

EXTREME ARTICULATION FOR BANGKOK FLOOD PREVENTION



TERRATEC Tight Radius Shields (TRS) facilitate a challenging curved alignment on a major new drainage tunnel project for the Bangkok Metropolitan Administration (BMA).

In April 2017, TERRATEC celebrated the successful Factory Acceptance Tests of two new 5.70m diameter tight radius Earth Pressure Tunnel Boring Machines (EPBMs) destined for the Bueng Nong Bon to Chao Phraya River Diversion Tunnel Project, in Bangkok, Thailand. The ceremonies were attended by representatives of the Bangkok

Metropolitan Administration (BMA) and Thai contractor Sino-Thai Engineering & Construction Public Company Limited (STECON).

Located in the south-east of Bangkok, the 9,187m-long Bueng Nong Bon to Chao Phraya River Diversion Project is the third of four major flood prevention tunnels to

be built under the Bangkok Metropolitan Administration's long-term plan to manage the severe flash floods that currently plague the Thai capital during the rainy season. Due to the densely developed nature of the city, the east-west route between the Bueng Nong Bon reservoir and the Chao Phraya River has largely been dictated by



the need to stay within public road easements, which has imposed a number of very tight radius curves on the tunnel alignment. To achieve these, the TERRATEC Tight Radius Shield (TRS) machines have been designed with an extreme X-type articulation system that provides a maximum articulation angle of 7.5-degrees to accommodate a minimum radius curve of 35m.

The first machine to get going on the project will be the S54 machine, which will be launched into a 65m radius

curve – from a 15m diameter shaft at the Bueng Nong Bon reservoir intake – southwards towards the Klong Nong Bon Inlet Station. Following an intermediate breakthrough at Klong Nong Bon, the TBM will then be turned 90 degrees within the 12m diameter shaft and re-launched westwards to the Klong Kled Inlet. The third and final run for the S54 machine will require a sharp 40m radius curve mid-drive to turn the TBM northwards to the Sukhumvit 101/1 Shaft, where the TBM will be dismantled. The total length of

this first section is 5,523m.

Meanwhile, the S55 machine will complete the two remaining sections of the tunnel. Launching from the 15m diameter Bang Aor Pump Station (Inlet) Shaft – which, along with the Bang Aor Pump Station (Outlet) Shaft, has been constructed within a large diaphragm wall groundwater cut-off structure – this TBM will also commence its 2,975m drive with a 65m radius curve, heading eastwards to the Sukhumvit 66/1 Inlet Shaft. Here, the

machine will need to negotiate a challenging, double 40m radius, S-shaped spiral curve before completing its drive to the Sukhumvit 101/1 Shaft, where it will be dismantled and transported back to the Bang Aor Pump Station (Outlet) Shaft. Following reassembly, the S55 machine will complete a final 690m drive westwards from the Bang Aor Pump Station (Outlet) Shaft – again starting on a 65m radius curve – to the Chao Phraya River Outlet Shaft.

Geological conditions along the alignment consist of soft to medium sandy clays, stiff clays

