UNDERGROUND INNOVATIONS

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THE NEXT GENERATION CROSSOVER
LAUNCHED

MEXICO CITY'S TEP II PROJECT STARTED on August 10, 2015, but its first milestone occurred before its TBM even bored a stroke. The complex wastewater conduit is the first project to utilize the latest generation of Crossover TBMs, featuring improvements gleaned from projects in difficult ground worldwide.

While a number of Robbins Crossover machines are already in operation or have completed tunnels, this latest iteration of the XRE (Crossover between Rock and EPB) includes a single-direction cutterhead for more efficient excavation in abrasive ground conditions, and two-speed gearboxes that enable the machine to power through fault zones and squeezing ground that might leave standard machines stuck. The 8.0 m (26.2 ft) XRE also incorporates a canopy drill designed to enhance probe drilling capabilities and to allow for forepoling if needed.

The new design features, which will now come standard on XRE TBMs, will be needed at TEP II (also known as Túnel Emisor Poniente II). The 5.9 km (3.7 mi) long tunnel is expected to consist of weathered volcanic rock including basalt and breccia, but with some sections of softer ground including sand and clay interspersed into the sections of rock. The tunnel will finish in a section entirely made up of soils. The XRE TBM is therefore optimized for rock excavation.

The contractor, ALDESA/PROACON/RECSA JV, is confident in the TBM design: "In my opinion the best part about the design of this TBM is the cutterhead; it is very robust," said Sebastián Gallego Murillo, TEP II Production Manager for Proacon.

He added that the biggest challenge would come near the end of the tunnel drive: "We expect to convert to EPB mode due to the soils in this area. We will need to change out the cutters and modify the cutterhead."

For Gallego and all those involved, the benefits of the project are worth all of the potential obstacles. "This tunnel will reduce flooding in the west and northwest areas of the Valley of Mexico, and increase wastewater capacity. It will benefit three municipalities that are home to 2.1 million people."

On August 10, 2015 a next generation Crossover (XRE) TBM was launched at Mexico City's Túnel Emisor Poniente II, in what will be a challenging tunnel drive through volcanic rock, sand, and clay.

The first of three breakthroughs for the 6.5 m (21.3 ft) Robbins EPB at Seattle's North Link Project occurred on July 13, 2015.

SEATTLE'S STAR EPB

BREAKS THROUGH IN GLACIAL GEOLOGY

THE FIRST OF SEVERAL BREAKTHROUGHS for a Robbins mixed ground EPB is complete as of July 13, 2015, but there is much more to be done. Seattle, Washington, USA's North Link Light Rail will extend rail lines southward from the community of Northgate, north of Seattle, to the University of Washington (UW). Parallel 7.0 km (4.3 mi) long rail tunnels will each travel through three underground station sites, the last one linking up with the UW.

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>
> --RIck Capka, PE, Construction Manager, Sound Transit

About 5.6 km (3.5 mi) of the line are underground, requiring two EPBs to be outfitted for glacial geology including sand and clay with glacial till and boulders.

Contractor JCM North Link LLC and owner Sound Transit were present for the breakthrough of the Robbins TBM, and both parties were positive. "It has a lot of power," said Rick Capka, PE, Construction Manager for Sound Transit, of the Robbins EPB. "It has a very good ability to advance in the ground conditions that we're in. We have sand, silt, till, and clay. We have lots of groundwater and it's been able to handle those conditions."

The Robbins TBM has advanced at rates as high as 120 mm (4.7 in) per minute, which Robbins Project Manager Matt Greger explains, is "the upward operating limit of this tunnel boring machine." Average rates were about 90 mm (3.5 in) per minute. He continued that some clogging of the cutterhead in sand and clay had occurred, so time would be taken at the station site to increase the opening ratio of the cutterhead to improve muck flow.

The Robbins EPB has more challenges ahead, including excavation below the UW, where vibration and settlement are held within strict limits. The feeling of excitement at the intermediate breakthrough, however, was palpable: "With this hole through, we are just beyond 50 percent complete for all of the tunneling on this project, so it's a tremendous day for us to celebrate," said Capka.

