FORUM

TECHNICAL SITE VISIT TO SUNGAI BESI TUNNEL

TUNNELLING AND UNDERGROUND SPACE ENGINEERING TECHNICAL DIVISION

reported by

Ir. Chong Chi Koong

(All illustrations and photographs in this report courtesy of PAAB and CSRK)

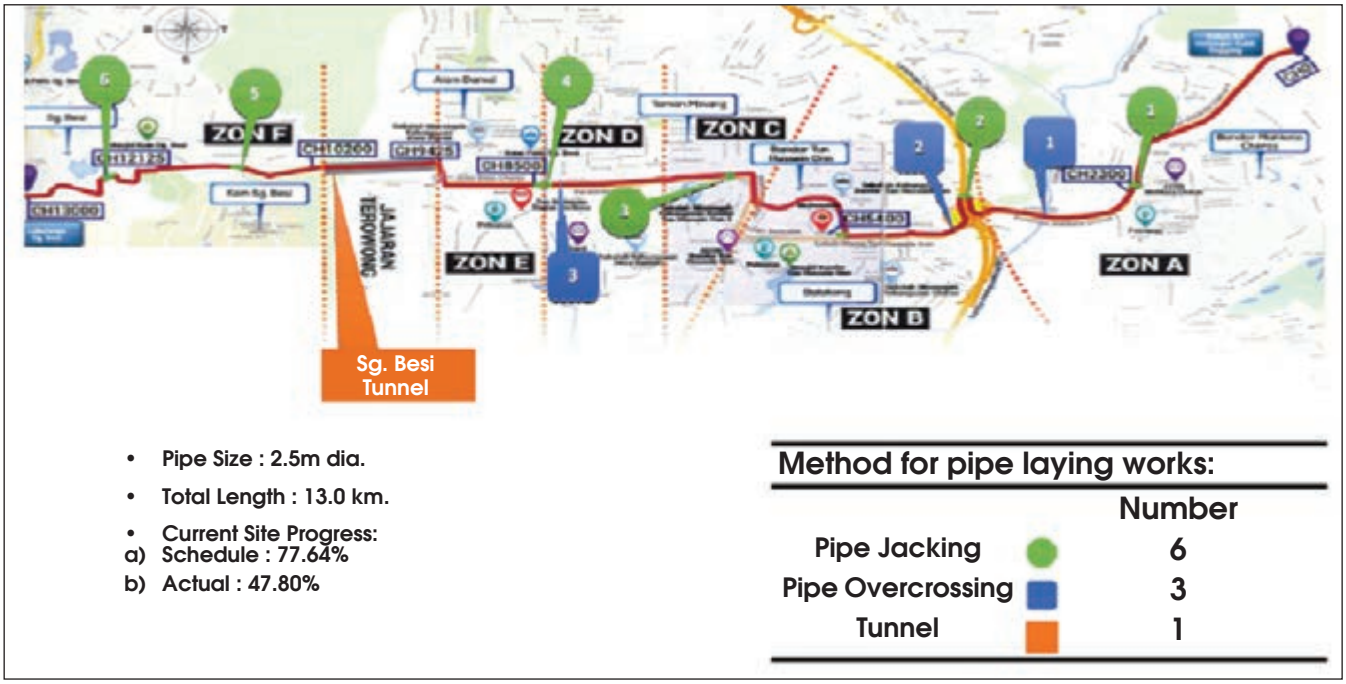

Figure 1: Package 10 pipeline alignment

The Tunnelling & Underground Space Technical Division (TUSTD of IEM organised a technical site visit to Sg. Besi tunnel on 29 June, 2019, with 11 participants. The group left Bangunan Ingenieur, Petaling Jaya, at 8.30 a.m. and arrived at the project site office in Damai Perdana, Cheras at 9.10 a.m., where they were welcomed by Puan Nurhaidah binti Jamil, project manager from the developer, Pengurusan Aset Air Berhad (PAAB).

Puan Nurhaidah said the Consultant is a consortium of consulting engineers comprising SMHB Sdn. Bhd., Ranhill Consulting Sdn. Bhd. and KTA Tenaga Sdn. Bhd. (CSRK). The main contractor is Pembinaan Ikhasas-Merak Sdn. Bhd. (PIMSB). After a self-introduction session, two videos were presented on PAAB and Langat 2.