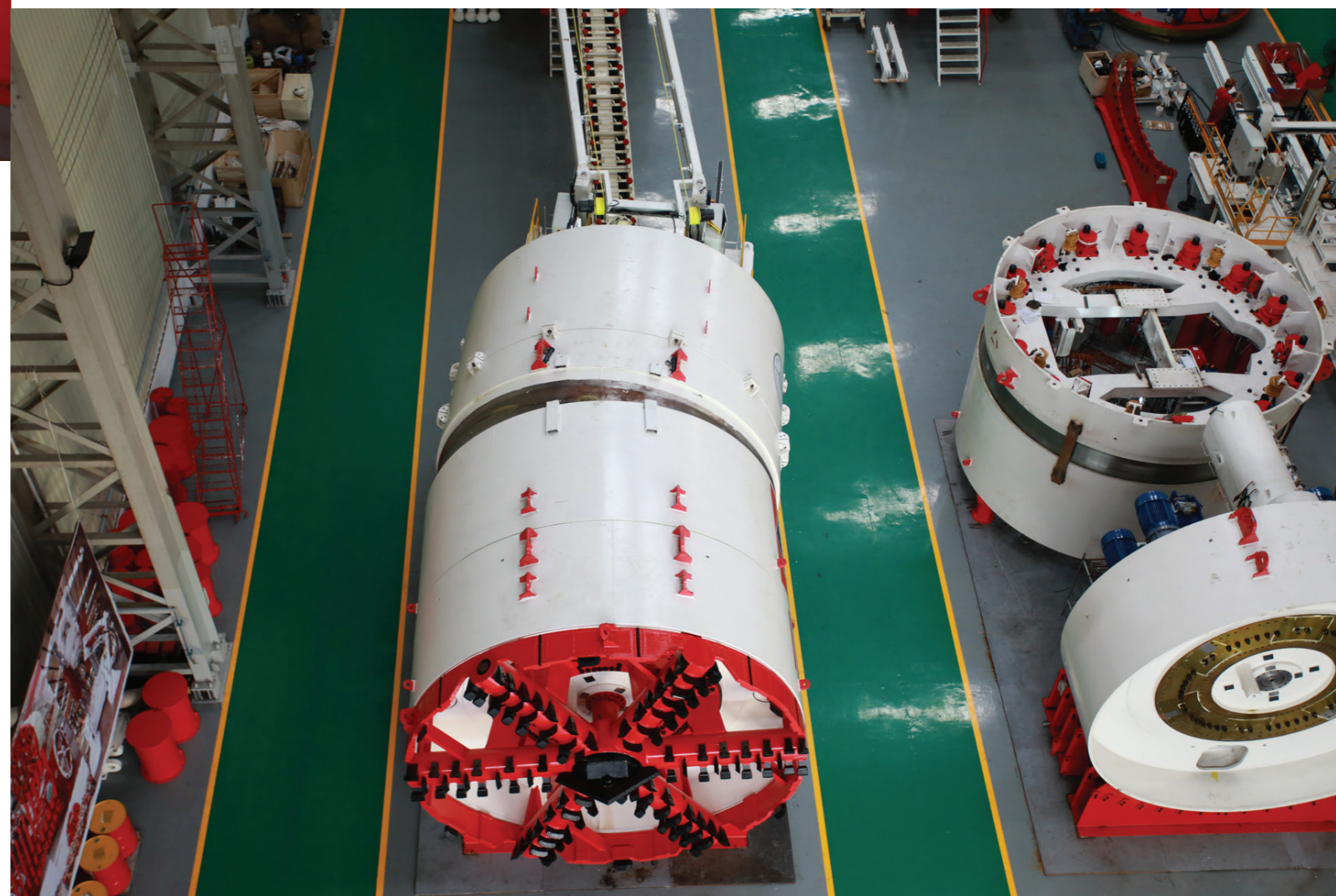
and very dense sands, with an average overburden of 30m and a maximum groundwater head of about 1.5 bar.

Following their successful factory acceptance tests, the machines will now be shipped to Thailand, with excavation due to commence later this year. Machine operation will be assisted at all times by TERRATEC's highly-experienced Field Service staff, providing quality after sales support to ensure optimum performance and successful project completion.

When complete, the tunnel

will have a drainage capacity of 60 cubic metres per second, providing much needed flood relief to an area of approximately 85 square kilometres.

The TBMs' soft ground cutterheads feature an open spoke design with the addition of knife bits to assist break-in and break-out of the shafts. Traditionally reinforced 1.2m thick, 5m internal diameter, precast concrete segments will typically be installed as the machines progress, with shorter steel segments utilised during the course of the sharp 40m radius curves.



