UP FOR THE CHALLENGE

UNDERGROUND INNOVATIONS

ISSUE 4+ 2017

Difficult Ground Solutions (DGS) features have been incorporated in the Robbins machine's design for the Delaware Aqueduct Repair.

ROBBINS SINGLE SHIELD TO REPAIR A PART OF WORLD'S LONGEST TUNNEL

Robbins has completed the manufacture and testing of a unique tunnel boring machine that will be used to repair the longest continuous tunnel in the world. The TBM will be used to overhaul a section of New York City's Delaware Aqueduct, a 137 km (85 mi) long tunnel that delivers about 50 percent of the City's drinking water each day. Over the span of two days in February, representatives from the owner New York Department of Environmental Protection (NYDEP), consultant McMillen Jacobs (MJ), and JV contractor Kiewit-Shea Constructors (KSC) traveled to the Robbins facility in Solon, Ohio to witness the Factory Acceptance Testing of the custom tunnel boring machine.

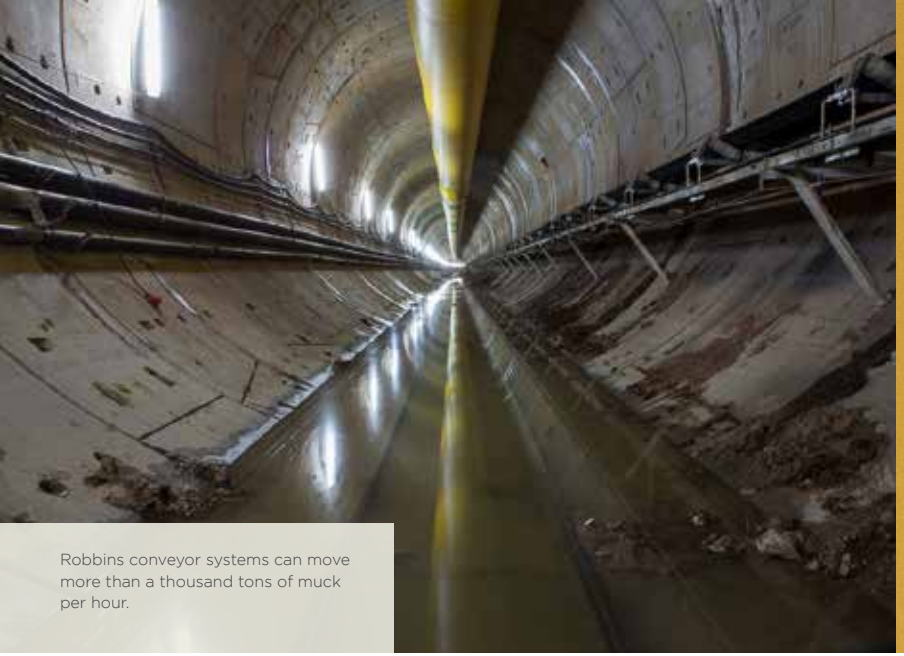
The Robbins Single Shield TBM will bore a tunnel to replace a 3.8 km (2.4 mi) stretch of the Delaware Aqueduct. The Delaware Aqueduct currently leaks about 75 million liters (20 million gallons) of water per day into the Hudson River through cracks in the tunnel lining. While several inspections with an automated underwater vehicle showed that these cracks were stable, it was determined they could not be fixed from within the existing tunnel. New York City then decided that a new tunnel would be built under the river to bypass the leakage.

To build a bypass tunnel around the aqueduct's leaking section, Robbins manufactured the 6.8 m (21.6 ft) diameter Single Shield TBM to safely seal against pressures up to 30 bar, and to operate in variable hard rock conditions. Because this particular section of the tunnel lies 183 m (600 ft) below the Hudson River, the inflows are under immense head pressure and thus require the unique tunneling technology.

Due to the challenges presented by the Aqueduct Repair, such as difficult geology and considerable water inflows, the TBM had to be designed accordingly. Difficult Ground Solutions (DGS) features, including powerful drilling, grouting, and water inflow control systems have been incorporated into the machine's design to overcome the expected challenges. "One unique feature of this TBM is the closeable bulkhead, which allows the excavation chamber to be sealed off," said KSC Tunnel Manager Niels Kofoed. "We expect this to be a key feature in the event that groundwater flows (shunt flows) from the excavated portion of the tunnel cause washout of the annulus grout. Once the bulkhead is closed the groundwater flows are stopped and secondary grouting of the precast liner can be performed, effectively cutting off the flow path of the shunt flows."

