

# Box Jacking in Urban Areas

TUNNELLING AND UNDERGROUND SPACE TECHNICAL DIVISION



reported by  
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The Tunnelling and Underground Space Technical Division (TUSTD) organised an evening talk on "Box Jacking in Urban Areas" on 8 October 2015. It was delivered by Mr. Don Hall, Managing Director, CREG Asia & Africa, and was attended by 70 participants.

The talk focused on a case study in Zhengzhou, China, and the planned works for the box jacking section of the Thomson Line, Singapore.

## OVERVIEW

The Zhengzhou Project runs along Hongzhuang Road, crossing underneath Zhongzhou Avenue, a major arterial road in Zhengzhou. The total project length is 801m, which comprises cut and cover 232m, box jacking 105m, with the balance as open cut. There are four box tunnels crossing the road with the size of 7.4m x 5.65m and 10.1m x 7.45m (Figure 1).

The box tunnels were constructed allowing only 3.5-4.0m overburden and 1m spacing between tunnels.

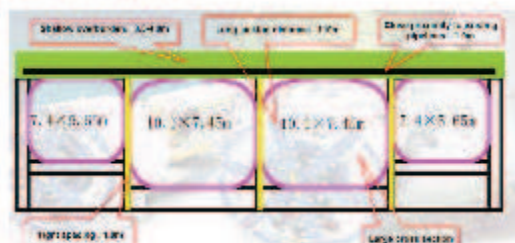


Figure 1: Zhengzhou Project: Box Culvert Cross Section

The jacking of box culverts started on 16 February 2014 and was completed on 31 August 2014 (total tunnel length is 420m; 105m x 4 tunnels).

The soil profiles comprised soft alluvial, silty clay, silt, backfill, silty soil and compacted sand. The SPT value was approximately between 10 and 15. Ground water level was 5m below ground surface.

## BOX JACKING MACHINE

Two rectangular shaped tunnel boring machines (TBMs) of size 10.12m x 7.47m, and 7.42m x 5.67m (Figure 2) respectively were used. The machine was manufactured with multiple rotary cutterheads. The TBMs were equipped

with 6 spoke type cutterheads and positioned in a 3 x 2 formation (three cutterheads in a row) with overlapping, resulting in 90.7% coverage of the excavation face. Drag bits were mounted on the leading edge of the front shield to provide ancillary cutting to blind areas (9.3% of uncovered excavation face). High pressure water nozzles and fittings for pneumatic drilling were reserved in the bulkhead for improvement of cutting face coverage.

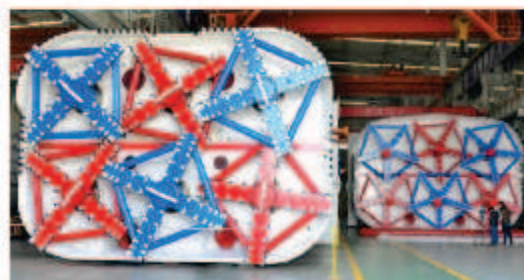


Figure 2: Square TBM

## JACKING SYSTEM

The thrust system comprised supporting rack and cylinders. The thrust cylinders were telescopic. The thrust cylinders had a working pressure of 30MPa and the maximum working pressure was 31.5MPa, with maximum thrust force of 7200T.

## BOX SEGMENTS

The segments were cast at site because of their large size and the difficulty in transporting them to site if they were cast at the manufacturing plant.

## CHALLENGES

Mr. Hall said that by using larger box shaped TBM, shallow overburden (3.5m-4.0m) and tight tunnel spacing (1m) might create problems such as piggyback soil, box deviation and settlement risk. To address these issues, a few counter measures had been taken.

A system which enabled high efficiency slurry injection was introduced to minimise the risk of piggyback soil. The slurry injected into the annular gap of front shield and tail skin. Additionally, the box segments were also provided with slurry injection points (at crown and side walls) as part of friction reduction measures.

The box deviation issue was controlled by introducing 16 articulation cylinders for correction in horizontal and vertical directions. Furthermore, to inject dense slurry for deviation correction, 10 built-in grouting ports were placed along the front shield.

In order to reduce disturbance to the surroundings and to minimise the settlement risk, multiple rotary cutterhead box TBMs were used in this project. Mr. Hall mentioned that maximum settlement of 28.2mm was recorded upon completion. The result complied with the specification.

#### UPCOMING PROJECT - THE THOMSON LINE

Mr. Hall said that part of the box jacking work at the Thomson Line is a trial project to replace an open cut method. The reason for the change is to reduce surface disruption and traffic congestion at the affected area. The soil profile consists of fill, marine clay and GVI. He explained that the ground will be treated at both launch and breakthrough zones with 800mm diameter jet grouted piles.

#### SUMMARY

In general, a maximum jacking distance of 200m is possible without intermediate jacking stations. Currently the rectangular TBM is only suitable for soft ground and applicable to straight alignment. Further research and development is being carried out to manufacture TBM with segmental box tunnel lining to accommodate curvature alignment. ■



*TUSTD Chairman Mr. Andrew Yeo w Pow Kwei presenting a memento to Mr. Don Hall (right)*

#### IEM DIARY OF EVENTS

**Title: Half-Day Seminar on Concrete and Waterproofing Technology for Underground Construction**

**19 March 2016**

Organised by : Tunneling and Underground Space  
Engineering Technical Division  
Time : 8.30 a.m. – 1.00 p.m.  
CPD/PDP : 3.5

*Kindly note that the scheduled events below are subject to change. Please visit the IEM website at [www.myiem.org.my](http://www.myiem.org.my) for more information on the upcoming events.*