Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 189 (2017) 560 – 568

Procedia Engineering

www.elsevier.com/locate/procedia

Transportation Geotechnics and Geoecology, TGG 2017, 17-19 May 2017, Saint Petersburg, Russia

Development of tunnel dismantling machine (TDM) in an underground railway project

P.L. Ng[a]*, T.N.D.R. Barrett[b], G. Roux[c], S. Polycarpe[d], M. Gonzalez[e]

[a]*Formerly Dragages-Maeda-BSG Joint Venture, Hong Kong, China*
[b]*MTR Corporation Limited, Hong Kong, China*
[c]*CSM Bessac, Saint Jory, France*
[d]*Dragages Hong Kong Limited, Hong Kong, China*
[e]*Bouygues Construction, Guyancourt, France*

Abstract

The MTR West Island Line (WIL) project in Hong Kong involved demolishing and backfilling a 132 m section of the existing Overrun Tunnel (ORT) through complex geology beneath densely populated urban area, in order to enable subsequent excavation of the WIL Down-track (westbound) running tunnel by tunnel boring machine (TBM). To tackle the challenge while minimizing construction risks, a bespoke tunnel dismantling machine (TDM) was innovated. The TDM worked backwards from the operational railway interface inside the ORT to remove each lining segment ring under 2.8 bar compressed air pressure, sprayed shotcrete lining for temporary support, and backfilled the remaining void left underground. The crew behind the demolition chamber of TDM worked under atmospheric pressure. Part of the backfilled tunnel was then re-excavated by slurry TBM to form the re-aligned WIL Down-track running tunnel. The TDM was able to accomplish the works safely and led to the successful opening of WIL. This paper explicates the development of the world-wide unprecedented TDM and the construction process of ORT demolition.

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology

Keywords: Confinement; hyperbaric intervention; lining segment; shotcrete; tunnel dismantling machine; tunnelling

* Corresponding author. Tel.: +852-9587-5310; fax: +852-2559-5337.
E-mail address: irdngpl@gmail.com

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology
doi:10.1016/j.proeng.2017.05.089

1. Main text

The MTR West Island Line (WIL) in Hong Kong extends the existing Island Line (ISL) from Sheung Wan Station (SHW) to Kennedy Town (KET) via Sai Ying Pun (SYP) and HKU Stations, adding approximately 3.3 km of the railway route length. The SHW to SYP Tunnels belong to the scope of WIL Contract No. 703 (WIL703), which comprises the Up-track (eastbound) and Down-track (westbound) running tunnels excavated by both tunnel boring machine (TBM) and Drill-and-Blast methods [1,2], construction of access tunnels and shafts, artificial ground freezing gallery at existing SHW Crossover Box (COB) to remove pre-existing obstructions prior to TBM excavation [3], construction of SYP Station Entrances A1/A2 structure, and other associated works. Fig. 1 depicts the general layout of WIL703 project.

During the construction of ISL in 1980s, the Sheung Wan Overrun Tunnel (ORT), which served as refuge siding for shunting of broken-down train, was designed with planned future extension in mind. The ORT stretched about 500 m from SHW COB to Ko Shing Street ventilation shaft. However, due to changes in land usage, the WIL tunnel alignment was shifted towards the south to better serve the development catchment of the Western District. Thus the end portion of the existing ORT no longer suited the revised alignment and the new westbound tunnel would connect halfway along the existing ORT, as illustrated in Fig. 2. A section of the ORT of 132 m length was in conflict with the Down-track running tunnel and needed to be demolished prior to the new tunnel construction.

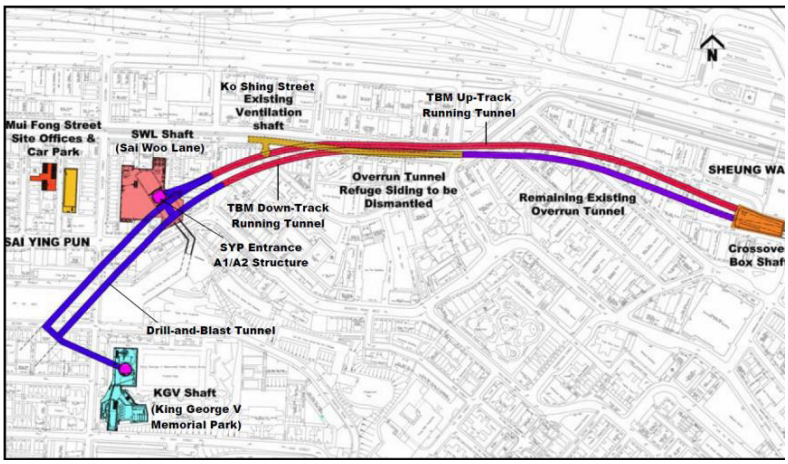

Fig. 1. General layout of WIL703 project.

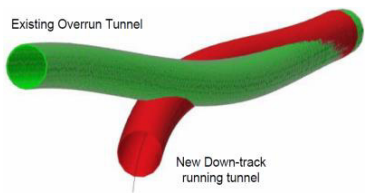

Fig. 2. Geometry of new tunnel connection to ORT.

The ORT was an undrained tunnel with external diameter of 5.8 m and was lined with precast reinforced concrete or spheroidal graphite iron (SGI) segment rings. Each ring of precast concrete lining was 1.0 m wide and 0.25 m thick, whereas each ring of SGI lining was 1.0 m wide and 0.15 m thick. The internal diameter of the ORT was 5.3 m at the precast concrete lining sections and 5.5 m at the SGI lining sections. A photograph of the ORT showing both types of lining is given in Fig. 3. The 132 m section of ORT comprised 125 precast concrete rings and 7 SGI rings. The ORT was curved on plan with a minimum radius of curvature of approximately 600 m, and it sloped down from SHW to Ko Shing Street at 0.5% gradient.

The geological condition was variable and complex. Fig. 4 illustrates the geology along the longitudinal section of ORT, which was mainly embedded in completely decomposed granite (CDG) with corestones, and overlain by alluvium and marine deposits. The maximum groundwater head above the tunnel invert level was 27 m. The ORT and the new westbound tunnel were situated underneath dense urban areas with limited clearances to the existing building foundation piles, the closest being circa 400 mm. The above restraints necessitated a promising construction methodology.