> "ONE UNIQUE FEATURE OF THIS TBM IS THE CLOSEABLE BULKHEAD, WHICH ALLOWS THE EXCAVATION CHAMBER TO BE SEALED OFF." -NIELS KOFOED, KIEWIT-SHEA CONTRUCTORS (KSC) TUNNEL MANAGER

Robbins Project Manager Martino Scialpi further noted that, "the TBM was designed with a 9,500 liter/min (2,500 gallon/min) dewatering capacity. The machine is equipped with two drills in the shields for drilling through the head in 16 different positions and a third drill on the erector to drill through the shields in an additional 14 positions. Drilling and pre-excavation grouting will be a routine job to control and minimize water inflows." In addition, water-powered, high pressure down-the-hole-hammers will allow for drilling 60 to 100 m (200 to 330 ft) ahead of the machine at pressures up to 20 bar. Once assembled, the machine is expected to begin boring in autumn 2017.



Robbins conveyor systems can move more than a thousand tons of muck per hour.

Workers inspect the Robbins continuous conveyor system operating behind a Crossover TBM at the TEP II jobsite in Mexico.

A YEAR IN REVIEW:

Lok Home looks back at 2016, and discusses what the new year may bring.

LOK HOME, PRESIDENT

The Robbins Company saw a lot of changes in the year 2016, the biggest change being Northern Heavy Industries' (NHI) investment into Robbins.

NHI, which owns NFM Technologies in France, as well as its own industrial machinery business in China, has invested heavily into the Tunnel Boring Machine industry. NHI's investment, as well as its accompanying TBM businesses, will give Robbins a strengthened financial base and a stronger presence in Europe and China. While it will take some time to consolidate and capitalize on the combined resources of Robbins, NFM, and NHI, this consolidation has already begun and is moving along nicely.

As a result of the transition period during the NHI merger, paired with a generally lower requirement for Robbins' core type of TBMs on projects worldwide, our sales were lower in 2016. Despite this fact, we are confident that 2017 will show improvement.

Robbins is currently excited about the progress of two new tunnel boring machines that will be boring rather close to home in the USA. The first of these is being built for the Delaware Aqueduct Repair Project in New York and the second will bore in Akron, Ohio. The 6.58-meter (21.6 foot) Robbins Single Shield Hard Rock TBM built for the Aqueduct Repair is designed to be sealed against up to 20 bar static pressure and has a 9,500 liter per minute (2,500 gallon/min) dewatering capacity. The Akron TBM will be the first Crossover--a new series of machines meant to cross between different geologies--to bore in the United States.

The 2017 market is anticipated to be very interesting for Robbins, with several quality projects coming to the United States and Canada. We are also continuing to focus on the mining industry. Throughout the year, we will join with NFM in order to combine our resources on new, large projects in Europe.

Additionally, our conveyor division has obtained several significant orders and is heavily focused on projects in China. Robbins knows the importance of obtaining higher advance rates, and our continuous conveyor systems play a key role in keeping each project moving forward. Every conveyor system is custom designed based on ground conditions, tunnel alignment, and project location. The ability to remove muck rapidly results in higher advance rates and better productivity for all ground types.

> "NHI's investment, as well as its accompanying TBM businesses, will give Robbins a strengthened financial base and a stronger presence in Europe and China."
>
> - LOK HOME, PRESIDENT

In 2016, we were able to witness several large projects which gave us the opportunity to compare Robbins cutter performance against our competitor's cutters in essentially identical conditions. The Robbins cutter performance clearly demonstrated our superior technology. In 2017, we are assured in our ability to continue showcasing new and improved technology in relation to cutter development.

Also noteworthy from 2016, was Robbins' ability to secure orders for several tunnel boring machines in Japan. Presently, we are the only non-Japanese company to supply TBMs for the Japanese market in several decades (see page 6-"Mega Slurry to bore Rock in Japan").

With the continued quality performance of our machines and an efficient business model, we are very optimistic about our future growth.

