AGS-HK Technical Seminar (Webinar) on 23/02/2023

"Engineering Challenges in the Design and Construction of Deep Excavation and Viaduct Foundation in Kuala Lumpur Limestone Using Case Studies" by **Ir. Sharmeelee Subramaniam** of Aurecon Malaysia, previously known as GCU Consultants

A technical report by **Caleb Sang**

Geotechnical challenges in Malaysia's Klang Valley identifies with karstic geology and ex-mining activities, resulting in heterogenous overburden material over the limestone bedrock, consisting of sand/clay slime, floaters, mining pond backfill, and the infamous slump zones. Ir. Sharmeelee highlights that slump zones are characterised by very weak soil of SPT-N values of 0 to 1 immediately above the rockhead, the layer above which consists of stiff soil measuring SPT-N value of greater than 30.

Two case studies illustrate the geotechnical challenges faced and the solutions implemented.

1: The case study is a 32-storey building including 5 basement levels. High groundwater levels and significant variation in rockhead levels increased the risk of sinkholes and ground settlement. Bored pile sizes between 750 and 2800mm for the foundation were validated by pre-drilling and sacrificial piles. Secant bored piles (SBP) with diameters of 800mm with 180mm overcut were predominant in the retention system, while contiguous bored piles (CBP) with diameter of 750mm were used in the deeper reaches. Visual and instrumentation monitoring, with predefined trigger values and action plans helped limit the lateral movement and stabilise the excavation works.

Challenge 1a: When ground conditions encountered by the contractor differed from anticipation, data from probe holes adjacent to the pile-in-question was communicated to the consultant. Changes in the pile design directly affected the superstructure and subsequently the construction sequence.

Challenge 1b: Fluctuations in groundwater resulted in additional risk to ground instability. The provided automated recharge wells were triggered when the groundwater level dropped by a difference of 1m.

Challenge 1c: Borehole collapse and loss of drilling fluid occurred during boring work for pile construction. Continuous monitoring and topping up of the drilling fluid/polymer were carried out to manage the stability of the hole where temporary casings were unavailable.

2: The case study is the design and construction of a 2.5km viaduct foundation constrained by an existing underpass, a SMART tunnel and two MRT tunnels within rock, along with the provision of a tunnel between the pier foundations of the viaduct. The site sits in a geological interface between differentially weathered karstic and meta-sedimentary rocks, and the cavities of which were identified and treated in advance.

Challenge 2a: Considering the pier foundation was in the zone of influence of multiple structures, preventive measures were pertinent to minimize load transfer to the surrounding ground. Adjacent to the operational underpass, multiple-size double casings were adopted for pile debonding.

Challenge 2b: To construct a future tunnel below the viaduct, SBP was adopted, which acted as the retaining wall and foundation of the pier. Tie beams were introduced between the portal structure to limit the lateral deflection.

Challenge 2c: Construction activities within the railway protection zone are subject to high scrutiny. Extensive assessments and discussions were made with MRT Corporation and SMART team. Consequently, an embankment of expanded polystyrene (EPS) contained within a reinforced concrete frame was adopted in areas directly above the railway and SMART tunnels. The EPS was wrapped in high-density polyethylene (HDPE) sheets and a geotextile separator for protection against petroleum products.