

UNDERGROUND INNOVATIONS

NEWS FROM ROBBINS



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COMPLEX TURKISH BORE TAKES ONE TOUGH TBM

VOLCANIC ROCK, CLAY, AND WATER

may not be the easiest of conditions to get through, but one TBM is up to the challenge. The 10.0 m (32.8 ft) diameter Robbins Double Shield machine is excavating Turkey's Kargi Kizilirmak Hydroelectric Project, located several hours from the city of Ankara.

The tunnel, for owner Statkraft AS, will source water from the Kizilirmak River in Corum Province, and together with a new power station will generate up to 470 GWh annually--enough to power about 150,000 homes.

Crews for contractor Gülermak and Robbins are guiding the machine through various conditions including volcanic rock, limestone, and clay with running ground for the first 3.0 km (1.8 mi). This gives way to harder rock including marble for the rest of the 11.8 km (7.3 mi) route.

The unstable ground will require segmental lining for the first 3.0 km (1.8 mi), with no segments in the remainder. This necessitated a highly adaptable machine design able to line with everything from segments to conventional ground support. The rest of the tunnel will be

supported with ring beams and rock bolts, as well as a final lining of shotcrete. The types of ground support made the design of the TBM and back-up complex—many features require space, from shotcreting to rock drilling to segment handling.

As of September 2012, the TBM had advanced over 800 m (2,600 ft) despite conditions including unexpected fault zones and inflows of water and mud. "We have had some very impressive efforts by the Gülermak and Robbins teams," said Glen Maynard, Robbins Field Service site manager. "After the TBM had bored 175 m (574 ft) with a temporary conveyor system, tunneling was interrupted to install the permanent conveyor system. Gülermak completed this installation in six days; on day seven the Robbins Continuous Conveyor was operational." Maynard continued to say that early signs were promising with regards to TBM advance, with shifts topping 15 m (49 ft), and 20 m (66 ft) daily advances becoming a regular occurrence.

The 10.0 m (32.8 ft) diameter Robbins Double Shield for the Kargi HEPP was designed for flexible ground support, ranging from segments to ring beams to rock bolts.



SINGAPORE SIX RAMP UP

IN THE MIDST OF A SPACE-STARVED CITY, the first of six Robbins EPBs is set for launch. The 6.65 m (21.8 ft) mixed ground machine is one of two that will excavate contract C927, running between Bedok Park and Bedok Reservoir, for contractor CMC di Ravenna of Italy. Four more Robbins EPBs will excavate contracts C925 and C937 for contractor GS Engineering & Construction of Korea.

The 62 tonne (68 U.S. ton) cutterhead for the first of the two machines was lowered in August and the TBM began excavation in autumn 2012. "Assembling the machine was a challenge due to the small shaft opening. This required assembling the shield in smaller sections than usual, and required the use of a purpose-built lifting adaptor to lower the cutterhead support and forward shield separately," said Mark Passey, Robbins Site Manager.

The two Robbins EPBs for the C927 contract will bore parallel 1.35 km (0.8 mi) tunnels through alluvium consisting of cemented sandstone and beach rock. Each of the EPBs was designed with mixed ground cutterheads and cutting tools interchangeable with disc cutters. Flexible additive systems are capable of injecting foam, polymer, Bentonite, or grout depending on the conditions.

A fourth, 6.2 m (20.3 ft) Robbins EPB with mixed ground cutterhead will take on a 2.3 km (1.4 mi) section of tunnel in fine sand, gravel, sandy loam, stiff clays, and limestone for contractor USK Most. All of the machines were custom designed with mixed ground cutterheads capable of switching out carbide cutting tools with disc cutters depending on the conditions.

The densely urban area of construction is expected to be a challenge: "We will be doing extensive surface monitoring to limit settlement. Another challenge will be keeping all equipment and operations running at maximum efficiency in the cold Moscow winter," said Vadim Bocharov of USK Most.

In order to further maximize the efficiency of the excavations, Robbins continuous conveyor systems will transport muck behind all of the machines. One machine was launched in August 2012 and has excavated about 100 m in sticky clays. The remaining launches are expected to occur between November 2012 and March 2013.

A 6.20 m (20.3 ft) diameter Robbins EPB for Moscow Metro was assembled in the Solon, Ohio, USA manufacturing facility in July 2012.

MOSCOW'S MIXED GROUND CALLS FOR CUSTOMIZED MACHINERY

LEGENDARY COMMUTE TIMES OF 2 HOURS

or more are part of the average Muscovite's daily routine. With a growing population of nearly 12 million, the Moscow Government has issued new metro projects across the city, totaling 50 km (31 mi) of track by 2018.

Multiple TBMs including four Robbins EPBs are tackling the mixed ground excavation. Three 6.6 m (21.6 ft) EPBs, including two new machines and one refurbished machine, are gearing up to excavate three 2.0 km (1.2 mi) sections of

"Avoiding surface settlement will be a challenge. The Robbins machine is nicely done though."

-- Vadim Bocharov of SK MOST

tunnel for contractor Engeocom. The machines will bore lines between Business Center and Park Pobedy stations.



TBMs TAKE OFF AT

TEXAN WATER TUNNEL

A SPRAWLING TUNNEL COMPLEX GROWS deep below Austin, Texas, USA. The 10.5 km (6.5 mi) Jollyville Transmission Main is set to dramatically increase capacity of the city's main drinking water reservoir.

The waterway is being constructed using three TBMs, including two Robbins machines, up to 107 m (350 ft) below the city. Contractor Southland/Mole JV is building the 2.1 m (84 in) finished diameter pipeline below residential areas and the protected Balcones Canyonlands Preserve.

