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TunnelTalk *Direct by Design*

Final breakthrough ends KVMRT TBM tunnelling 16 Apr 2015

Shani Wallis, *TunnelTalk*

All running tunnel TBM excavation for the Klang Valley metro Line 1 project in Kuala Lumpur, Malaysia, is complete. The last TBM breakthrough on Saturday 11 April completes 9.5km of 5.8m i.d. twin-tube TBM running tunnel alignment for the project from the Semantan North Portal to the Maluri South Portal. Final breakthrough at the Pasar Seni underground station completes the central underground section of the city's first 51km high-capacity heavy rail metro line and draws to a close TBM operations that started when the first TBM was launched in May 2013.

Table 1. Technical details of the KVMRT Line 1 underground section

- Tunnels**
- Total length of tunnel bored 15,920m
 6,625m in limestone ; 9,895m in Kenny Hill Formation
 - 8 TBMs used – 5 VDMS and 3 straight EPBMs
 - Total days deployment (including stops) – 2,728 days
 - Total number of segments cast - 91,200 all but 27 rings were used
- Longest single TBM drive**
- Cochrane to Pasar Seni - 4,412m by VDM S774
 - Launched in Cochrane - 4 June 2013 and broke through at Pasar Seni - 11 April 2015
 - All 4,412m in operation except for 145m when pulled across Merdeka Station
 - It was first TBM to start and last to finish
 - It was the first VDM launched designed jointly by Herrenknecht and MMC Gamuda
 - Bored through limestone and Kenny Hill Formation using its different modes
 - VDM technology design jointly by Herrenknecht AG and MMC Gamuda
- Best progress rates**
- Best advance in one day - 15 rings (21m) achieved by VDM S779 on drive from Cochrane to Maluri South Portal.
 - Best EPBM advance rate shared by the two CREG machines at 14 rings per day.
- Underground stations**
- Deepest and largest station - Tun Razak Exchange (formerly Pasar Rakyat Station)
 - Most difficult station to excavate geologically and structurally - Pasar Seni Station
 - Stacked configuration - Bukit Bintang Station

The last breakthrough is in fact achieved by the first TBM launched on the project and after completing a drive of 4.4km of excavation through a mix of karstic limestone and Kenny Hill sedimentary deposits. It completes the longest drive of any TBM on the project and is a breakthrough for a Herrenknecht multi-mode TBM. The machine started in the VD (variable density) slurry mode from the Cochrane open cut station box at the end of May 2013 and passed through three station zones and two intermediate shaft locations before ending its drive on Saturday 11 April at the Pasar Seni open cut station excavation.

Ten TBMs were procured for the underground central section of the first MRT line for the Malaysian capital city and eight were launched and operated (Fig 1). By completing the 4.4km running tunnel from Cochrane to Pasar Seni, the last machine to breakthrough spared the launch of one VD machine and also a Herrenknecht EPBM. The change in strategy was adopted to mitigate various programme conflicts together with the possibilities available to the contractor that was engaged to complete the total underground section as one contract.

MMC-Gamuda, the Malaysian construction JV engaged to complete the 9.5km underground section of the 51km long MRT Line and its seven underground stations, procured six specialist variable density TBMs (VDMS) from Herrenknecht AG to work through Kuala Lumpur's karst limestone; and four EPBMs, two from Herrenknecht and two from CREG of China, to

excavate the sedimentary clays and silts of the Kenny Hill Formation (Fig 1).

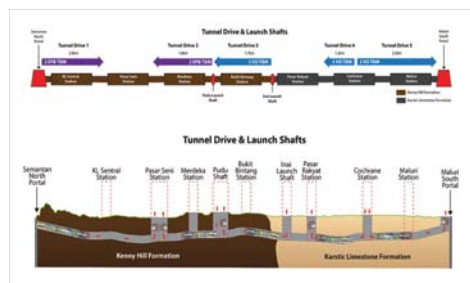


Fig 1. Original strategy for the 10 TBMs procured for the project with the continuous drive of one machine from Cochrane to Pasar Seni saving launch of two machines

The two CREG EPBMs launched from the Semantan North Portal in June 2013 and completed their programmed drives at Pasar Seni station (Fig 1).

Four VDM machines launched in opposite directions from the Cochrane open cut station box with the two heading south completing their drives at Maluri South Portal in April 2014. Another Herrenknecht VDM machine launched from the Inai intermediate working shaft in December 2013, completing its planned drive at the Pudu shaft; and a Herrenknecht EPBM launched in May 2014 from the Pudu shaft, completing its planned drive through Merdeka station to finish at Pasar Seni station in January 2015.

