

# FIRST TERRATEC TBM BREAKS THROUGH ON MUMBAI METRO



*The first of seven TERRATEC TBMs being used on Mumbai Metro's highly anticipated 33.5km underground Line 3 corridor, in India, breaks through on its inaugural drive.*

**I**n mid-February, TERRATEC joined workers from the J. Kumar – China Railway No. 3 Engineering Group (CRTG) JV to celebrate the breakthrough of a 6.68m diameter TERRATEC dual-mode hard rock Tunnel Boring Machine (TBM) at work on Mumbai Metro Rail Corporation Ltd's (MMRCL) Line 3 project, in India. The machine is one of three new TERRATEC dual-mode TBMs being used by J. Kumar-CRTG to excavate portions of the line's

4.94km-long twin-tube tunnel contract UGC-05 and 4.45km-long twin-tube tunnel contract UGC-06 (stretching from Dharavi Station to the CSIA International Airport).

"We congratulate TERRATEC on the performance of the Dual Mode TBM T62 and the completion of its first 690m drive of from the [CSIA] International Airport Station to Sahar Road Station," said Haluk Emre, J. Kumar-CRTG's

Project Manager on Package 6. "The machine has travelled successfully through mixed geology and considerable water ingress and we credit TERRATEC's TBM field service support experts for assisting our tunnelling operations with close monitoring throughout this period."

The versatile TERRATEC single shield TBMs are equipped to



operate in either Open or Closed mode in the predominantly fresh and slightly to moderately weathered Basalt and Breccia expected on these contracts. The robust hard rock cutterheads are mounted with heavy-duty 17" disc cutters, which are interchangeable with ripper tools, and feature large bucket openings that provide a 10% opening ratio.

Other state-of-the-art features include 2,000kW Electric Variable Frequency Drives – that allow the cutterheads to cut efficiently in harder rock zones at maximum speeds of 7rpm and deliver an exceptional torque of 8,500kNm to cope with more fractured zones of ground along the alignment – as well as active shield articulation and built-in two component backfilling grout systems.

In addition to the three new hard rock TBMs, TERRATEC has also supplied two re-manufactured 6.61m diameter mixed/rock Earth Pressure Balance Machines (S63 and S64) to J. Kumar-CRTG in Mumbai, which have been put to work on a section of highly weathered ground on contract UGC-05. "The TBMs are performing very well," says TERRATEC Site Operations Manager, Bill Brundan. "The five J. Kumar-CRTG machines have excavated a total of more than 5.7km of tunnel to date."

A further two new 6.68m diameter dual-mode hard rock TBMs are being used by the Hindustan Construction/Moscow Metrostroy JV to build the twin tunnels on the line's 4.049km-long contract UGC-02. Both machines were deployed

from the Chhatrapati Shivaji Terminal (CST) TBM launch shaft and are currently mining towards the Mumbai Central Station TBM receiving shaft, having now completed 3.7km of tunnel with progress rates of up to 525m per month.

In total, the seven TERRATEC machines have mined 9,462m (42%) of their planned drives to date.

When complete, Mumbai Metro's much-anticipated Line 3 will be the first underground metro line in the city. The 33.5km-long line will connect Cuffe Parade business district in the far south to the Santacruz Electronics Export Processing Zone (SEEPZ) in the

north-central with 26 underground and one at-grade station (see map).

Construction of the line is divided into seven tunnel-and-station packages that were awarded to five contracting joint ventures in 2016. These five contractors will deploy a total of seventeen (17) TBMs with TERRATEC being the lead TBM supplier on the project with a 41% market share.



## A FLEET OF TERRATEC EPBMS GEAR UP FOR ACTION ON ISTANBUL'S NEW HALKALI AIRPORT METRO CONNECTION

TERRATEC is pleased to announce the delivery of a further two new 6.56m diameter Earth Pressure Balance Tunnel Boring Machines (EPBMs) for the ongoing expansion of Istanbul's Metro system, in Turkey, following successful factory acceptance testing earlier this week. The new EPBMs, along with two other sister machines that have already been delivered to the project, will bring the number of TERRATEC machines working concurrently on the city's metro to a total of nine.

The new TBMs will be used by the Halkali-Yeni Havalimani Metro JV (consisting of Cengiz İnşaat, Kalyon and Kolin) on the Halkali-Istanbul New Airport metro line, which was awarded to a consortium comprising Özgün Yapı and Kolin by the Turkish Ministry of Transport and Infrastructure (AYGM). The 31km-long line, along with 6 new stations and connections, will form the western-leg of the new M11 Line that runs from the recently opened third International Airport on the European side of the city

southwards to Halkali (which will also be the final terminus of the new Marmaray railway). The robust TERRATEC TBMs have versatile mixed-face dome-style cutterheads that have proven to work extremely effectively in Istanbul's mixed geology – which includes sandstones, siltstones, limestones and volcanic rock – as well as other state-of-the-art features such as VFD electric cutterhead drives, tungsten carbide soft ground cutting tools that are interchangeable with 17" roller disc cutters, high torque screw conveyors and active







articulation systems.

As the TBMs progress, they will install 1,500mm wide by 300mm thick pre-cast concrete lining rings, which consist of five segments plus a key.

“Terratec is excited to be providing yet more machines to metro projects in Istanbul,” says TERRATEC Sales & Marketing Director, Bruce Matheson. “We are confident they will perform as well as previous machines have in the city and we look forward to breaking more records for on-time delivery, quick assembly and excellent production rates.”

