Geotechnical challenges of the construction of a mega underground railway station on reclaimed land

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The West Kowloon Terminus (WKT) is a mega underground terminus for the Hong Kong section of the Guangzhou-Shenzhen-Hong Kong Express Rail Link which began to operate in 2018. The construction of the WKT involved large-scale excavation covering a plan area of approximately 550m by 220m to a depth of over 30m in an urban reclaimed area of Hong Kong. To meet the tight construction programme, the construction sequence of the central portion of the deep excavation involved open excavation with the formation of temporary cut slopes which serve to support the diaphragm wall until the core station structure was completed, after which the slabs along the periphery, i.e. immediately in front of the diaphragm wall, were constructed by top-down construction. The stability of the temporary cut slopes, hence the excavation, was adversely affected by the presence of soft marine deposits left behind during reclamation. Ground improvement works in the form of jet grout columns were therefore carried out to enhance the overall stability of the temporary cut slopes before excavation. The interaction between the diaphragm wall and the soil berm in front of the wall treated by jet grouting was a major design challenge for the designer.

To further complicate the story, the construction of the entire underground station was carried out by two separate contractors who adopted different construction methods. The contractor for the northern part of the site adopted the bottom-up construction method as described above. The contractor for the southern portion adopted top-down construction for the top two levels of slabs (i.e. B1 and B2), and then switched to bottom-up construction for the remaining two levels (i.e. B3 and B4). Due to the differences in construction sequence, differential lateral movements at the D-wall were anticipated at the interface of the two excavations. This was demonstrated by the predicted wall movements using 2D finite element methods. A transition zone was anticipated at the interface, however, the extent of this zone could not be estimated using 2D models. To investigate the response of the lateral support system at the interface, including that of the diaphragm wall, struts and structure slabs, a series of three-dimensional finite element models were formulated. The numerical analyses revealed the extent of three-dimensional effects near the interface, the impacts on the lateral deflection profile of the diaphragm wall, and the support forces in the slabs of the station structure. The three-dimensional analyses also allowed an assessment of the distortion induced in individual wall panels due to the interface effects. The analyses enhanced the understanding on the response at the interface of the two excavations and enabled advanced planning of measures to mitigate potential impacts to the lateral support system.

In this lecture, the geotechnical analyses carried out pertaining to the challenges described above will be presented. Overall performance of the geotechnical works will also be discussed.