BREAKING RECORDS IN CHINA

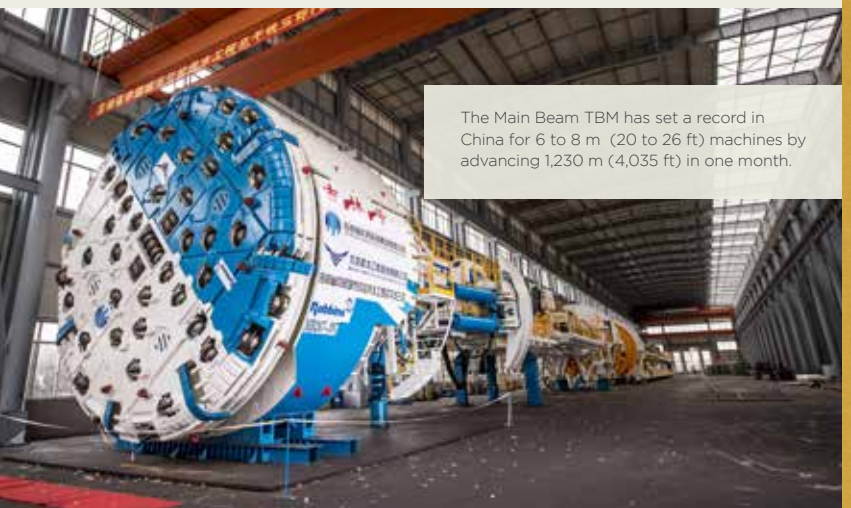
MCNALLY SYSTEM AIDS IN ACCELERATED ADVANCE

In Jilin, one of the three provinces of Northeast China, a 26 ft (7.9 m) diameter Robbins Hard Rock Main Beam TBM has achieved a national record for 6 to 8 meter (20 to 26 ft) machines with a daily advance of 75.1 m (246 ft) in 24 hours and a monthly advance of 1,230 m (4,035 ft). The tunnel, which is being bored as part of a water conservation project, will be 16 km (10 mi) long when complete. Under contractor Beijing Vibroflotation Engineering Co. Ltd. (BVEC), the machine has excavated nearly 10 km (16.2 mi) of the tunnel as of April 2017.

Throughout its bore, the Main Beam is anticipated to encounter 24 faults within the tunnel and a maximum of 220 MPa UCS (32,000 psi) rock. In order to handle the unstable rock, consisting of tuff, granite, sandstone, and andesite, the TBM is equipped with four rock drills, McNally pockets in the roof shield, a ring beam erector, and a shotcrete system.

The McNally Roof Support System was designed and patented by C&M McNally for exclusive use on Robbins TBMs. By replacing the roof shield fingers on a Main Beam TBM, the McNally system prevents rock movement in the critical area immediately behind the cutterhead support. The system has been tested and proven on projects worldwide—including the world's second deepest civil works tunnel, the 2,000 m (1.2 mi) deep Olmos Trans-Andean Tunnel in Peru—to increase advance rates while still maintaining worker safety on Main Beam machines in difficult rock conditions.

According to Project Manager Hu Ding of Robbins China, the project's high advance rates are attributed to "the excellent performance of the Robbins TBM, as well as the solid construction experience of the contractor BVEC."



The Main Beam TBM has set a record in China for 6 to 8 m (20 to 26 ft) machines by advancing 1,230 m (4,035 ft) in one month.

TBM "Augustine" will bore the Janots gallery to improve access to water in the communities east of the Aix-Marseille-Provence metropolis.

The Robbins Main Beam TBM, 135 m (443 ft) long and 3.5 m (11.5 ft) in diameter, began boring in March 2017.

ROBBINS TBM TAKES ON EIGHTH BORE FOR GALERIE DES JANOTS

BUILT TO LAST

On March 3, contractor Eiffage Civil Engineering launched a Robbins tunnel boring machine for Galerie des Janots in La Ciotat, France. The TBM, recently christened "Augustine", will bore the Janots gallery to improve access to water in the communities east of the Aix-Marseille-Provence metropolis (Cassis, Roquefort-la-Bédoule, La Ciotat and Ceyreste). "It's a single machine 3.5 meters (11.5 ft) in diameter, 250 metric tons (275 US tons), and 135 meters (443 ft) long, that will work 24 hours a day for almost ten months during this operation," says Marc Dhiersat, Project Director of Galerie des Janots for Eiffage. Despite its new name, this will be the eighth bore the rebuilt Robbins TBM has undertaken after completing seven other successful projects across Europe and Hong Kong.

