UP FOR THE **CHALLENGE**

UNDERGROUND INNOVATIONS

ISSUE 1 + 2014

Robbins field service personnel worked with the contractor to safely build seven bypass tunnels at the Kargi Hydroelectric Project.

TOUGH TURKISH TBM MOVES THROUGH FRACTURED AND FAULTED ROCK

Obstacles in tunneling are unavoidable, which means experienced field support is invaluable. Just ask Gülermak, the contractors leading the Kargi Hydroelectric Project in Turkey, who relied on Robbins personnel to overcome early challenges.

Launched into poor geology in early 2012, the project's 10 m (32.8 ft) diameter Double Shield TBM bored only 80 meters (260 ft) before getting stuck in a section of collapsed ground. Conditions varied widely from solid rock to running ground, causing the cutterhead to stall on numerous occasions. In the first 2 km (1.2 mi) of boring a total of seven bypass tunnels were needed to free the TBM from collapsed ground.

Given these extraordinary circumstances, Robbins Field Service, Statkraft (the project owner) and Gülermak worked together to find innovative solutions. "We engineered a custom canopy drill and positioner for Gülermak to allow pipe tube support installation through the forward shield," said Glen Maynard, Robbins Site Manager on the Kargi Project. The workarounds were successful and allowed the project to keep moving forward.

In addition to the ground support, the cutterhead drive torque capability was increased by more than 100% for excavation in adverse ground conditions. Robbins Field Service personnel also collaborated with Gülermak to develop and improve bypass tunneling and hand tunneling techniques, resulting in an average bypass tunnel construction time of just 14 days. All tunnels were completed safely and in a timely manner.

THE CUTTERHEAD DRIVE TORQUE CAPABILITY WAS INCREASED BY MORE THAN 100% FOR EXCAVATION IN ADVERSE GROUND CONDITIONS

Despite the early setbacks, the TBM has succeeded in crossing numerous faulted sections that would have trapped a machine with less power. In fact, Gülermak has measured cavity heights above the cutterhead in some of these fault zones at over 30 meters (100 ft).

Since June 2013, the TBM has recorded rates up to 650 meters (2,130 ft) per month and 39.7 m (130 ft) per day, with no additional bypass tunnels needed. Crews are moving forward with regular probe drilling, allowing the TBM to advance between 25 and 38 m (82 and 125 ft) forward between drillings.

Once complete, the Kargi Kizilirmak Hydroelectric Project will generate 470 GWh annually—enough to power about 150,000 homes. The 11.8 km (7.3 mi) tunnel will source water from the Corum River in central Turkey, several hours from the city of Ankara, sending it to a new generating station operated by owner Statkraft AS.

"The total package of cooperation and trust between Statkraft, Gülermak, Robbins Management, Engineering and Field Service Support resulted in the correct modifications being successfully installed on the Kargi TBM," said Maynard.

THE YEAR IN REVIEW

A LETTER FROM LOK HOME

LOK HOME, PRESIDENT

The year of 2013 was a big turnaround year: Robbins made major progress on some of our biggest challenges and growing pains.

Among our biggest improvements were machine deliveries going out on schedule and progress in our overall delivery process. These improvements are in part due to the better cooperation and improved systems between Robbins Chinese and U.S. locations.

Robbins machines performed well worldwide throughout 2013. There were some problems on our EPB supply for San Francisco's Central Subway and challenges at the Emisor Oriente project in Mexico City, but overall we had good performance. On the Emisor Oriente and Liaoning projects, where our machines and our competitors' machines are each boring specific sections, the Robbins TBMs are making a stellar performance.

In 2013 there were many significant projects, but two were worthy of special mention. The first is the Grosvenor project in Australia, which is a coal mine decline. On this machine the design was finished, components procured, OFTA assembled and we started boring in 2013. Another interesting project was the undertaking of the rebuild of the CAT/Lovat TBM for the Harbor Siphon project in New York City after catastrophic flooding. With the announcement of the closure of CAT/Lovat, Robbins stepped up and completed this project on schedule and under budget.