EPBs IN MOSCOW MAKE THEIR MARK

JULY 15, 2015 MARKED ANOTHER FINISH for a Robbins EPB excavating the Moscow Metro. A total of four EPBs in Moscow are tackling multiple mixed ground tunnels, with the latest EPB launching on August 16, 2015 following Onsite First Time Assembly (OFTA).

The TBM that broke through, a 6.2 m (20.3 ft) diameter EPB, had been excavating in silty clay with some interspersed limestone. The 1.7 km (1.1 mi) long tunnel took about eight months to complete, and is the second tunnel for this machine. Contractor SK MOST used the TBM for its first 1.9 km (1.2 mi) long tunnel at the metro in ground including sand, clay, and limestone.

The TBM is scheduled to do more tunnels on the project. According to the SK MOST Supervisor at the jobsite, the TBM will be sold to local contractor Engeocom, who already own several other Robbins machines on the project, to continue boring more tunnels.

Moscow Metro's construction is vast, with the government aiming to add 150 km (93 mi) of new metro lines within eight years. Given the robust nature of Robbins EPBs, which are designed for 10,000 hours of useable life, these workhorse machines will be able to excavate multiple tunnels for years to come.

MID-HALTON'S MID-SIZED MAIN BEAM

IS A HEAVY HITTER

WATER TREATMENT IN ONTARIO, CANADA is getting an upgrade with the startup of a new tunnel project, known as the Mid-Halton Outfall Tunnel. The scheme involves two sections of tunnel totaling 6.3 km (4.0 mi) and designed to carry treated effluent water from a treatment plant in Oakville into Lake Ontario.

Contractor Strabag, who has had several projects in Canada including the epic Niagara Tunnel project, is in charge of the works. The company first had to construct two deep shafts and then procured a 3.5 m (11.5 ft) Robbins Main Beam TBM to bore the tunnel.

Launched on July 22, 2015 from a 12 m (39 ft) diameter, 62 m (203 ft) deep shaft, the rebuilt TBM has been beefed up for high capacity tunneling. Geology is expected to consist of laminated shale with interbedded limestone and siltstone layers and a maximum rock strength of 120 MPa UCS.

While this will be the seventh tunnel for the veteran TBM in a career spanning 32 years and some 26 km (16.2 mi) of tunnel, unique modifications were made for Mid-Halton. "We have kept this a simple, streamlined Main Beam machine, but we modified the cutterhead with larger muck buckets, so material can be moved through it faster," explained Robbins Project Manager Lynne Stanziale. The back-up system was also modified to make it more mobile through two 130 m (427 ft) radius curves that the TBM will have to navigate, one in each direction.

That portion of the drive will curve to run directly under Lake Ontario for 2.1 km (1.3 mi), though the tunnel is deep enough that it will remain in bedrock. Once the machine has completed its final bore under Lake Ontario, it will be backed out of the blind heading and removed from a 7.2 m (24 ft) diameter shaft in a local park.

The Mid-Halton TBM is a tunneling "rock star". With this, its seventh tunnel in its career, the 32-year old machine will have bored more than 26 km (16.2 mi).

Though the TBM has just started up, ground conditions are good and crews are moving forward with a plan to line the tunnel with mesh panels and ring beams if necessary. A cast in place liner will follow on after tunneling is completed in approximately 39 months.

TURKEY'S CUTTING EDGE CROSSOVER MACHINES

Robbins TBMs have bored some of Turkey's toughest tunnels throughout the years, and upcoming projects are no exception. At the Gerede Water Transmission Tunnel near Ankara, difficult ground in a 31.6 km (19.6 mi) long tunnel caused two hard rock Double Shield TBMs from another manufacturer to become stuck. The project is desperately needed to alleviate Ankara's chronic drought, and a new machine is being brought in to complete the excavation as quickly as possible.

The new design, a 5.56 m (18.2 ft) diameter Robbins Crossover XRE TBM, will be optimized towards hard rock excavation in sandstone, breccia and limestone with karst and fracture zones. The TBM will have excellent probing and grouting capabilities, and will be capable of statically holding up to 20 bar water pressure during emergency inflow events--an incredible feat. The XRE TBM is expected to begin boring the remaining 9.0 km (5.6 mi) of difficult ground in 2016, while one of the stuck TBMs will stay in place.