Hj. Zariffuddin bin Othman, project executive of PAAB, then gave a slides presentation on the overall water supply scheme, comprising Pahang-Selangor Raw Water Transfer Tunnel and Langat 2 Projects, followed by Cik Noordini binti Ahmad, assistant RE of CSRK, with a slides presentation on Package 10 (Figure 1), Sg. Besi Tunnel.

Sg. Besi Tunnel is located between Taman Desa Cheras and Sg. Besi Army Camp, crossing a hill from east to west. Besides the tunnel, there are also inlet and outlet portals (Figure 2).

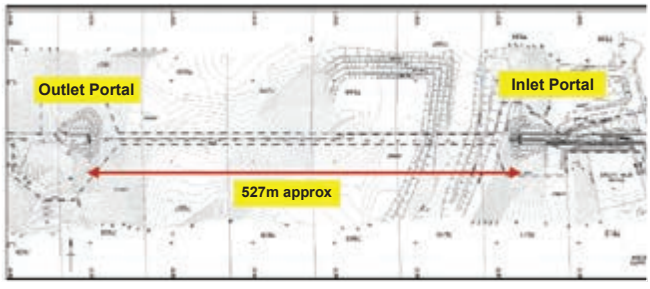

Figure 2: Portals and tunnel locations

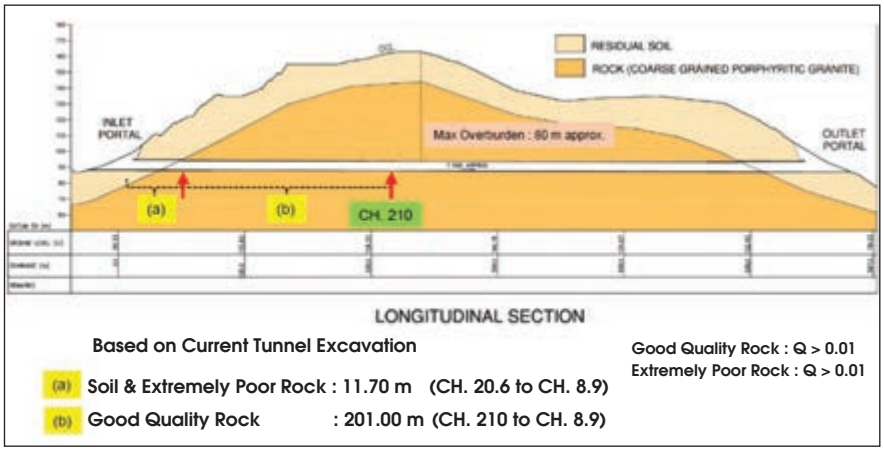

Figure 3: Longitudinal section profile/geology of tunnel

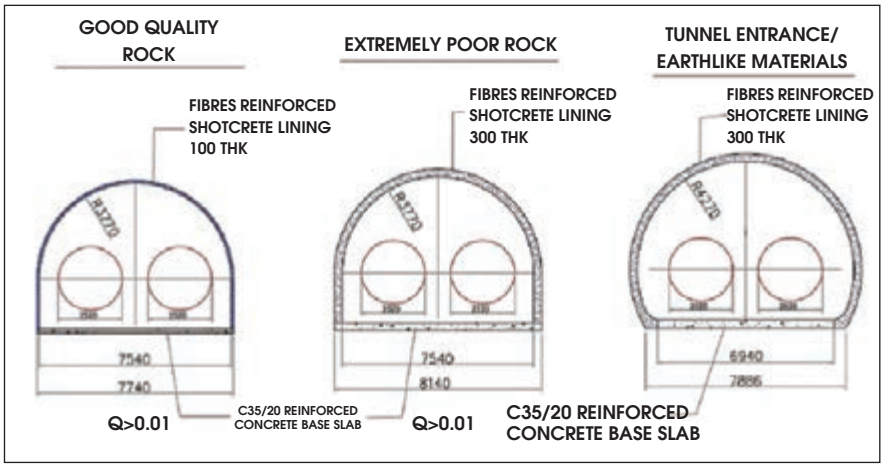

Figure 4: Typical lined tunnel sections

The tunnel is being constructed using the conventional "drill and blast" method. It is of a modified horseshoe shape measuring 527m in length. The heights at both rock and soil faces are 5.78m and 6.28m respectively while the span/width at both rock and soil faces are 7.54m and 8.54m respectively with sectional area of 44 sq m. For good quality rock face, the construction method is of full face "drill and blast", while for both poor quality rock and earth-like material (soil) face, the method comprises of top heading and bottom benching.