Robbins is dedicated to working with our customers as a team. This has been shown in the multiple projects around the world that have been successful even in the most difficult conditions. Working with contractors to develop good solutions to complex problems is where we excel. We look forward to another great year in 2014.

NOTES FROM UNDERGROUND:

INSIGHTS FROM FIELD SERVICE

Working deep below the surface, Robbins Field Service Personnel have a unique perspective on what makes a successful project. When members of the Field Service Team came together to share their insights, a common theme emerged: planning is everything.

''Good early planning pays in the end," said John Gibson, Site Manager at Norway's Røssåga Tunnel. "There needs to be a good procurement plan prior to starting and enough resources for purchasing and shipping."

Nick Power, a Robbins Site Manager, agreed. "The best thing a contractor can do for their project is to allocate enough time to assemble and test the machine prior to excavating," he said. "Hiring skilled and experienced assembly personnel may cost a little more in the beginning but they will pay for themselves many times over when the machine is put together correctly."

> "DURING MY FIVE YEARS WITH ROBBINS FIELD SERVICE I HAVE EXPERIENCED A CAMARADERIE THAT IS SECOND TO NONE."
>
> -JIM CLARK, PROJECTS MANAGER INDIA

For Jeremy Pinkham, Robbins Field Service Manager for The Americas, missteps can be avoided with proper project management. "Many times there is a lack of tools when we get to the jobsite as not everything on [our recommended] list has been purchased," said Pinkham. "This causes delays, which could easily be fixed with the right detailed preparation and purchasing."

According to Gibson, effective training of the labor force is another important element to a smooth project. "In new and emerging markets I often see unskilled labor come on board with no experience," he said. "It is a misconception that they can be trained entirely on the job. These personnel could greatly benefit from training classes."

Gibson offered a final word of wisdom on what contractors can do to better ensure project success: "Even when the finish line is in sight, make sure to continue carrying out timely maintenance and repairs."

HARBOR SIPHONS PROJECT

BRINGING A TBM BACK TO LIFE

The Tully/OHL JV contractors behind New York City's Harbor Siphon tunnel expected a challenging project, but there was one thing they could never anticipate: Hurricane Sandy, the devastating super storm that pummeled the United State's eastern coast in October of 2012.

By the time the 186 kph (115 mph) winds and torrential rains subsided, the 2.9 km (1.8 mi) long tunnel traversing New York's harbor between Brooklyn and Staten Island was completely submerged. Somewhere inside, a 3.6 m (11.8 ft) diameter Caterpillar EPBM laid trapped, having only excavated 460 m (1,500 ft) of its 2.9 km (1.8 mi) goal.

With Caterpillar announcing their impending closure, the Tully/OHL JV turned to Robbins for extensive repair work. Though the task was daunting, the Robbins crew rallied together to bring the TBM back to life.

"The storm damaged everything," said Jeremy Pinkham, a Robbins Field Service Manager. "99% of the electrical system needed replacing. Some parts were corroded by the salt water—we had to inspect everything."

The Robbins team led onsite personnel in replacing corroded hydraulic components and all new electrical—from Variable Frequency Drives to PLCs and wiring—inside the small tunnel under a water pressure of 3 bar. The machine had been stopped with its thrust cylinders in, and thus certain components could not be replaced before the machine started up.

"We completely replaced all of the PLCs, and since we only had limited general assembly drawings from the CAT manual, we had to work backwards to create a new program," explained Pinkham. "We had to observe the machine and how it worked to build an effective PLC system."

The process didn't stop there. One field service crew member, Roger Cope, was dedicated full-time to documentation, taking pictures and inspecting various components. Engineers then pieced together information from vendor documents to create new machine components.

"We took on a project that nobody else would," said Pinkham. "We were able to rebuild an unknown machine from an unknown supplier, all while working outside our system. There were no detailed drawings and part numbers to refer to, just our observations."