The Halkali-New Airport metro line is one of a number new metro lines currently being built in the city that will increase Istanbul’s current 145km Metro network to more than

480km. Members of the JV were so impressed with the performance of previous TERRATEC machines used on the Mecidiyeköy-Mahmutbey Metro, the Dudullu-Bostancı Metro Line and the Ümraniye-Ataşehir-Göztepe Metro contract – that they were keen to employ a further four TERRATEC machines on this latest project.

In March 2018, one the Dudullu-Bostancı TERRATEC EPBMs completed an outstanding advance of 19 rings in a single shift (equating to 28.5m of excavation in just 12-hours), accomplishing a new production record for a TBM of this size and class in Istanbul.

More recently, on the other leg of the new M11 International Airport metro line (the 37km-long Gayrettepe-New Airport metro line that is being

constructed by the Kolin-Şenbay consortium), the refurbished TERRATEC S42 machine is going strong, achieving a best day of 33 rings (46m) earlier this month.

## TERRATEC TBMS DELIVERING RESULTS IN THAILAND

Having delivered seven TBMs to Thai underground works projects in the last three years (representing every machine currently being operated in the country), TERRATEC continues to make great progress, with a number of milestones being celebrated over recent months. In Bangkok, solid results are already being seen on the first phase of tunnelling for the Orange Line metro project, as well as on a number of tight radius Earth Pressure Balance Machine (EPBM) drives for drainage and cable tunnel projects across the capital. Meanwhile, in the northern province of Chiang Mai, two TERRATEC hard rock Double Shields are achieving steady progress on the 25km-long Phase

2 tunnelling works for the Royal Irrigation Department’s Mae Tang-Mae Ngad water diversion project.

In January, TERRATEC joined workers and officials in celebrating the launch of the 6.39m diameter S70 EPB machine by contractor Italian-Thai Development PCL (ITD) on one of three underground civil works contracts for the first 23km-long (East) phase of the Mass Rapid Transit Authority of Thailand’s (MRTA) Orange Line Project.

Contract E3, which was awarded to ITD in May 2017, totals over 6km of TBM driven tunnel and three underground stations, extending from Hua Mak to Khlong Ban Ma. The S70 machine began

mining westwards from the Khlong Ban Ma station box on January 12, 2019, and quickly got up to speed following its initial drive. By late-March, the TBM had already mined 400m – achieving progress rates of up to 18 rings per day – and had undertaken its first intermediate breakthrough into a ventilation shaft (IVS 17) where it was undergoing a cutterhead inspection.

The TERRATEC S70 TBM was designed to tackle the variable soft ground geology of the city – which ranges from soft and medium to stiff and very stiff clays, with lenses of dense sand and the potential for high pressure groundwater inflows – as well as the need to mine through numerous diaphragm

*With seven TBMs currently at work on major underground projects in Thailand, TERRATEC marks its latest milestone on Bangkok’s Orange Line metro project.*





wall shafts and, potentially, concrete piles.

"We are in a very congested area of the city, tunnelling underneath a busy highway that has a flyover directly above it and buildings with deep foundations on both sides," says Prakin Arunotong, Senior Vice President of ITD's MRT Business Unit. "So we need to carefully protect those structures during tunnelling and station construction."

In order to handle these challenging conditions, the TBM's

soft ground cutterhead features a spoke style and the addition of back-loading knife bits to assist break-in and break-out of the shafts. In addition, the machine is fitted with an active bentonite face support injection system and double gated screw, to ensure face stability and mitigate settlement during excavation in areas of flowing sands and high groundwater pressure.

As the machine progresses along the alignment, it is installing a precast concrete segmental lining consisting of five x 1200mm wide

Universal style segments plus key, with an internal diameter of 5.7m. These are being produced by ITD at the same factory. These are being produced by ITD at the same factory used for segment manufacture during its MRT Blue Line underground works contract five years ago, which also employed a TERRATEC TBM.

In total, TBM tunnelling operations for ITD's Orange Line (East) contract are expected to last approximately two years and are being assisted at all times by TERRATEC's highly-experienced Field Service staff – who's quality after sales support service has created very loyal client-base in Thailand – to ensure optimum performance and successful project completion.

"We have worked closely with TERRATEC since 2012, when we won our MRT Blue Line extension contract," says Arunotong. "TERRATEC has a very similar working style to our own and because of this we consider our partnership with them as more of an 'Alliance' than that of the traditional contractor-TBM manufacturer relationship."

Bangkok's new Orange Line will eventually total about 35.4km with 26.2km aligned underground with 23 underground stations and another 9km and seven stations on elevated structures. When complete, in 2023, the Orange Line will provide a vital transportation link from Bangkok's city centre to districts in the east, reducing traffic congestion and paving the way for improved accessibility, economic growth and new residential and commercial opportunities along the alignment.



## WATCH US ON

A video featuring TERRATEC dual-mode TBM breaking through on UGC-06 in Mumbai



A video featuring TERRATEC TBM S76 at Manufacturing Centre



## WHEREABOUTS

Meet TERRATEC at the following conferences and exhibitions!



hhUnderground Works, Principle and Application  
April 18-20, 2019  
Bangkok, THAILAND



World Tunnel Congress 2019  
May 3-9 | Naples, ITALY



Tunnel construction In India, Conference  
June 4-5 | Mumbai INDIA



Rapid Excavation Tunneling Conference  
Jun 16-19 | Chicago, Illinois, USA

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