

## BREAKTHROUGH AT NIAGARA



L to R: Mike Kolenich, Robbins Manager of Projects; Gilles Moffat, Strabag Shotcrete Operator; and Lok Home, Robbins President on May 13, 2011.

**M**ay 13, 2011 marked the completion of the world's largest hard rock TBM drive at Canada's Niagara Tunnel Project. A well-attended ceremony celebrated the final breakthrough of the 14.4 m (47.2 ft) diameter Robbins Main Beam, following an initial breakthrough into a grout tunnel on March 1.

Ontario Premier Dalton McGuinty, as well as the CEOs of project owner Ontario Power Generation and contractor Strabag AG gave speeches in front of a diverse crowd including hundreds of tunnel workers. "We have a group of up to 500 people directly and indirectly involved with the project. Their determination, hard work, and willingness to work as one team while keeping focused on safety have all contributed to this project's success," said Ernst Gschnitzer, Project Manager for Strabag.

The completion of the project comes after both highs and lows, from significant over-break to multiple world records. Poor rock conditions in Queenston shale at the beginning of the TBM drive required the tunnel alignment to be raised by 45 m (150 ft) into more stable rock. While in the difficult ground, crews undertook significant measures to safely scale

down loose rock from the tunnel crown, as loose rock was not permitted behind the final concrete lining. After surmounting the difficult conditions, the Robbins machine achieved two records for any TBM 11 m (36 ft) in diameter or larger—468 m (1,535 ft) in one month, and 153m (503ft) in one week, both in July 2009.

"There is a tremendous sense of accomplishment here. There were huge logistical challenges just delivering and assembling the TBM onsite, and the machine has now overcome significant geologic challenges as well," said Mike Kolenich, Robbins Manager of Projects, who followed the Niagara TBM from pre-order to breakthrough.

The Niagara Tunnel Project was initiated in June 2004 by provincially-owned company Ontario Power Generation. The Robbins machine was launched in summer 2006 less than 12 months from contract signing, following Onsite First Time Assembly (OFTA). The project marked the first use of OFTA, which saves both time and money to contractors compared to factory-assembled TBMs.



The record-breaking West Qinling TBM holed through into an adit in May 2011, following landmark advances of 235 m (771 ft) per week and 841.8 m (2,751 ft) per month.

## CHENNAI METRO EPB FITTED FOR MIXED GROUND CONDITIONS

In 2012, a new 6.65 m (21.8 ft) Robbins EPB will tackle mixed ground conditions in densely urban Chennai.

The southeastern Indian city is a rapidly growing technological and industrial center with a population of more than 8.2 million people. Owner Chennai Metro Rail Limited (CMRL) has commissioned two new rail lines to help with traffic congestion, totaling 45.1 km (28.0 mi) in length.

The Robbins EPB will excavate two 1 km (0.6 mi) tunnel sections of Lot UAA-01 on Line 1, extending from the Washermanpet area toward Chennai International Airport.

The EPB, for contractor Afcons Infrastructure Ltd, will excavate variable ground consisting of granite, sand, silt, and clay with boulders up to 300 mm (12 in) in diameter.

The mixed ground EPB design will utilize a combination of 17-inch diameter disc cutters as well as soft ground tools. Specialized, small grippers located around the circumference of the machine's shield will allow for cutterhead stabilization in harder ground, and in addition will react the forces needed to pull the cutterhead back from the face.

Following shipment to the job-site in January 2012, the TBM will be assembled and launched from a 28 m (92 ft) deep starting pit.

## WORLD RECORD WINS FOR WEST QINLING MAIN BEAMS

At up to 1,400 m (4,600 ft) of cover and more than 10 hours from the nearest airport, China's West Qinling Mountains may not seem like an ideal site to set tunneling records. Two Robbins TBMs are proving that assumption wrong, however, with landmark rates in difficult conditions.

The first of two 10.2 m (33.5 ft) Main Beam Machines advanced 235 m (771 ft) in one week, and 841.8 m (2,761 ft) in one month during April 2011—rates higher than any ever recorded for TBMs in the 10 to 11 m (33 to 36 ft) diameter range. The previous long-standing rates, from a Robbins machine at Chicago, USA's TARP project, were for 185 m (607 ft) in one week and 685 m (2,247 ft) in one month.