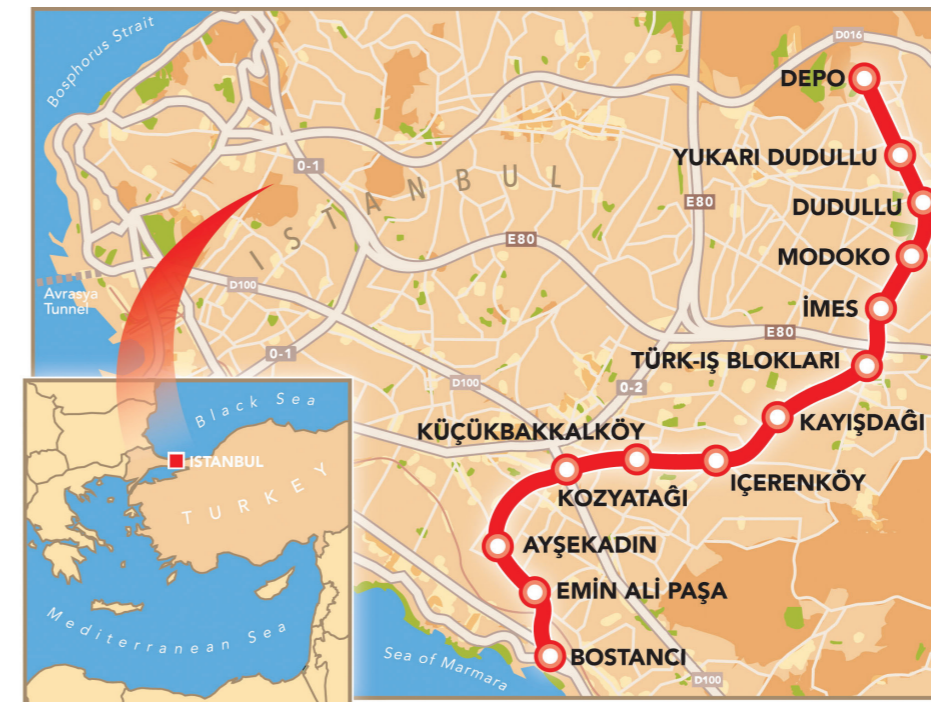
TERRATEC EPBMS GET INTO GEAR ON ISTANBUL'S NEWEST METRO LINE

Şenbay Madencilik-Kolin-Kalyon JV makes good early progress on the Dudullu-Bostancı Metro Line – located under the densely-populated Anatolian side of Istanbul, in Turkey – with multiple TBM tunnel drives now fully underway on the project.

Two TERRATEC 6.56m diameter Earth Pressure Balance (EPB) Tunnel Boring Machines are making good progress on the latest expansion of Istanbul's Metro system, with both machines now fully up and running and

achieving good advance rates for the project. The new TBMs are being used by the Şenbay Madencilik-Kolin-Kalyon Joint Venture (SKK JV) – along with two other machines – on the €1.4 billion Dudullu-Bostancı Metro Line project, which runs

approximately north to south under the densely-populated Anatolian side of the city (see map). The 14.2km-long line, along with its 13 new stations, will be located entirely underground at an average depth of about 30m.



trapezoidal segments (5+1), with an outer diameter of 6,300mm, an inner diameter of 5,700mm and a width of 1,400mm. These are currently being produced by SKK JV at its factory in Ferhafpasa, which is located about 10km away from the central project worksite.

The fully automated Dudullu-Bostancı Metro Line (GoA4) – with driverless trains, CBTC, and platform screen doors at stations – will provide numerous connections to other Istanbul transportation systems, such as the Bosphorus ferry (at Bostancı Harbour), the Marmaray railway, the Kadıköy-Kartal metro line and the Üsküdar-Çekmeköy metro line.

Tunnelling is expected to be complete by spring 2018, with the project due to open to the public in mid-2019.

The customized TERRATEC TBMs have versatile mixed-face cutterheads with an opening ratio of about 35%, designed to manage Istanbul's geology – which includes low-strength sandstones, siltstones, limestones and shales – and state-of-the-art features such as VFD electric cutterhead drives, soft ground cutting tools that are interchangeable with 17" roller disc cutters, high torque screw conveyors, and active articulation systems.

Assembly of the TERRATEC S50 and S51 machines began at a central shaft site at Kayışdağı station in early February and by early March the S50 machine had already been launched south-west toward İçerenköy station. Three weeks later, the S51 machine also began mining north-east on its journey towards Türk-iş Blokları station.