Based on site investigations with both geophysical and boreholes data, the sub-surface along the tunnel alignment (Figure 3) indicates that the tunnel, with maximum 80m overburden, is considered to be a shallow tunnel. Current tunnel excavation progress is indicated in Figure 3. The classification of rock quality is based on Q value, for good quality rock, Q > 0.01 and for extremely poor

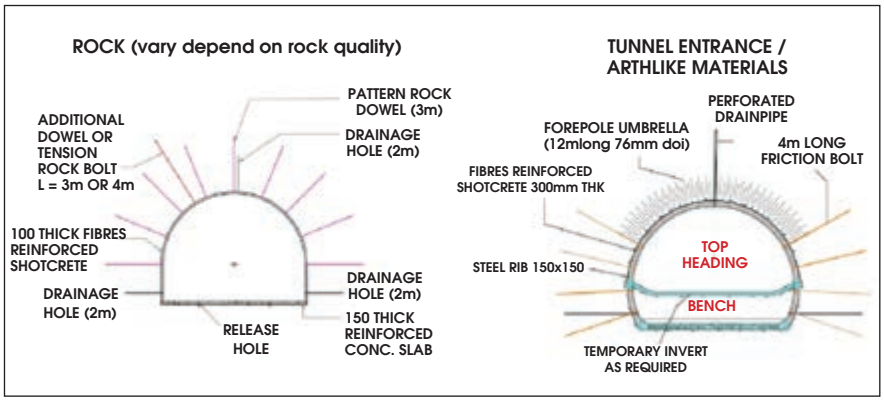

Figure 5a: Typical tunnel support

Forepole Umbrella Installation

Top Heading at Inlet Entrance

Figure 5b: Typical tunnel support

Figure 6: Rock dowel installation

Figure 7: Fibre reinforced shotcrete lined rock face

quality rock, Q < 0.01. The Q value at each tunnel face is derived based on face mapping after each blasting operation.

The construction of the lined tunnel (Figure 4) is based on the Q value. For Q > 0.01, the fibre reinforced shotcrete lining is 100mm thick and for Q < 0.01 as well as for soil face, the fibre shotcrete lining is 300mm thick.

Typical tunnel supports are either rock dowels or forepoles umbrella (Figures 5a & 5b). Rock dowels are installed using jackhammer (Figure 6), followed by grouting of the installed dowels. The pattern of the rock dowels is also based on the Q value, as shown in construction drawings. However, any additional rock dowel required is based on site condition. See Figure 7 for a completed fibre reinforced shotcrete lined rock face.

