# Design and Construction of Excavation Works: Cochrane Station, Kuala Lumpur Workshop on "Soil Parameters - Interpretation for Design"

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The evening talk entitled "Design and Construction of Excavation Works for Klang Valley Mass Rapid Transit Underground Station at Cochrane, Kuala Lumpur, Malaysia" was organized by Geotechnical Engineering Technical Division (GETD) of IEM on 7 March 2014 at Tan Sri Prof. Chin Fung Kee Auditorium, Wisma IEM.

The talk was delivered by Ir. Koo Kuan Seng and attended by 90 persons. It was based on the technical paper presented by Ir. Koo in the Fifth International Young Geotechnical Engineers' Conference – iYGEC 2013 at Ecole des Ponts Paris Tech (ENPC) on 31 August and 1 September, 2013.

Ir. Koo started by presenting the background of the Klang Valley Mass Rapid Transit (KVMRT) project before zooming into the project site, which is the Cochrane Station.

Cochrane Station is one of the underground stations in Kuala Lumpur with maximum excavation depth of 32 m. This station serves as the launching shaft for the tunnel boring machine (TBM) from both ends of the station. Figure 1 shows the construction site layout plan. Cochrane Station is located within the Kuala Lumpur Limestone Formation with highly erratic karstic features and the overburden soils above the limestone formation are mainly silty sand with highly variable thickness due to the irregular topography of the limestone bedrock. Based on the subsurface investigation conducted, the interpreted geotechnical parameters are tabulated in Table 1. The RQD for the limestone is reported to be 0%-100% due to the highly variable nature of the limestone condition at the project site. There is no specific average value that can be concluded from the available data.

Main excavation works involved soil excavation and rock excavation.

First, at the commencement of soil excavation, a rectangular cofferdam measuring about 37 m by 176 m was constructed as shown in Figure 1 to facilitate removal of overburden until bedrock level. Schematic of the excavation works is shown in Figure 2.

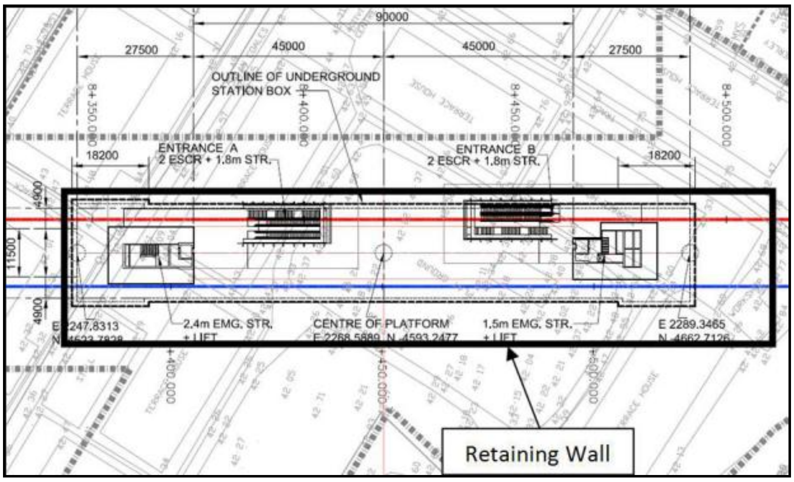
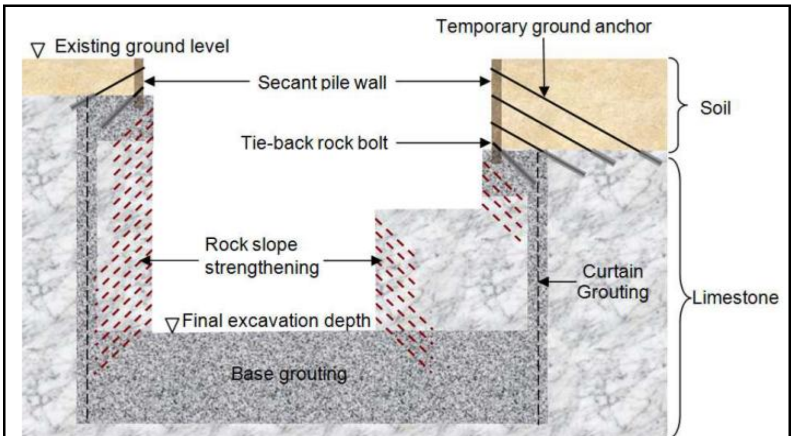