The machine is expected to pass through 30 or more fault zones, where it will be sealed so crews can perform pre-consolidation grouting before continuing on in open, hard rock mode. In case crews run into softer EPB type ground, the TBM will be run in EPB mode. The XRE will then bore sequentially using the forward and aft screw conveyor gates to allow the screw to fill with muck, then close, empty and repeat. EPB mode is designed for conditions up to 3 bar.

While designs for the Gerede tunnel are being finalized, Onsite First Time Assembly (OFTA) is underway at a rail project in Southeastern Turkey. The 8.0 m (26.2 ft) diameter TBM, a Single Shield machine with Crossover features, is expected to begin boring the first of two 7.2 km (4.5 mi) tunnels for the Bahce Nurdag Railway in the last quarter of 2015.

LEFT: The July 15, 2015 breakthrough of a Robbins EPB in Moscow.
TOP RIGHT: The long-running Main Beam rebuilt for Mid-Halton.
BOTTOM RIGHT: The Mid-Halton TBM will bore below Lake Ontario.

LEFT: The Remote Controlled Small Boring Unit (SBU-RC) is ideal for boring line-and-grade-sensitive tunnels in rock at small diameter.
RIGHT: The SBU-RC is curently manufactured in the 36-inch (900 mm) diameter range, but could be designed as small as 30 inches (760 mm).

NEW REMOTE CONTROLLED SBU IS SET TO

REV UP THE INDUSTRY

THE NEW SBU-RC FILLS A NICHE IN UTILITY tunneling, and it is doing so in a big way. Formally known as the Remote Controlled Small Boring Unit, the SBU-RC is the answer for contractors looking to bore small diameter tunnels with strict line and grade requirements in hard rock. It also does so more cost effectively than other methods such as slurry microtunneling in rock.

The SBU-RC's proving ground was a recent project in Bend, Oregon, USA, where contractor Stadeli Boring & Tunneling found themselves in unique circumstances. "We had a contract to furnish and install 323 ft (98 m) of 36-inch (900 mm) steel casing under railroad tracks for a gravity sewer interceptor. Line and grade were very crucial, and the tolerances were very close. We had to be right on," said Larry Stadeli, president and owner of Stadeli Boring & Tunneling. The crossing was to be in solid basalt rock.

Stadeli turned to Robbins, whom they had been working with for over 10 years on various SBU projects. While the company owned several SBU-As, it needed a piece of equipment with precision guidance. SBU Product Manager Kenny Clever was working on a machine that fit the bill.

The SBU-RC, available in the 36-inch (900 mm) diameter range, operates much like a Motorized SBU (SBU-M) with a circular cutterhead and cutting tools that can excavate hard rock or mixed ground conditions. An in-shield drive motor provides torque to the cutterhead, while a pipe jacking system or Auger Boring Machine (ABM) provides thrust.

Clever explains the biggest differences: "There is no manned entry. It eliminates the human element, so it is safer and there is no need for ventilation. With its smart guidance system, it also eliminates much of the risk on line-and-grade-critical bores." In addition muck is removed via a vacuum tube connected to a truck.

Robbins delivered the SBU-RC onsite, where it quickly began achieving rates of 20 ft (6 m) per day. For Stadeli, the proof is in the results: "As we got used to the machine we went up to 40 ft (12 m), and one day we got 50 ft (15 m). We were able to cut two weeks off of our schedule time. Everyone was very pleased about it. When you look down the pipe now after it's finished, it looks like a rifle barrel. There is no sag, it's all in one straight line."

2015 EVENTS CALENDAR

Robbins will participate in the following trade shows:

Underground Design & Construction Conference
September 11-12
Hong Kong
Keynote Lecture:
A Comparison of OFTA vs. Shop Assembly by Lok Home

Cutting Edge Conference
September 21-23
Denver, Colorado, USA
Technical Session:
Mexico City's Mega Wastewater Projects: TEO and TEP II

ICUEE
September 29-October 1
Louisville, Kentucky, USA

EUROCK
October 7-10
Salzburg, Austria

Australian Tunnelling Conference
October 13-14
Sydney, Australia

Robbins

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