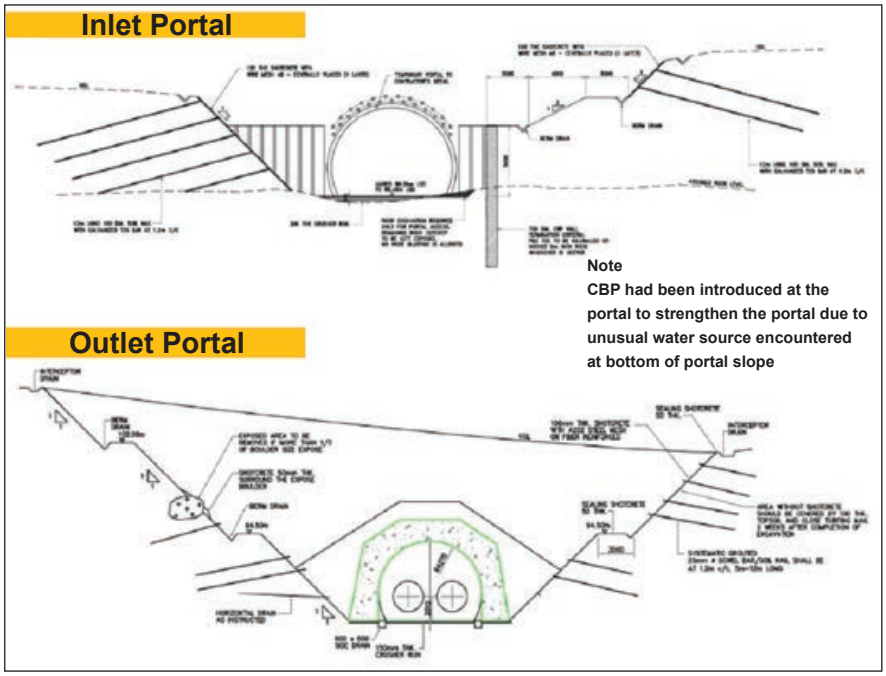

Figure 8: Details of portals

Inlet Portal

Outlet Portal

Figure 9: View of portals

For soil face, the pre-support is 12m long, 76mm diameter forepoles umbrella at 300mm centres. The 5 stages of construction in extremely poor rock and soil faces are:

1. Installation of forepoles umbrella including grouting
2. Excavate under the forepoles umbrella
3. Installation of steel ribs
4. Shotcreting
5. Installation of friction bolts.

A contiguous bored piles (CBP) wall was designed and installed along one side of the inlet portal (Figures 8 & 9) due to unusual groundwater source encountered at the bottom of the portal slope. Soil nailing was also designed and installed at both portals (Figures 8 & 9) for slopes stabilisation.

The monitoring aspects (Figure 10) of the inlet portal and tunnel construction are:

- Before construction – dilapidation survey on all buildings within the vicinity of the tunnel site.
- During construction – crackmeters at surrounding buildings, settlement markers at surrounding areas and optical targets on portal slopes.
- Inside tunnel – optical targets at 60m centres for convergence monitoring of tunnel soffit settlement.
- During blasting – vibrometers to monitor vibration in Peak Particle Velocity (PPV) and loudness in decibels (dB). Limits of Jabatan Mineral & Geosains (JMG) for PPV is 3 mm/sec. and loudness is 120 dB.

In general, all instrumentation locations are at surrounding areas and buildings within a 100m radius of the inlet portal site as indicated in the figure.

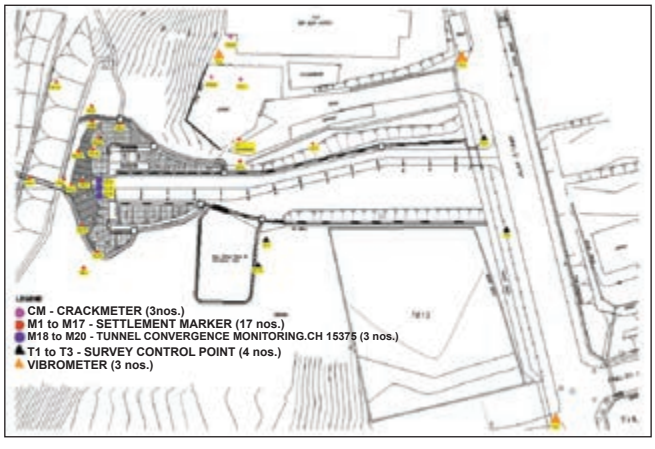

Figure 10: Monitoring Points at Inlet Portal Plan

After the technical briefing was a briefing on Health & Safety in Tunnel Construction. The participants raised many pertinent questions that were addressed by representatives from PAAB, CSRK, main contractor and subcontractor on site. At the end of the tunnel face, a set of explosives was in place at the rock face ready for a blasting operation. The explosives were installed to a horizontal depth of 3m in a specific configuration/pattern to allow split second interval detonations in succession to yield maximum rock breakage.

After the tunnel visit, all participants and personnel exited the tunnel for a group photograph. The highlight of the site visit was the much-anticipated blasting operation.

After the visit, the group returned to the project site office where session chairman Ir. Chong Chi Koong started the Q&A session. Then, he thanked the hosts, saying that the site visit was very beneficial to the participants who not only learnt both the design and construction aspects of the Sg. Besi Tunnel but also about PAAB and Langat 2.

The visit concluded with Ir. Chong presenting IEM plaques to Hj. Zariffuddin, Cik Noordini and En. Mohd Yusoff bin Ramly, project engineer of PIMSB. Hj. Zariffiddin then thanked the participants for visiting and presented them with PAAB souvenirs. This was followed by a hearty lunch hosted by the project team. The group left the project site office and arrived at Bangunan Ingenieur, Petaling Jaya at 1.30 p.m. ■