FORUM

GEOTECHNICAL IMPACT ASSESSMENTS DUE TO UNDERGROUND TUNNELLING

TUNNELLING AND UNDERGROUND SPACE ENGINEERING TECHNICAL DIVISION

reported by

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IEM's Tunnelling and Underground Space Technical Division (TUSTD) and Geotechnical Engineering Technical Division (GETD) co-organised an evening talk on Geotechnical Impact Assessments Due To Underground Tunnelling at the Tan Sri Professor Chin Fung Kee Auditorium in Wisma IEM, Petaling Jaya, on 2 May, 2019, at 5.30 p.m. There were 65 participants.

There are huge challenges in tunnelling, including its impact on surrounding structures. As such, potential damages and the need for protective works must be assessed before construction work begins.

Dr Boon Chia Weng, senior Geotechnical Engineer with MMC-Gamuda KVMRT (T) Sdn. Bhd., had represented Malaysia at the IEM-CIE-HKIE Tripartite Seminar 2018 on 4 September, 2018, and spoke on Geotechnical Challenges in Infrastructure & Transportation Projects.

He started the talk by describing the impact to structures with shallow foundations using the work of Burland & Worth (1969) and Boscardin & Cording (1989), in which bending strains and diagonal strains were calculated based on predicted ground settlement profiles. He also highlighted that most cracks were affected by the presence of openings within existing structures.

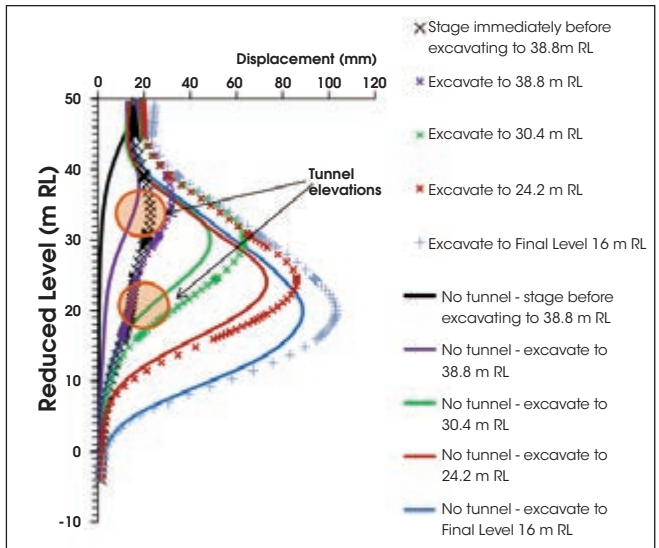
Using as example a structure on raft foundation, Dr Boon pointed out that 2 methods can be adopted, using Finite Element Analysis (FEA), to model the influence of tunnelling on surrounding structures. These are internal-pressure-reduction and contraction through volumetric strains. For structures on spread footings, a simplified method of using an equivalent beam and discrete springs at the foundation support was discussed. This method takes into account localised settlements which may occur in the Kuala Lumpur Limestone Formation.

For structures with piled foundation, there are two common methods of assessment:

1. Stress-based to calculate the reduction in geotechnical capacity.
2. Greenfield settlements can be obtained and ground deformations can be assigned as input to another software to calculate the pile vertical response due to the loss in mobilised resistance.

Axial responses of piles due to tunnelling works can be predicted following the procedures in Boon & Ooi (2016) using load transfer t-z and q-z analyses. The implication of downdrag or negative skin friction can be estimated, based on the pile location in relation to the influence zone of tunnelling works. Dr Boon also presented another scenario where the observational approach was adopted during the excavation of a station box that accommodated the boring-through of two Tunnel Boring Machines. Based on his experiences, a few considerations were of notable importance with respect to working with the design-and-build contractor in the Klang Valley Mass Rapid Transit (KVMRT) Project, Sungai-Buloh Kajang (SBK) Line. These considerations were:

- Impact on retaining wall.
- Building damage assessment.
- Impact on tunnel rings (both structural & geotechnical).
- Instrumentation and monitoring.
- Glass Fibre Reinforced Polymer (GFRP) at the softeyes.
- Alignment impact.
- Programme impact.



Summary comparison of wall deflection between the cases with and without the contribution of tunnel bore-through

INFLUENCE OF TUNNEL BORE-THROUGH ON WALL DEFLECTIONS

With reference to the observation, the influence of tunnelling work, with the assumption of 1% volume loss in FEA, it was

Ir. Frankie Cheah, session chairman for the evening talk, presenting a certificate of appreciation and souvenir to Dr Boon Chia Weng (left)

observed that 14mm of additional deformation of the diaphragm wall was obtained when tunnelling successfully bored through the station box.

This finding suggested that the impact should not be neglected accordingly in practice.The interaction between the tunnel lining and diaphragm wall was considered.

The convergence and heaving measurements of the upper tunnel, obtained through optical prisms, were studied to enable more optimal design procedures to be adopted for the lower tunnel; 60% backfilling on the lower tunnel was adopted to limit the structural deformations of the tunnel linings, as well as to eliminate potential buoyancy considerations. In practice, the latter depended on seepage and permeability of the ground, although it was found that the mechanism of uplift tended to manifest in effective stress calculations in FEA. The talk ended at 7 p.m., followed by a brief question and answer session. ■