Currently, the machine is ramping up as back-up decks are being installed. As of April 2017, the machine has bored 51 m (167 ft), mainly encountering limestone. "Limestone is a rock easy to dig, but one can be confronted with the phenomenon of karst," explains Loïc Thévenot, Director of Underground Works for Eiffage. "For this purpose, the tunnel boring machine is equipped with a drilling machine. If the karst is small, we will fill it with concrete. If it is large, we will erect a small parallel gallery."

Galerie des Janots is one of the fourteen operations designed to save water and protect resources, which are being carried out by the Aix-Marseille-Provence metropolis, water agency Rhône Mediterranean Corsica, and the State Government. The future Janots gallery will replace existing pipelines currently located in the railway tunnel that have significant deficiencies including estimated water losses of 500,000 cubic meters (132 million gallons) per year. According to Danielle Milon, Mayor of Cassis, "This is an investment of 55 million euros (USD $59 million) with 11 million in aid from the water agency. This project required 10 years of reflection and work to improve water supply. And water is essential for the development of each municipality, and for citizens' well-being."

Augustine will bore a tunnel 2.75 km (1.7 mi) long, with cover between 15 and 180 m (50 to 600 ft), in order to replace upgrade the current water supply network. "[The current pipes] have a capacity limited to 330 liters (87 gallons) per second, which is largely insufficient in the summer period. The objective of the operation is to increase to 440 liters (116 gallons) per second," says Dhiersat. Once the project is complete, networks can easily be maintained in comparison to the old pipes currently running beneath the railway.

SBU, TIMES TWO

ONE MACHINE WITH TWO CUTTERHEADS TACKLES VARIABLE GROUND

The 72-inch diameter Motorized Small Boring Unit (SBU-M) was required to bore three crossings adding up to 992 ft (302 m) in total.

Can one machine handle it all? That's the problem a U.S. contractor faced recently when taking on a project with multiple crossings in hard rock and mixed ground.

When Strack Inc. began the installation of a new 54-inch (1.4 m) water main in Cobb County, Georgia, which consisted of three crossings through multiple ground conditions, they put their 72-inch (1.8 m) Robbins Motorized SBU to work. "The performance of the machine was great," said Strack Inc. Project Manager, Keith Mayfield, "it was able to provide us with success on all crossings from hard rock to mixed ground conditions." The cutterhead was changed between crossings with in-shop modifications, which kept everything clean and allowed use of an overhead shop crane. Depending on the ground condition, the machine went from utilizing a hard rock cutterhead equipped with disc cutters to a mixed ground cutterhead mounted with tungsten carbide cutters and bits.

One of the major challenges Strack Inc. encountered with their Southwest Connector Project was the first crossing. "On the first bore under Rottenwood Creek we were concerned that, with the seams in the rock, we would take on a lot of water, so we lined the creek bed with a tarp and sandbags. This worked well along with the head itself being sealed off so well," stated Mayfield. "The other two crossings were more in a mixed ground condition and the head was able to motor right through." If any other issues presented themselves during the bore, a Robbins Field Service Technician was there to help. "The field service tech was great," said Mayfield. "He was very hands on, knowledgeable and helpful."

In solid rock, the machine advanced at approximately five feet per hour. In softer material, it advanced up to 15 feet (4.6 m) per hour. Ultimately, the machine holed through within line and grade requirements. "These were bores for a water main so line and grade wasn't as critical as your gravity bores would be," added Mayfield.

The 54-inch (1.4 m) ductile iron pipe was laid to replace an aging pipe system of 20, 24, and 30 inches (500, 600, and 800 mm) in diameter that was reaching the end of its useful life. The new water main will provide adequate water supply to Cobb residents and neighboring customers for decades to come. When asked if he would use a Robbins SBU-M again, Mayfield replied, "Absolutely, we are currently bidding on projects to put our SBU-M back in the ground."