"The Robbins machines have a good performance, we are very happy with the weekly rates, and hope for even better monthly rates," said Mr. Xu, Chief Engineer & Vice Project Manager for contractor China Railway Tunnel Group Co. Ltd. (CRTG). The 18th Bureau of CRTG is managing the Left Line Tunnel, while China Railway Construc-

tion Corporation (CRCC) is managing the Right Line Tunnel. The two parallel 16.6 km (10.3 mi) routes are just 40 m (130 ft) apart.

The record-breaking Left Line machine also broke through into an intermediate adit on May 28, 2011 at the 5.5 km (3.4 mi) mark, where it underwent planned maintenance and inspection before being re-launched.

Ground has consisted mainly of phyllite and limestone with some sections of high quartz content. Crews have also encountered fault zones of breccias and clay, as well as a 600 m (2,000 ft) long section of broken rock. Despite the conditions, only about 100 cutters have been changed on the Left Line machine so far. The Right Line machine, launched a month later, is also experiencing good cutter life.

The West Qinling tunnels are part of the Lanzhou to Chongqing Railway project, an extensive 820 km (500 mi) long scheme that will open to traffic in 2014. The new railway will shorten transport times from 17.5 hours to 6.5 hours and enable an annual freight capacity of 100 million metric tons.

## TOUGH DOUBLE SHIELDS ACHIEVE LANDMARKS AT AMR



The Robbins Double Shield at the inlet end of India's AMR Tunnel was successfully rebuilt, then launched in June 2011 following a once-in-a-century monsoon that covered it in 20 m (65 ft) of water.

Two Robbins TBMs are no strangers to challenging conditions, having persevered through severe floods and difficult ground at India's remote AMR water tunnel. On June 18, 2011, a 10.0 m (32.8 ft) Double Shield machine at the inlet end of the tunnel was rebuilt and launched following a once-in-a-century flood that inundated the machine with 20 m (65 ft) of water. During the same week, an identical machine boring at the outlet end of the tunnel reached the 10 km (6.2 mi) mark.

The outlet TBM is now stopped to undergo cutterhead maintenance and refurbishment due to the highly abrasive and blocky ground, consisting of granites up to 230 MPa UCS. "This TBM is the strongest machine I have seen in my life. It just keeps boring, even in these rock conditions," said Elisa Comis, Robbins Project Engineer at the AMR jobsite. During its drive to date, the TBM has achieved rates of up to 512 m (1,680 ft) per month.



Left: The first of three 8.93 m (29.3 ft) EPBs was fast-tracked at Lot 1 of Mexico's Emisor Oriente Wastewater Tunnel.

Above: A 6.25 m (20.5 ft) Main Beam TBM was partially assembled at the Robbins Shanghai manufacturing facility. The machine will bore India's Mumbai Water Tunnel.

## FIRST OF THREE EPBs LAUNCHED AT MEXICAN MEGA PROJECT

Mexico City's torrential rains and their ensuing floods have fast-tracked commissioning of one Robbins EPB at the country's most critical infrastructure project. The 8.93 m (29.3 ft) diameter machine was launched on July 13 at Lot 1 of the Emisor Oriente Wastewater Tunnel—a change from its originally designated tunnel at Lot 5.

Six lots, using three Robbins TBMs and three Herrenknecht TBMs, were ordered for the massive 62 km (39 mi) long wastewater line, but problems with the first TBM on Lot 1 prompted the change. "A flood in shaft 0 delayed the Herrenknecht machine for six months. In order to compensate for time lost, we began boring with the Robbins machine at shaft 5 of Lot 1," said David Juarez, site manager for Lot 1 contractor Ingenieros Civiles Asociados (ICA).

The critically-designated Lot 1 site, located in the Ecatepec area outside of downtown Mexico City, has seen widespread flooding during each rainy season. The Gran Canal, an open sewer commissioned in 1910, is the area's main sewer line—a waterway that floods its banks regularly, causing road closures and health problems to those living

nearby. Due to a loss of slope because of the city's sinking lake clays, the canal now has a positive vertical alignment below Mexico City--the portion of canal outside the city has not been affected.

"We are currently building a treatment plant and a pumping station at Shaft 5 of Lot 1, to pump the water diverted into Emisor Oriente back into the Gran Canal where the slope has not been affected," said Jose Miguel Guevara, General Supply Coordinator for Potable Water and Sanitation at project owner CONAGUA. The pumping station will go into service as soon as tunneling is completed at Lot 1 and the finished section is sealed off.