The refurbishment project took four months and was ultimately completed on schedule. Crews began reassembling the machine in November. They are looking forward to a February launch.

NEW SBU-M DESIGN DEBUTS IN OMAN

In the harsh, desert climate of Oman, a new type of Robbins machine is reshaping the infrastructure of the country. In the process, it's also expanding the capabilities of traditional small diameter boring machines.

This first of its kind, the machine is a Motorized Small Boring Unit (SBU-M) that combines the boring capabilities of larger units with remote controlled steering. The new design delivers added safety and offers contractors and owners a more cost-effective solution for boring small diameter tunnels in hard rock.

The new SBU-Ms are more compact than their other SBU-M counterparts, which start at 1.2 m (48 in) in diameter. The new sizes, from 7.62 mm to 1.1 m (30 to 44 inches), fill a niche in hard rock, small diameter bores. In the past, larger diameter machines or microtunneling machines, modified to bore through rock, were utilized.

The machine is facing its first true test, excavating a tunnel that is a portion of a larger 40 km sewer project in the province of Bausher. So far it has proven up to the challenge, despite difficult ground conditions. Designed for solid ground and competent rock, the actual geology of the site has ranged from soft, sandy gravel with cobbles and boulders to solidified material that crumbled upon impact. Coupled with the scarcity of water, this caused materials to get lodged in the forward section of the shield.

Robbins engineers overcame these challenges by modifying the machine's bearing housing. This created a larger area for muck to pass through, and increased the cubic feet per minute to the vacuum system for greater airflow, thereby creating more suction.

Crews are currently excavating at a moderate rate to monitor spoil removal. They hope to have future production rates of 6 to 9 meters (20 to 30 feet) per shift.

NATIONAL RECORD

URBAN TUNNELING A TIGHT SQUEEZE AT MOSCOW METRO

On a small piece of property, lined by an elevated freeway and glass skyscrapers, a narrow shaft drops down to Moscow's underground. This is one of several sites where three Robbins EPBs—ranging from 6.2 m (20.3 ft) to 6.6 m (21.6 ft) in diameter—were hard at work, setting advance rate records on a massive metro project.

The SK MOST crew celebrates a record-setting drive and breakthrough at the Moscow Metro in May 2013.

Of all the challenges contractors at SK MOST and Engeocom had to overcome during the Moscow Metro Tunnel project, the jobsites' small footprints proved to be one of the biggest. While all of the sites were tight, one Engeocom site was particularly so. The box-cut shaft was squeezed in between the elevated freeway and a service road near skyscrapers. The shaft required more support than was originally planned and was reduced from 10 m to 8 m (32 to 26 ft) in diameter. The site was so small and the access shaft so tight, that back-up gantries had to be lowered vertically, with deck items bolted down. To combat the impact of the small access shaft on muck removal, Robbins supplied a vertical belt conveyor to go with the horizontal tunnel conveyor, which marks the first time a vertical belt has been used for tunneling in Moscow. Each of the machines faced similar launches in close quarters.

Once all three machines were in the ground, geological challenges had to be addressed. The ground was generally mixed face, containing water up to 3 bar, as well as limestone rock. Mixed face cutterheads with rear-mounted, interchangeable disc and cutting tools helped address these issues. Electric Variable Frequency Drives (VFDs) helped maintain advance rates with greater efficiency. Foam and water injection systems prevented sections of sticky clay from blocking the cutterhead.

In spite of all these hurdles, the first Robbins EPB machine broke through ahead of schedule on May 24, 2013 for contractor SK MOST. During its bore, it set a Russian record advance rate for metro-sized EPBs by boring 37.8 m (124 ft) in a single day. "The soil condition, crew experience, rigorous schedule, continuous conveyor, and the reliability of the Robbins TBM are all factors that helped achieve the record," said Vadim Bocharov of SK MOST. Robbins Field Service was at the site to assist in training of the crew in proper operation and maintenance of the variable frequency drives. "We can operate the power, thrust, and torque at 100%, because that is the benefit of a Robbins machine." The second EPB, for contractor Engeocom, celebrated breakthrough in October of 2013.