Two TBMs were launched in August 2012, while one contractor-owned machine completed its 1.4 km (0.9 mi) section in mid-2012. The two Robbins machines include a 3.25 m (10.7 ft) Main Beam TBM, and a 3.0 m (9.8 ft) Double Shield TBM refurbished in its Solon, Ohio, USA manufacturing facility.

"We needed the Robbins High Performance Main Beam TBM for the longest bore, which is on the critical path for the project," said Tim Winn, Director of Southland Contracting.

Conditions along the way are expected to consist of uniform limestone and dolomite rock. Although karst features are present throughout the formation, the depth of the tunnel should circum-

vent these features. Other obstacles are associated with the protected wildlife area—endangered cave-dwelling invertebrates including six species of arachnids and insects are present in and around the karsts. Because of this, no probe grouting can be performed due to the risk of seepage into the water features. "We don't expect any features that will need significant support. Rock bolts will be the predominant form of support, and there

"It's built to beat our schedule, and for even tougher conditions than are foreseen here."

-Tim Winn, Director of Southland Contracting, on the robust Robbins TBM

may be some areas requiring wire mesh," said Winn.

Within a week of its launch in late August 2012, the Main Beam machine had advanced about 90 m (300 ft), and is currently progressing well. Once complete in 2013, the pipeline will transfer up to 190 million liters (50 million gallons) of treated water per day from Lake Travis.



LEFT: The first of six Robbins EPBs being assembled in Singapore.
TOP RIGHT: The hard rock cutterhead being lowered at Jollyville.
BOTTOM RIGHT: Two Robbins TBMs were launched in August 2012 to excavate the Jollyville Transmission Main in Austin, Texas.

AUSTRALIAN MINING MACHINE TO MAKE THE GRADE

In 2013, an 8.0 m (26.2 ft) diameter Robbins Hybrid EPB will bore the Grosvenor Decline Tunnel for Australia's Anglo-American Coal Mine. The machine will be built using Onsite First Time Assembly (OFTA) in order to fit within a tight project schedule.

The 1.0 km (0.6 mi) decline tunnel, at a grade of 1:6, will be used for mine access to new coal seams. The dual mode machine will tackle mixed ground conditions ranging from sand and clay to varying grades of hard rock up to 120 MPa (17,000 psi) UCS and coal seams. A center-mounted screw conveyor will be used to allow for efficient excavation of varying ground on a decline, and to provide assistance in controlling any methane gas present.

FOUR MIXED GROUND EPBs WILL BORE FORTALEZA

In 2013, four 6.92 m (22.7 ft) diameter Robbins EPBs will excavate one of Brazil's largest tunnel projects. Line 3 of the Metro Fortaleza will connect southeastern areas of Fortaleza with the downtown, and transport thousands of daily passengers in what is Brazil's fifth largest city.

The four EPBs, purchased by the Infrastructure Secretary of the State of Ceará (SEINFRA), are designed for a complex mix of silt, clay, sandstone, and basalt. The EPBs will be designed with mixed ground cutterheads, and will be capable of injecting a variety of additives based on the ground encountered.

Robbins continuous conveyor systems will additionally remove muck behind each of the four TBMs as they excavate sections of tunnel ranging from 4.3 km (2.7 mi) to 5.8 km (3.6 mi) in length.





LEFT: Robbins SBUs garnered overwhelmingly positive responses in the Robbins 2012 annual survey.

RIGHT: More than 85% of respondents rated Robbins SBU-As as "Excellent" or "Good to very Good" in terms of quality.



ROBBINS SBUS

EARN TOP SCORES

THE RECENT ANNUAL ROBBINS SURVEY was a success, thanks to record numbers of respondents. Small bore contractors and consultants made themselves heard, casting an overwhelmingly positive vote for Robbins Small Boring Units (SBUs).

More than 85% of people selected "Excellent" or "Good to Very Good" when asked about the quality of SBU-As, with the majority picking the highest possible rating. The same was true of Rockheads, which received an "Excellent" or "Good" rating from 100% of respondents.

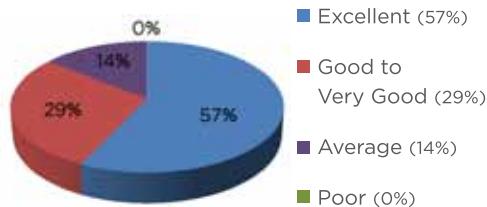
The success of Standard Small Boring Units (SBU-As) is one shared with contractors, who have used them on hundreds of projects across the U.S., in conditions ranging from mixed ground to hard rock up to 175 MPa (25,000 psi) UCS. The cutting heads, which range in diameter from 24 to 72 inches (600 mm to 1.8 m), are used with a standard Auger Boring Machine to excavate utility crossings up to 150 m (500 ft) in length.

In addition to numeric responses, write-in experiences were also positive: "This is a great product that does the job," said one U.S. contractor. Others charac-

terized Robbins staff as "Knowledgeable" and "Helpful."

The positive reviews are well-earned, and highlight the good performance of SBUs on recent challenging excavations.

Rate the Quality of Robbins SBU-As



Within the past three years, SBU-As have broken distance records in both hard rock and mixed ground: 183 m (600 ft) through clay and basalt and 107 m (352 ft) through limestone.

The continued success of these machines was summarized best by one experienced contractor: "Your engineering, support and quality take the equipment out of the project challenge. Love your products."

2012 EVENTS CALENDAR

Robbins will participate in the following trade shows:

CityBuild

October 16-18
Moscow, Russia

TAC 2012

October 17-20
Montreal, Quebec, Canada
*Technical Presentation:
Niagara Tunnel Project*

Trenchless Live

October 23-24
Melbourne, Australia

Bauma China

November 27-30
Shanghai, China

Australian Tunneling Conference

December 4-5
Brisbane, Australia