Drive name	TBM Manufacturer and type	Tunnel Drive	Launch date	Breakthrough date	Distance (in meters) and Breakthrough sequence
COC 1	Herrenknecht VDM 774	Cochrane to TRX Pasar Rakyat	30 May 2013	Mine-through	1,000 Mined through
COC 2	Herrenknecht VDM 776	Cochrane to TRX Pasar Rakyat	19 Jul 2013	9 Jan 2014	1,000 2nd
MAL 1	Herrenknecht VDM 778	Cochrane to Maluri	28 Sept 2013	8 Apr 2014	1,800 4th
MAL 2	Herrenknecht VDM 779	Cochrane to Maluri	9 Nov 2013	24 Apr 2014	1,800 5th
INAI 1	Herrenknecht VDM 774	Inai to Bukit Bintang	15 Mar 2014	23 Jul 2014	1,150 Mined through
INAI 1	Herrenknecht VDM 774	Bukit Bintang to Pudu LS	24 Jul 2014	16 Oct 2014	492 7th
INAI 2	Herrenknecht EPBM 775	Inai to Bukit Bintang	28 Nov 2013	15 Aug 2014	1,150 Mined through
INAI 2	Herrenknecht EPBM 775	Bukit Bintang to Pudu LS	16 Aug 2014	18 Oct 2014	492 8th
PUDU 1	Herrenknecht VDM 774	Pudu LS to Merdeka	4 Nov 2014	4 Jan 2015	650 12th
PUDU 1	Herrenknecht EPBM 774	Merdeka to Pasar Seni	28 Jan 2015	11 Apr 2015	500 13th

ALERT!		on TBM launch and breakthrough dates				
Are you signed up to our free weekly Alert email? Take a moment to check and stay on top of the tunnelling world's news and views		Launch date	Breakthrough date	Distance (in meters) and Breakthrough sequence		
		Merdeka	5 May 2014	6 Oct 2014	650	6th
		Pasar Seni	28 Oct 2014	3 Jan 2015	500	11th
		Portal to Sentral	13 Jun 2013	24 Dec 2013	1,800	1st
		SMT 1 CREG EPMB SMT 1 Muzium Negara to Sentral	28 May 2014	29 Oct 2014	1,200	10th
		SMT 2 CREG EPMB SMT 2 Semantan Portal to Sentral	14 Jul 2013	16 Jan 2014	1,800	3rd
SMT 2 CREG EPMB SMT 2 Sentral to Pasar Seni	21 Apr 2014	21 Oct 2014	1,200	9th		

But it was the Herrenknecht VDM launched by the Prime Minister of Malaysia Datuk Seri Najib Tun Razak in May 2013 from the Cochrane station box heading north that is the star of the project. Instead of completing its work at Pasar Rakyat station box, as planned, it was running ahead of station excavation and the plan changed to allow the machine to mine through the Pasar Rakyat station zone as well as the Inai shaft location, where there were ground condition and water inflow problems, before proceeding through the Bukit Bintang and the delayed Pudu shaft excavation locations for a breakthrough and pull through at Merdeka station and relaunch on the last drive to the Pasar Seni station in January 2015.

As the trail blazer, the TBM arrived ahead of programme at Pasar Rakyat station box and mined on through while its partner and following VDM from Cochrane broke through and was withdrawn from Pasar Rakyat station as planned. Problems with groundwater control at the Inai shafts saw launch of only one of two planned VDMs at the intermediate working shaft with the machine from Cochrane mining through. Both machines progressed through the narrow Bukit Bintang station corridor on a stacked configuration and while the leading machine launched from Inai shaft was retrieved from Pudu Shaft as planned, and an EPB machine introduced at Pudu for the drive to Merdeka station, the same machine from Cochrane was again pressed into further duty, mining through the bottom of the delayed Pudu shaft, after starting the upper machine of the stacked configuration first. Both machines then broke through at Merdeka station to be pulled through and relaunched at the far end wall to complete the last drives in Pasar Seni station: the TBM from Pudu Shaft finishing in early January 2015 and the TBM from Cochrane breaking through on 11 April after completing 4.4km of continuous operation.



Prime Minister Datuk Seri Najib Tun Razak powered up the first VDM and the first machine on the project in May 2013

Further to its long drive performance, the last TBM to break through functioned successfully in its different modes. After starting in the variable density slurry mode to work through highly karstic limestone from Cochrane station, it finished its 4.4km long drive in full EPB mode, making the changeover soon after driving through the Inai shaft location for the final drive through Bukit Bintang, Pudu shaft and Merdeka station and on to final breakthrough in Pasar Seni station.

"The performance of the machine was excellent in both modes," said Gus Klados, Project Manager for the MMC-Gamuda JV tunnelling team. "It proved its ability through the karstic limestone strata and also in the converted EPBM mode through the Kenny Hill sedimentary deposits in which a second EPBM from Herrenknecht had been planned to operate from the Inai shaft location to final breakthrough at Pasar Seni station."



Water inrush through the end wall of the Pasar Rakyat station box from a network of karst features

inflow from a karst feature became too much. "While drill+blast of the starter tunnel was successful for launch of the upper VDM, the deeper shaft for launch of the lower one had to be abandoned and backfilled. The change of strategy was to have the VDM from Cochrane mine on through the troubled zone, which it did without any problem whatsoever," reported Klados.

The two TBMs not launched on the project – a Herrenknecht EPBM and a Herrenknecht VDM – are both held in storage by MMC-Gamuda, along with the other six machine supplied by Herrenknecht, ahead of potential use on the 10.2km underground section of the planned MRT Line 2. The project has been approved by the Government of Malaysia and the contract procurement phase is expected to begin during 2015 for a potential start of construction in 2016 or early 2017. Services on the completed Line 1 project are scheduled to start by end of 2016 for Phase 1 and by mid-2017 for Phase 2, which includes the 9.5km section beneath the streets of the city centre.

References

TBM excavation in final run in Kuala Lumpur – *TunnelTalk*, January 2015
 New design TBM tames the Kuala Lumpur karst – *TunnelTalk*, January 2014
 First TBM launch on Klang Valley MRT – *TunnelTalk*, June 2013

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