OFTA ADVANCES NORWAY'S TBM TREND

After a 22 year absence, TBMs have returned to Norway. Dubbed "Iron-Erna" after the country's Prime Minister, Erna Solberg, the 7.2 m (23.6 ft) Robbins Main Beam Machine began boring sections of the Røssåga Hydroelectric Project in January. The project is not only the first TBM used in Norway in over two decades, but also the first use of Onsite First Time Assembly (OFTA) in Europe.

Located less than 100 km (62 miles) from the Arctic Circle—temperatures often plummet as low as -32°C (-25°F)—The Røssåga Hydroelectric Project involves an overhaul and addition to existing power stations. The Norwegian contractor, Leonhard Nilsen & Sønner (LNS) was awarded a 450 m (1,476 ft) access tunnel and 7.4 km (4.6 mile) long headrace tunnel through hard rock.

"THE CREW FROM ROBBINS ON SITE HAVE BEEN VERY PROFESSIONAL, EFFICIENT AND SKILLED."

- FRODE NILSEN, MANAGING DIRECTOR OF LNS

"The logistics were complex for bringing the TBM, conveyor system, spare parts, and cutters from all over the world to almost 'the top of the world,'" said Frode Nilsen, Managing Director of LNS, the contractor leading the project. "The crew from Robbins on site have been very professional, efficient and skilled. They have a lot of experience in working under conditions where the logistics have been challenging."

Developed in 2006 and first used at the Niagara Tunnel Project, Robbins' OFTA method allows for machine components to be shipped directly to the job site, so that the entire machine is assembled for the first time on location. This method reduces shipping and manpower requirements, with proven time savings of up to 5 months and cost savings up to $4 million USD.

Only five months after the first part was delivered in September 2013, the Robbins Main Beam machine started boring. Favorable weather resulted in bare road conditions and allowed delivery before winter snow arrived. Altogether, more than 90 loads were delivered to the remote job site without any major setbacks. This included the heaviest component, the center cutterhead, weighing in at 62,000 kg (136,687 lbs). LNS expects the tunneling to be complete in summer of 2016, and the newly renovated power station to go online in spring of 2017.

For the team at LNS, choosing Robbins' TBM built using OFTA proved to be a wise choice. "We think that more project owners will consider the use of a TBM as interesting after seeing that we've got the technology back in Norway again," said Frode. "We are already seeing it for upcoming projects in both infrastructure and hydropower. We think TBMs are here to stay in Norway."

One of three mixed ground EPBs sets segments at Mexico's largest infrastructure project.

After encountering abrasive ground, cutterheads were modified from their original design for increased wear resistance.

OVERCOMING ABRASIVE GROUND AT EMISOR ORIENTE

THERE ARE URGENT TUNNELING PROJECTS, AND THEN THERE IS EMISOR ORIENTE

In a concerted effort to prevent massive flooding in Mexico City—home to over 20 million residents—Mexico's National Water Commission (CONAGUA) ordered the construction of the 62 km (39 mi) long wastewater tunnel. The site's geology—made up of watery clays and large boulders—increases the complexity and urgency of the project. Thankfully, Robbins EPB machines have been up to the challenge.

Located in the Valley of Mexico, Robbins Earth Pressure Balance Machines (EPBs) were selected to excavate four of the project's six lots. To tackle the conditions, engineers customized the original EPB designs with mixed-ground, back-loading cutterheads, ribbon-type screw conveyors, and redesigned pressure bulkheads. Continuous conveyors were added behind each machine for efficient muck removal.

The first machine was launched at Lot 1 in 2011 and made a successful breakthrough 15 months later. However, two machines at Lots 3 and 4 that started excavation in 2012 quickly encountered sections of abrasive basalt rock and ash, boulders, and blocky ground that wore on cutting tools and the cutterhead. These harsh conditions led to damage of cutting tools and screw conveyors.

