of the ramp to solidify it as well as to control the loss of granular materials during the pipejacking operation;
2. Permeation grout is injected below the RE wall strip foundations to enhance its bearing capacity; and
3. Steel tie-rods at 1.2m spacings are introduced in a triangular pattern which are inserted and tightened horizontally to ensemble and sandwich both faces of the RE walls to enhance the ramp stability against the pipejacking forces, and both the RE wall faces are then covered with reinforced concrete gunite.

The above measures not only serve to enhance the stability of the RE walls but also serve to limit ground movements during the pipejacking operation. This is so that settlements of both overlying and road pavement as well as movement of the RE walls are minimised and maintained within acceptable limits. Otherwise, this would cause subsidence of the highway above and disrupting the live traffic. And for that purpose, two types of monitoring systems are implemented, i.e. Automatic Total Station (ATS) and Terrestrial Laser Scanning (TLS) which have been counterchecked by precise manual levelling monitoring survey. Dr Esam also mentioned that digital cameras were also fixed to monitor the movements on both faces of the RE walls as well as the highway pavement daily, and so far, zero and very small movements within limits were recorded.

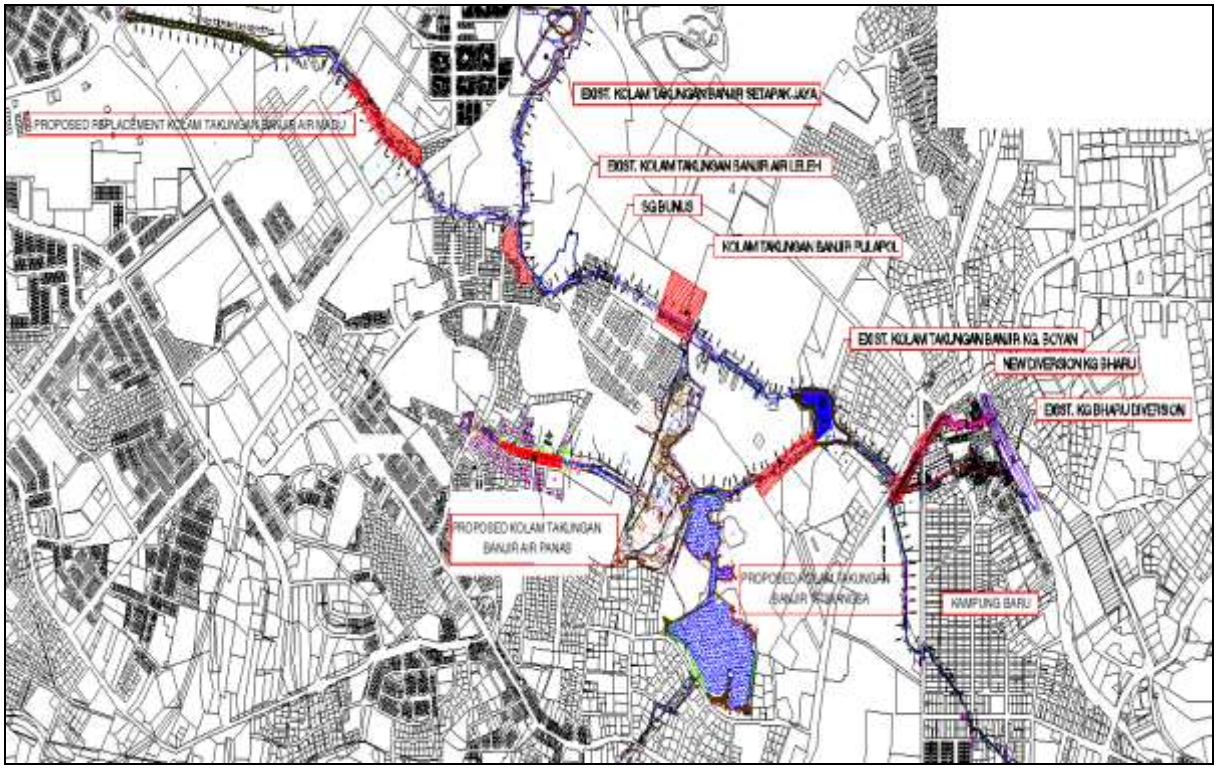
On an aspect unrelated to the purpose of this site visit, Dr Esam stressed on never to design and construct RE walls next to a river. This is because RE walls would contain lots of fine materials within them that would easily be washed away with the fluctuating river water levels and giving rise to a lot of problems. This is certainly 'food for thought' for engineers who may be required to design RE wall at some point in their careers. He also mentioned on not to fully trust any data results coming from laboratory but to investigate oneself using available tools and systems with the help of contractor at the site.

During the technical visit to the pipe-roofing site, the participants raised many pertinent questions that were swiftly answered by either En. Azman or Dr Esam, as well as by other site personnel from both the main contractor and pipejacking contractor on site. It was also observed that a series of 6m deep well points have been installed and connected to a pump, adjacent to one side of the contiguous steel pipes, which is for the purpose of lowering the fluctuating water-table so as to facilitate the jacking operation of the steel pipes below the existing ground level. A water pumping exercise was also carried out for the benefit of the participants to show the actual lowering of the water-table.

After the site visit, the participants returned to the project conference cabin for some light refreshments courtesy of the project team. After that, the session chairman, Ir. Chong Chi Koong proposed a few words of thanks and appreciation to the project team for having hosted our IEM members to this very interesting technical visit, and as Dr Esam had put it, the first of its kind in the world project site. The technical visit was concluded with presentation of a souvenir to En. Azman as

a token of appreciation. The participants re-boarded the chartered bus from the site and arrived at Bangunan Ingenieur, Petaling Jaya at about 12.30pm.

Presentation of Souvenir to En. Azman by Session Chairman Ir. Chong



Sungai Bunus Flood Mitigation Scheme

Group photograph in front of pipe-roofing tunnel