TOUGH TUNNELS FOR CLEAN ENERGY

In April 2017, a ceremony was held to celebrate the commissioning of the Dariali Hydropower Project in the Republic of Georgia. Many attended the ceremony, including the President of Georgia, Giorgi Margvelashvili. The plant, an independent power project (IPP) developed through Dariali Energy Ltd, was a joint venture involving three other firms: Georgian private companies Peri Ltd and Energy LLC, and state-owned Georgian Energy Development Fund (GEDF). The Dariali HPP gathers water flows from the Tergi River and directs it through the headrace tunnel to the power house located near the Russian—Georgian border. Each year, the site will generate 500 GWhs of carbon-neutral energy, with 70 percent of power production occurring during the country's summer months.

The 5 km (3 mi) long headrace tunnel for the power station was bored with the use of a 5.5 m (18 ft) diameter Robbins Main Beam TBM starting in 2012. Due to the remote and mountainous location of the jobsite 160 km (100 mi) from the capital Tbilisi, the machine was shipped in pieces to contractor Peri's workshop where they were refurbished and then delivered to the site to be assembled. Each piece was moved via trucks, which drove down narrow, winding roads that eventually gave way to dirt paths.

THE DARIALI HPP IS THE WORLD'S FIRST CARBON-NEUTRAL HYDROPOWER PROJECT

"The main challenges we faced were boring the tunnel at a 6 percent incline and having restricted access to service the machine. There were also two major landslides that delayed the project for over a year," said Lok Home, President of The Robbins Company. When the machine was nearing the end of its bore, the second landslide blocked the exit portal for the machine as well as access to the main highway. Despite these challenges, tunneling crews persevered and the machine successfully holed through in October 2014.

Throughout the construction process, careful steps were taken to minimize the carbon footprint. Although the plant's energy production is carbon emission free, construction of the plant was not. To offset these emissions, 7,000 seedlings are being planted all around the area in a reforestation effort. In years to come, the trees will absorb enough carbon dioxide to compensate for the emissions produced during the construction of the hydropower plant, making it the first carbon neutral hydropower project in the world.

Overall, the project has immense benefits, said Home: "Not only does it provide affordable electrical power for the country with essentially no pollution effects, but it also provided jobs during construction and will continue providing jobs during its operation and maintenance."

The 6.2 m (20.3 ft) diameter Robbins Crossover (XRE) TBM is the first Crossover machine to be used in Europe.

The unique Crossover TBM for the Moglicë Headrace Tunnel is sealable up to 20 bars and is made to excavate through challenging mixed ground conditions.

EUROPE'S FIRST CROSSOVER TBM

ALBANIAN HYDROPOWER PLANT WILL INCREASE COUNTRY'S ELECTRICAL PRODUCTION

On November 21, 2016 The Robbins Company launched the first Crossover TBM to ever be used in Europe. The 6.2 m (20.3 ft) diameter Crossover XRE TBM was built in Moglicë, Abania, using Onsite First Time Assembly (OFTA), and is operating with a Robbins continuous conveyor system. The headrace tunnel is for one of two future hydropower plants being built in the Devoll Valley. The machine was commissioned by Devoll Hydropower, an Albanian company owned by the Norwegian power company Statkraft. The contractor building the tunnel and operating the machine is the Limak-AGE JV.

Currently, nearly all of Albania's electricity is provided by aging hydroelectric power plants, which are becoming ineffective due to increasing droughts. The asphalt-core rock-fill dam will be 320 m (1050 ft) long, 150 m (492 ft) high, and 460 m (1510 ft) wide. "The dam is anticipated to be the world's highest of its kind upon completion, with storage capacity of about 360 million m3 (95 billion gal). The energy generated by the Devoll Hydropower Project can supply more than 300,000 Albanian households," stated Robbins Field Service Contractor, Stefano Umiliaco.

Since its initial launch the machine has mainly encountered siltstone flysch, but is expected to bore through ophiolite, mélange, and breccia with several fault zones that could result in variations in ground type and possible inrushes of water. When asked about the challenges, Umiliaco replied, "The risk of encountering high water pressure was assessed as high for the section of sandstone and siltstone flysch at the middle of the TBM tunnel section. In this section, more permeable sandstones might be connected to limestones in the north, where several springs indicate a water level at about 950 m (3117 ft) above spring line. This could implicate locally high water pressure during tunnelling. For the rest of the tunnel the risk is assessed to be low."