WORKING TOGETHER, THE CONTRACTORS AND ROBBINS DEVELOPED **SOLUTIONS TO OVERCOME EXTRAORDINARY GROUND CONDITIONS.**

To manage sudden load impact, special attention is now being paid to operational parameters at Lots 3 and 4. A new rotary union has been designed for the cutterhead to improve cutter change time on the central disc cutters. More durable face and gage scrapers have been added to the cutterhead for better abrasive wear resistance. In addition, it is planned that when the Robbins machine at Lot 3 breaks through, it will be given a new cutterhead fitted with chromium carbide wear plates and a screw conveyor designed with wear plates and reinforced casing.

Despite the challenges, the Robbins EPBs have performed well. The Robbins Lot 3 machine has bored 2,172 m (7,126 ft) and the Lot 4 machine has bored 1,985 m (6,512 ft) so far. Although these machines were launched two years after the Herrenknecht machines at Lots 2 and 6, the distances are nearly half of what the Herrenknecht machines have been able to bore, and have been achieved in much harsher conditions.

For Mario Torres, TEO Project Director at contractor Carso, Robbins' continuous support has been an essential part of the project's success. "Engineering and Robbins USA always give immediate responses and solve problems quickly," he said. "Robbins Field Service personnel have provided good work and handled all problems as they arise."

THE CONTINUOUS CYCLE OF EPB CUTTER IMPROVEMENT

Since their first successful employment on a TBM over fifty years ago, disc cutters have constantly evolved. In 2013, Robbins engineers continued the legacy of technological innovation, rolling out a powerful new line of cutters that are allowing owners and contractors to take on projects of increased size and complexity.

Specialized pressure compensating EPB disc cutters allow EPBs to operate in high pressure conditions above 3 bar without seal failure. The new cutters include a two-piece end retainer that transmits external pressure to the inside of the cutter, zeroing out the differential pressure across the cutter seals. The device minimizes the risk of a cutter seal failure, which can happen if standard cutters are used in high pressure conditions.

The cutters are currently being used on the world's largest TBM—Seattle's 17.48 m (57.35 ft) diameter TBM known as "Bertha". "The SR99 machine probably has 10 to 20 disc cutters on it currently," said Aaron Shanahan, a Robbins Cutter Applications Engineer. "The contractor has been replacing disc cutters with knife bits because it doesn't seem that there have been many boulders that needed to be broken down." Other testing sites include Mexico City's Emisor Oriente project, where EPBs are experiencing pressures up to 6 bar.

Refinement of the design has not stopped at field testing. "We have an ongoing project with a European consortium, including the Norwegian university NTNU, to develop the next generation of disc ring steel," said Shanahan. "We've also created two new heat treat processes to reduce chances of non-abrasive damage on the cutter rings."

MOBILIZING CHINA'S MEGA MACHINES

Northeastern China's Liaoning NOW project involves eight hard rock machines each boring tunnels between 6 and 8 km (4 and 5 mi) long in a massive water scheme. Five Robbins Main Beam TBMs and seven continuous conveyor systems at the project site required mobilization of an army of personnel.

The first of the 8 m (26 ft) diameter machines was refurbished and launched in early 2013, and has already bored 4.7 km (2.9 mi) as of early 2014. The remaining machines are being mobilized simultaneously by Robbins Field Service in a carefully coordinated plan. Two machines, designated T4 and T5, were launched in late 2013 and have already excavated 1,000 m (3,280 ft) and 1,070 m (3,510 ft), respectively. Two more machines, designated T3 and T8, began boring in mid-January 2014. Two additional Robbins continuous conveyor systems, operating behind Herrenknecht machines, have been in place since September and December of 2013.

The new Robbins TBMs are uniquely designed for the long tunnels in magmatic hard rock, and are fitted with adaptable ground support systems. "We are building heavy duty machines for hard rock," said Lok Home, Robbins President. "It is satisfying to see all we have learned from past projects being put to use. The cutterheads are reinforced and fully equipped with wear resistant material, and the TBMs are designed with much more sophisticated ground support than we have ever provided before."