"We were very impressed with the speed and efficiency of the TBMs' assembly," says Enver Koc, Chief Tunnel Mechanical Engineer for the Şenbay Madencilik-Kolin-Kalyon JV. "From clearing customs to being ready to bore so quickly was a great achievement."

The S50 machine will now mine 4,585m towards the coast passing through stations

on its way and terminating at an intermediate shaft located to the north of Ayşekadın station (with the balance of the running tunnel to Bostancı being completed by NATM). By the second week of May, the TBM's conveyor system had been fully installed and it had already advanced 524m.

Meanwhile, the S51 machine is due to mine a total distance of 5,135m to Yukarı Dudullu (with another section of NATM works completing the line to Depo). Having been launched a few weeks later than the S50 machine, this TBM had advanced 202m by mid-May and, with all its systems fully installed, was rapidly picking up speed.

The tunnel linings will consist of reinforced concrete

TERRATEC RAISES THE BAR IN CHINA

One of TERRATEC's TR3000 Raise Boring Machines (RBM) has successfully achieved a series of impressive inclined raises with a high level of accuracy at the Huanggou Pumped Storage Power Station Project, in the Heilongjiang Province of China.

Following its initial transportation from the factory in Australia, in [June 2015](#), to copper mines located in the Yunnan and Sichuan provinces, the TR3000-R18 Raise Boring

Machine carried out a number of 300m deep, 3.1m diameter, raises in medium strength rock (averaging 100MPa) for ventilation, manways and ore passage. This reaming work was carried out in [record time](#), setting a benchmark for this diameter of raise bore shaft in the country.

After this, the R18 machine was moved to another mining region in the far north of China where the machine undertook several more 300m

deep inclined shafts of 2.4m in diameter.

Last summer, the RBM was put to work on the 1,200MW Huanggou Pumped Storage hydroelectric power station project, which is currently under construction about 90km (56-miles) north of Mudanjiang, in the Heilongjiang Province, in the far north of China.

From the commencement of operations to date, the TERRATEC machine has



completed five (5) inclined shafts at angles ranging from 30- to 50-degrees with raise lengths varying from 350m to 370m and a reaming diameter of 2.4m. Each shaft was completed over a period of about two months, including both the pilot hole and the reaming.

Despite the challenging inclines, the TR3000 machine has achieved very high levels of accuracy with very limited downtime for maintenance in the medium strength rock, which has a hardness of around 120MPa to 150MPa. The machine will now go on to bore a further eleven (11) shafts at the Huanggou project.

Manufactured at the company's workshop in Tasmania, Australia, the TR3000 Raise Boring Machine is a highly robust piece of equipment, designed for ease of operation and maintenance, providing a high level of reliability.

The low-profile unit has a nominal boring size of 3 metres in diameter and 500 meters in depth and has a standard pilot hole diameter of 311mm. It has a maximum pilot drilling torque of 78,000Nm, reaming torque of up to 237,000Nm and breakout to 266,000Nm. The maximum down thrust force is 1,600kN with up thrust being 4,500kN. Total installed power on the machine is 352kW.

TERRATEC has similar Raise Boring Machines working around the world, chiefly in Australian and North American and South American mines. The company's highly experienced Engineering and Field Service Teams can assist buyers from the planning stage, including custom design specifications, through to assembly and operation of the RBM on site.

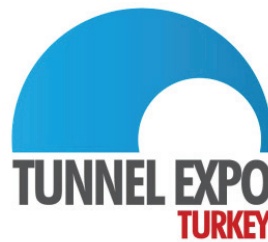
The company's RBM programme incorporates standard Raise Boring Machines (TR Series), as well as Combination Down-Reaming/Rise-Boring Machines (TDR Series) and its Universal Borer Machines (UB Series).

WHEREABOUTS

Meet TERRATEC at the following conferences and exhibitions!



Thailand Underground & Tunnelling Conference
July 25-27 | Thailand



Expo Tunnel 2017
Sept 1-4 | Istanbul, Turkey

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