Preventative measures have been taken to prepare for the event of an inrush of water, especially in the case of the muck chute. Since the Robbins Crossover machine uses a belt conveyor and not a screw conveyor, the chute needed to be able to be sealed off in the case of an inrush of water. According to a Robbins Project Engineer, Missy Isaman, "The bulkhead has a large sealing gate just above the belt conveyor. These are pressure relieving gates. These gates can also be used in a semi-EPB mode: As the pressure builds in the cutting chamber, the gate is opened by the pressure, and material spills onto the belt. As the pressure is relieved, the gates then automatically close, again sealing off the chamber. In extreme cases, the gates can be sealed and the probe/grout drills can be used to forward drill and grout for ground consolidation and to seal off the water." Additionally, the gripper shoes and inner telescopic shield are equipped with inflatable seals to further protect against inrushes of water.

> "The energy generated by the Devoll Hydropower Project can supply more than 300,000 Albanian households." -Stefano Umiliaco, Robbins Field Service Contractor

The Moglicë Hydro Power Plant is expected to be completed in 2018. Once online, the hydropower project will generate 800 Gwh annually, increasing electricity production in Albania by 20 percent.

MEGA SLURRY TO BORE ROCK IN JAPAN

The Robbins Company has recently been selected by the Obayashi-Taisei-Kosei JV to build a hard rock Slurry TBM for Hiroshima Expressway Line 5. The machine is 13.67 m (44.8 ft) in diameter and will be the first Slurry TBM of such large diameter to excavate in hard rock in Japan. The tunnel will be 1.4 km (0.9 mi) long, and will be lined with reinforced concrete segments.

The production of the machine is a joint venture between Robbins, JIM Technology Corporation (JITC), and Obayashi. The machine is a Robbins design, with JITC supplying the cutterhead drive and articulation seals, and Obayashi providing the slurry transport system and slurry separation plant. The geology is estimated to include maximum 190 MPa (28,000 psi) UCS granite with high water pressure of up to 13 bars. The Slurry TBM is designed to excavate the dense rock with specialized 20-inch pressure compensating disc cutters, which utilize a patented design to effectively operate under high water pressures.

THE 13.67 M (44.8 FT) DIAMETER TBM WILL QUITE POSSIBLY BE THE LARGEST SLURRY EVER COMMISSIONED TO EXCAVATE HARD ROCK IN JAPAN

"This new tunnel will directly connect the Hiroshima city center area with a major national highway network, and save a lot of time for commuters," said Kiyomi Sasaki, General Manager, Robbins Japan. The TBM is expected to launch in late 2018. Due to noise restrictions, boring must take place during limited time periods. "There is a residential area on the surface," added Sasaki. There are also restrictions on delivering the TBM—in order to meet controlled transportation limits within the city—so the TBM will need to be divided into small transportable weights and sizes, then assembled onsite. The tunnel is expected to be completed late 2019.

The development of the unique machine—from high-pressure cutters to robust components able to stand up to abrasive wear—is indicative of just how versatile Slurry TBMs can be. This TBM will challenge the preexisting understandings of what a Slurry TBM can do, and its ability to excavate in hard rock. "The development of this TBM is a milestone," remarked Sasaki, "it will lead to new tunnel applications worldwide."

ROBUST MACHINE TO BORE URBAN CHICAGO TUNNEL

REFURBISHED TBM WILL STOP FLOODING IN ALBANY PARK

In the neighborhood of Albany Park in Chicago, Illinois, USA, Kenny Construction is gearing up to put their Robbins TBM back in the ground. "Keri", a Main Beam machine, has been owned by Kenny since the 1990s and has been used on other projects in the area. Prior to its ownership by Kenny, the TBM completed several successful projects around the world, including in Saudi Arabia and the Dominican Republic. This time, the TBM will be excavating the Albany Park Stormwater Diversion Tunnel, a project owned by the Chicago Department of Transportation.

In recent years, Albany Park has been plagued with floods. "The tunnel is designed to help control surface flooding in the local community," says Clay Spellman, Project Manager for Kenny Construction. The mile-long tunnel will divert stormwater from the North Branch of the Chicago River, eliminating the danger of floods during times of heavy rains, while not affecting the river's water level in normal times.