The ground support systems offer maximum flexibility, allowing the contractor to choose between the McNally System—consisting of steel slats extruded from pockets in the roof shield—or ring beams, rock bolts, and wire mesh.

On each of the machines the specially designed ring beam erector and roof drill system are mounted on the same rail system, but are capable of independent movement. The rotating ring beam erector utilizes six pieces that are loaded into the erector and then pinned before they are expanded against the wall to make a ring.

To date, the ground support systems on the two operating TBMs are performing well, with advance rates as high as 200 m (650 ft) per week.

CONVEYORS PUSH A VETERAN TBM TO A NEW RECORD

On June, 12, 2013, a speedy machine in Indianapolis, Indiana, USA achieved 124.7 m (409 ft) of excavation in 24 hours, a world record for TBMs in the 6 to 7 m (20 to 23 ft) diameter range.

The TBM was launched in early 2013 and began its excavation in limestone and dolomite rock. Muck removal is being achieved with a Robbins continuous conveyor system using both horizontal and vertical belts to haul muck up a 76 m (250 ft) deep shaft. These conveyors, paired with good ground conditions, enabled the machine to achieve its high operating efficiency.

The record breaking rate is just one of many triumphs for the 6.2 m (20.2 ft) Robbins Main Beam TBM operating at the Indianapolis Deep Rock Tunnel Connector (DRTC). The veteran machine was originally built in 1976 and used on multiple projects, most recently on the Second Avenue Subway Project in New York City. The robust TBM has been rebuilt many times.

The machine, owned by the Shea/Kiewit JV contractor, was refurbished and redesigned to include variable frequency drive motors, a back-loading cutterhead with 19-inch disc cutters, and a rescue chamber.

Once complete, the Indianapolis Deep Rock Tunnel Connector will be lined with unreinforced concrete, making the finished diameter 5.5 m (18 ft). Cleaner water is the ultimate goal of the city's new DRTC, which will include four shorter tunnels for the project owner, Citizens Energy Group.

2014

GLOBAL TUNNELING'S NEXT BIG PUSH

This year we're excited as the tunneling market picks up and new regions, from the Middle East to South America and Central Asia, open up. Tunnel boring machines are here to stay, and are even gaining acceptance in markets traditionally favoring drill and blast, such as the Robbins machine for the Røssåga Hydroelectric Project. The January launch marked the return of TBMs to Norway after 22 years' absence, and there is more TBM work upcoming.

In terms of scale, projects are becoming larger. All around the world, contractors are using more machines, and looking at larger sized tunnels. Seattle's 17.48 m (57.35 ft) giant EPB for the SR 99 tunnel project is a notable example of large-sized TBMs. This trend can also be seen in large diameter, double-track metro tunnels planned or underway in the Middle East and Europe. In Ankara, Turkey, high speed rail tunnels will utilize massive (over 13 m/43 feet) machines to excavate in mixed ground conditions, prompting a new design for hybrid TBMs that allows for in-tunnel conversion between modes.

Mega metro projects tip the other side of the scale in terms of the sheer numbers of machines being used. Some 30 machines are up for bid this year for Singapore's Thomson Line, even as scores of EPB machines excavate the country's new Downtown Line. Five Robbins EPBs are or were excavating the Downtown Line, with one machine breaking through in autumn 2013 for contractor CMC di Ravenna after a very successful run. Similarly massive metro projects are underway in Russia, Azerbaijan, India, and China. We believe this trend is one that will be with us for a while.

Finally, we are looking forward to increased cooperation and communication in our industry to streamline design and technology that will lead to safer and faster tunneling. Robbins works extensively with universities, research labs, and international tunneling societies, such as the International Tunneling Association (ITA), to develop industry standards, protocols, and other technical documents. This past year, a new working group known as ITAtech brought together manufacturers such as Robbins, Hitachi Zosen and other companies to develop standards and introduce new concepts to the industry with solid recommendations and a consensus from all members. The group released a standards guide on L10 Main Bearing Life calculations for TBMs, which will be helpful across the industry, and is working towards more standards in 2014 to introduce novel types of shotcrete and other innovations.