**Figure1: Construction site layout plan**

**Table 1: Interpreted geotechnical parameters**

| | Overburden | Bedrock |
|---|---|---|
| Material type | Silty sand | Limestone |
| Average depth | 0 - 5 m | 5 m below |
| Unit weight | 18 kN/m³ | 20 kN/m³ |
| SPT N-value | 2 - 4 | - |
| RQD | - | 0 - 100% |
| Average UCS | - | 50 MPa |
| Effective shear strength | c' = 1 kPa; ϕ' = 29° | c' = 400 kPa; ϕ' = 32° |
| Elastic modulus, E' | 4 - 12 MPa | 1,000 MPa |
| Hydraulic conductivity, k | 1.0 x $10^{-5}$ m/s | 0 - 31 Lugeon |




(Note: Rock slope strengthening indicated is provisional only. Actual locations and length of rock slope strengthening are determined after geological mapping works and kinematic analysis).

**Figure 2: Schematic of excavation works**

In soil excavating Ir. Koo explained secant pile wall was selected as the earth retaining wall supported by temporary ground anchors. The advantages of the selected system are: (i) water-tightness to prevent groundwater draw-down at the retained side; and (ii) the ability to vary the pile lengths to suit the irregular limestone bedrock profiles. The excavation of overburden soils was carried out in stages, facilitated by installation of temporary ground anchors. Subsequently, a row of tie-back rock bolts were installed above the bedrock level to enhance the toe stability. All the secant piles have minimum required socket into competent bedrock. When the soil excavation reached bedrock level and before commencement of rock excavation, a row of tie-back rock bolts are installed from level about 0.5 to 1 m above bedrock level with 45 degree inclination. Since the bedrock level has been confirmed at site after soil excavation, the tie-back rock bolt can be anchored into bedrock with sufficient rock socket after 1 to 2 m drilling through secant pile concrete. The tie-back rock bolts were drilled through secant pile concrete (at pile without reinforcements) and casted together with a row of concrete waler to form a tie-back support system.

Second, for rock excavation, it was carried out using conventional pre-split blasting followed by bulk blasting with suitable delays to minimize the impacts of blasting works. Blasting was controlled at 1.25 to 1.5 m away from wall and the remaining rock surfacing will be removed by hacker. Vibration limit was specified for blasting control in order not to damage the wall structure and support system. After blasting, geological mapping was carried out by qualified engineering geologist to determine the probable mode of rock slope failures and suitable rock slope strengthening works were adopted.

Apart from the excavation works, Ir. Koo emphasized the importance of grouting works. Basically grouting works were carried out to reduce the rate of groundwater inflow and reduce pathways of water flow into excavation area as risk mitigation measure. Rock fissure grouting was carried out along the perimeter of excavation area to form a curtain grouting as shown in Figure 2. Rock fissure grouting was also adopted in this project for base grouting at a larger grout hole spacing. If any cavity was detected during drilling/grouting, compaction grouting with cement mortar would be used as cavity treatment.

Overall, the system performs satisfactorily and the excavation works were successfully completed within the contract period.

After ending of his talk, Ir. Koo took on a few questions from the floor. The evening talk came to the end after the presentation of appreciation certificate and memento to Ir. Koo by Ir. Liew, the GETD Chairman.


**Figure 3: Presentation of memento by Ir. Liew to Ir. Koo**