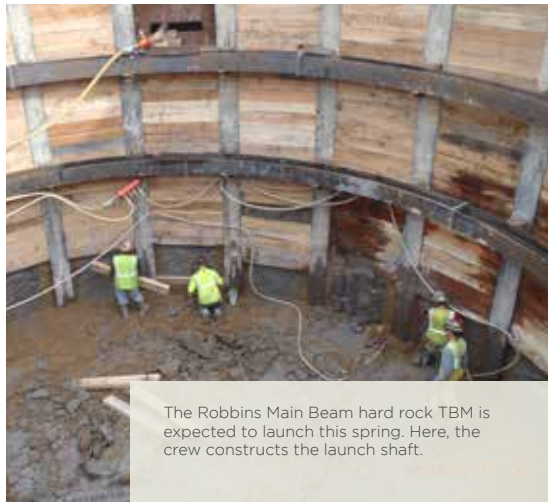
Because the project is located in a residential area of Chicago—with the drainage tunnel starting in Eugene Park and extending for approximately 1.6 km (1 mi) under Foster Avenue to the North Shore Channel—possible effects on the community had to be considered. Plans were made for haul trips that could affect traffic and for the allotted frequency of blasting that would be allowed per day.

While the tunnel is under construction, the city's Office of Emergency Management and Communications (OEMC), the Department of Water Management (DWM), and the Department of Transportation (CDOT) have developed an action plan to respond to emergencies, which includes early monitoring of river levels and mounting an immediate response if flooding occurs.

The TBM was "rebuilt by Kenny Construction with size modifications designed by Robbins. We took an existing cutterhead, rebuilt it, and then added segments, taking it from 5.2 m (17.2 ft) to 6.2 m (20.4 ft) in diameter," says Robbins Project Manager, Mark Belli, adding that Robbins is also supplying scrapers and grill bars.

During the bore, the TBM is expected to encounter mainly limestone. When asked if any difficult ground conditions such as fault zones or water inflows were anticipated, Spellman replied there "shouldn't be any difficult ground, but you never know." Thread bars in a 1.5 by 1.5 m (5 by 5 foot) pattern will be used for ground support and the final lining will be cast in place with concrete. The machine is expected to launch this spring. The project as a whole is expected to be complete in April 2018.

The 6.2 m (20.4 ft) diameter tunnel boring machine was rebuilt by Kenny Construction with size modifications by Robbins.



The Robbins Main Beam hard rock TBM is expected to launch this spring. Here, the crew constructs the launch shaft.

Below: The original prototype SBU used on a project in 1996 in Leesburg, Virginia, USA.
Right: More than 20 years later, the first small boring unit was remanufactured in Robbins' Solon, Ohio, USA manufacturing facility.

MORE THAN 20 YEARS

ROBBINS SBUs, TRIED AND TRUE

The Story of the First Small Boring Unit

The story of the first Small Boring Unit (SBU) is one of necessity—New York-based contractor Bortech Co., Inc. was excavating a 140 ft (43 m) long crossing in hard diabase rock tested at 16,000 to 20,000 psi (110 to 138 MPa) UCS, a strength far above what typical Auger Boring Machine (ABM) roller cone cutting heads could do. The crossing, requiring 42-inch (1.1 m) steel casing to be placed under Goose Creek at the mouth of the Potomac River for a new water main, would need a new type of boring attachment.

The contractor first tried a prototype cutting head with limited success in the hard rock, and then called The Robbins Company. "I contacted Robbins and spoke to David Long (now retired), and we spoke in length about the Robbins design. As an engineering graduate I felt comfortable with the design," said Robert Titanic, Bortech President, CEO, and Founder.

Also on that team at Robbins was current Project Engineer John Kocab. "The first thing we made was the cutter itself. We wanted to develop a small cutter (6.5 inches diameter). We also started conversations with a few different companies to see if we could make a cutterhead to mount on their equipment. We knew that we needed to mount the head on a bearing rather than on the end of the auger."

The newly designed machine worked—it bored through the rock in nine days, with 8-hours of drilling each day. Titanic recalled that the bore "went quite well, and everything stayed on line and grade." Only one set of disc cutters was needed for the hard rock crossing.

As of 2017, more than 400 small boring units have been built—at least 90% of these are still in use.

SBUs gained popularity as word of their usefulness spread. "We were introducing a different kind of technology to the trenchless industry. Any time contractors used roller cone cutters in hard rock, there was a problem. We found that with disc cutters you could cut rock much better," said Kocab. Some modifications were of course made after that initial project, and the line of Small Boring Units expanded to encompass diameters anywhere from 24 to 72 inches (600 mm to 1.8 m).