2014 is primed to be a banner year for tunneling globally, and with our increased willingness to look at challenges as a natural part of tunneling through the organic earth, we can make it a safer and more efficient process for all.

ROBBINS RESOURCES FOR MORE INFORMATION

Robbins publishes up-to-the-minute project information and photos online, along with informative videos and technical papers. In-depth information is just a click away.

CURRENT PROJECT VIDEOS & 3D ANIMATIONS

youtube.com/user/TheRobbinsCo

PEER-REVIEWED WHITE PAPERS ON THE LATEST TUNNELING RESEARCH

therobbinscompany.com/en/news-events/white-papers/

BREAKING NEWS ON PROJECTS FROM AROUND THE WORLD

twitter.com/Robbins_Co

INDUSTRY INSIGHTS & ANNOUNCEMENTS

Search for "Robbins TBM" under Groups on LinkedIn

For a complete list visit the Robbins website, therobbinscompany.com

Below: A record-breaking Main Beam advanced 124.7 m (409 ft) in 24 hours in Indianapolis, USA. Center: Personnel refurbish cutters in an on-site cutter shop in India.
Far Right: Robbins Field Service inspects cutters from inside a back-loading cutterhead in Malaysia.

2014 TECHNICAL PRESENTATIONS

+ NASTT NO DIG
April 13 - 17
Orlando, Florida USA

Small Diameter, Remotely Controlled Tunneling with the SBU-M

Kenny Clever, SBU Products Manager

+ ZAGREB UNDERGROUND SYMPOSIUM
March 27-28
Zagreb, Croatia

Metro-sized TBM Concepts for Mixed Ground Tunneling

Detlef Jordan, Sales Manager Europe

+ ITA-AITES WORLD TUNNEL CONGRESS
May 9-15
Iguassu Falls, Brazil

Extreme Tunneling at Emisor Oriente

Andrei Olivares, Robbins Mexico & Marco Antonio Lara, Carso

Raising EPB Performance in Metro Sized Machines

Joe Roby, Vice President-Business Development & Desiree Willis, Technical Writer

Rock Tunneling Machines: Options & Methods for Variable Geology

Brad Grothen, Engineering Manager

Limited Space Urban Tunneling at Singapore's Mega Metro

Steve Smading, General Manager Robbins Singapore

+ NORTH AMERICAN TUNNELING CONFERENCE
June 22-25
Los Angeles, California, USA

Urban EPB Tunneling at the San Francisco Central Subway

Noah Johnson, Design Engineer

The Greatest Challenges in TBM Tunneling: Experiences from the Field

Jim Clark, Projects Manager-India

The Next Level: Why Deeper is Better for TBMs in Mining

Ryan Gratias, Project Engineer

Achieving Fast EPB Advance in Mixed Ground

Joe Roby, Vice President-Business Development & Desiree Willis, Technical Writer

+ AUSTRALIAN TUNNELING CONFERENCE
September 17-19
Sydney, Australia

Tunnel Boring Machines in Mines

Joe Roby, Vice President-Business Development & Martin Rauer, General Manager, Robbins Asia Pacific

TBM Usage Speeds up Development at the Stillwater Mine

Desiree Willis, Robbins & Curt Jacobs, Stillwater Mine

+ AFTES
October 13-15
Lyon, France

Evolution and Future of EPB Machine Tunneling

Presented by Detlef Jordan, Sales Manager Europe

SHARING OUR KNOWLEDGE TO ENCOURAGE INNOVATION.

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Breakthrough of the world's largest hard rock TBM at Niagara, awarded Canadian Tunnelling Project of the Year in 2013 by the Canadian Tunnelling Association.