The Robbins TBM at Lot 1 has started excavation using umbilical cables and a sludge pump for muck removal. Once it has bored ahead 150 m (490 ft), a Robbins continuous conveyor system will be installed for the remainder of the drive in lake clays and sand.

At the end of the machine's 5 km (3.1 mi) drive, it will be removed and readied for its original 8.6 km (5.3 mi) long bore at Lot 5. Two more Robbins EPBs are scheduled for launch in 2011 on 9.2 km (5.7 mi) and 10.2 km (6.3 mi) bores at Lots 3 and 4, respectively.

## MUMBAI WATER TUNNEL TBM RAMPS UP FOR LAUNCH

A customer acceptance ceremony was held in June 2011 for a 6.25 m (20.5 ft) diameter Main Beam TBM that will dig India's Mumbai Water Tunnel. Some components of the TBM were partially assembled and shipped from the Robbins Shanghai, China manufacturing facility. The rest of the machine, including the main bearing, lube system, and back-up will be assembled on location using Onsite First Time Assembly (OFTA).

The OFTA process, starting in September 2011, will take place at the shaft bottom in a 100 m (328 ft) long starter chamber and 50 m (164 ft) long tail tunnel. TBM components will be lowered into the 109 m (357 ft) deep shaft using mobile and gantry cranes.

The urban location will also require a Robbins continuous conveyor system with vertical conveyor for muck haulage to the surface and temporary storage at the site using a radial stacker.

The 8.3 km (5.2 mi) long tunnel in basalt rock, for the Unity-IVRCL JV, will become part of the Mumbai Water Supply Tunnel running from Kapurbawadi to Bhandup areas. The new water tunnel is vital for the city, which currently experiences leakage from its aging lines, as well as intermittent flow of its drinking water during seasonal monsoons.



Left: The mixed ground SBU emerged in good shape after three 70 ft (21 m) bores. Above: Contractor Silver State Boring Inc. used the Robbins SBU to bore utility lines below an active hospital. Photo credit: Rick Landino/Silver State

## NEVADA CONTRACTOR SHARES FIRST TIME EXPERIENCE WITH SBUs

**T**ahoe Forest Hospital, located in Truckee, California, USA, is an expanding healthcare center with a new cancer wing under construction. The hospital was in the process of designing the high-tech wing in 2010, but needed to run all of their utility lines to the new building below the active main hospital.

"We were worried about what the ground was like. When they built the hospital, they unearthed a 25 ft (8 m) wide by 20 ft (6 m) tall boulder that they left on the grounds as decoration. We knew it was a possibility we might encounter the same type of boulders," said Charlie Landino, foreman for Silver State Boring Inc. The Nevada contractor opted for mixed ground auger boring using a 30 inch (760 mm) Small Boring Unit (SBU-A) to excavate three tunnels--the first time they had used this type of cutterhead.

Silver State began excavation of the first 70 ft (21 m) bore in October 2010. The crew was limited to a small site, and had restricted boring hours of 10:00 AM to 3:30 PM, as the hospital was concerned about noise and vibration.

"We were initially apprehensive about the SBU boring through high strength granite boulders, but it was very easy to use. We didn't even need to do cutter changes between bores," said Rick Landino, owner of Silver State Boring. The hospital eventually extended the boring hours once they determined that vibration and noise were not a problem.

The crew did indeed hit a large boulder below the hospital, though not as large as the one decorating the courtyard. The first bore caught the edge of a boulder around 12 ft (4 m) in diameter, while the second bore drilled straight through it. "There was no way another cutting head could have done this. It was very smooth when we were advancing through the rock, and didn't put too much stress on the ABM," said Charlie. Overall advance rates were in the range of 10 ft (3 m) per day.

Silver State finished all its bores on line and grade in November 2010. "The bores went very straight. As long as you get the SBU started straight, it will just keep going," said Charlie.

### EVENTS CALENDAR

**Robbins will exhibit at the following trade shows:**

#### 2011

**CRTS**  
August 23 - 25  
Shanghai, China

**IUT**  
September 14 - 15  
Sargans, Switzerland

**ICUEE**  
October 4 - 6  
Louisville, Kentucky, USA

**AFTES Congress**  
October 17 - 19  
Lyon, France

**BICES**  
October 18 - 21  
Beijing, China

**EXCON**  
November 23 - 27  
Bangalore, India

**STUVA**  
December 6 - 8  
Berlin, Germany