As of 2017, more than 400 small boring units have been built—more than 90% of these are still in use. The original 42-inch (1.1 m) SBU (now known as the SBU-A for SBU Auger) used by Bortech was rebuilt in the Robbins Solon, Ohio shop for use by a different U.S. contractor. SBU-As have tackled rock as hard as 38,000 psi (262 MPa) UCS, they have bored crossings over 600 ft (182.9 m) long, and the most-used SBU-A, a 30-inch (762 mm) diameter model, bored at least eleven crossings totaling 2,800 ft (853 m). The legacy is a long one, as the technology has proven itself again and again.

2017 WEBINAR SERIES

Robbins hosts three complimentary webinars annually, geared towards project owners, contractors and engineers. Attend a Robbins webinar to hear from our company executives, lead engineers, and onsite Field Service staff about the latest tunneling trends and ways to save time and money on your upcoming projects.

PERFORMANCE UNDER PRESSURE: THE DESIGN AND APPLICATION OF ROBBINS EPBs
April 12, 2017

CROSSOVER MACHINES: LESSONS FROM THE FIELD
September 2017

DIFFICULT GROUND SOLUTIONS: CASE STUDIES
November 2017

Exact dates to be announced soon

Visit www.TheRobbinsCompany.com and join our LinkedIn Group, Robbins TBM, for updates and registration.

2017 TECHNICAL PAPERS & PRESENTATIONS

+ RAPID EXCAVATION AND TUNNELING CONFERENCE

June 4-7 | San Diego, California, USA

Design and Implementation of a Large Diameter "Crossover" TBM for the Akron OCIT
Paper Authors: Elisa Comis, Robbins and David Chastka, Kenny/Obayashi JV

High Cover TBM Tunneling in the Andes Mountains: A Comparative Study of Two Challenging Tunnels
Paper Authors: Mark Belli, Carlos Lang, and Pablo Salazar, Robbins

Large Diameter 20-inch Disc Cutters vs. 19-inch Cutters: A Comparison of Tool Life and Performance on Rock TBMs
Paper Author: Steve Smading, Robbins

Rondout West Branch Bypass Tunnel - TBM boring in hard rock against high water pressure and high water inflows beneath the Hudson River in New York
Paper Author: Martino Scialpi, Robbins

Robbins Cutter Instrumentation Technology (CIT) Keeps Improving
Paper Author: Kamyar Mosavat, Robbins

Successful Excavation of Mexico City's TEP II Tunnel: Use of a Dual Mode, Crossover TBM in Challenging Geology
Paper Author: Roberto Gonzalez, Robbins Mexico and Martino Scialpi, Robbins

Use of "Command Chair" Simulator to Optimize Modern TBM Performance
Paper Author: Steve Chorley, Robbins

+ WORLD TUNNEL CONGRESS

June 9-15 | Bergen, Norway

Novel TBM for Hard Rock with Potential of High Water Inflows and Pressures
Paper Author: Tyler Sandell, Robbins

Difficult Ground Solutions (DGS): New TBM Solutions Carve a Path to Success
Paper Author: Doug Harding, Robbins

Low Cover EPB Tunnelling Beneath a Historic Monument on the Jaipur Metro
Paper Authors: Jim Clark, Robbins and Chris Cooper, CEC

The TBM Return to Norway at Røssåga HEPP - TBM operation through extremely hard rock, kartic features, and other challenges
Paper Authors: Sindre Log, Robbins, Tobias Andersson, Leonhard Nilsen og Sønner, Dag Brox, Leonhard Nilsen og Sønner

ITACET Seminar: Hard Rock TBMs in Soft Ground and Dual Mode
Presented by Brad Grothen, Robbins

Robbins will also give technical presentations at the following conferences:

+ CSM UNDERGROUND GROUTING & GROUND IMPROVEMENT SHORT COURSE

May 1-5 | Golden, Colorado, USA

+ CSM TUNNELING SHORT COURSE

September 18-21 | Golden, Colorado, USA

SHARING OUR KNOWLEDGE TO ENCOURAGE INNOVATION.

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The Single Shield Hard Rock TBM will bore a tunnel to replace part of the Delaware Aqueduct, which supplies 50% of New York City's drinking water.