

# UNDERGROUND INNOVATIONS

NEWS FROM ROBBINS



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## MAKE WAY FOR TBMs IN MINING

### MECHANIZED MINING USING TBMS

may be the way of the future, but for one mine it's all part of its history. Stillwater Mining Company, located in Nye, Montana, USA, began using TBMs in platinum and palladium mines in the late 1980s.

One Robbins TBM, operating at the East Boulder Mine since 1999, has excavated multiple tunnels totaling more than 18,500 ft (5.6 km). "It's one of the oldest operating TBMs that we know of, and it's been boring another 8,500 ft (2.6 km) mine development tunnel since September 2011, so by the time it's done

it will have bored 33,000 ft (10 km) total," said Mike Koski, Chief Geologist for the Stillwater Mining Company.

In addition to the veteran Robbins machine, Stillwater has ordered a second Main Beam TBM for its upcoming Blitz tunnel, to be launched this summer. The 5.5 m (18.0 ft) diameter machine will excavate at least 7.1 km (4.4 mi) of mine development tunnel, mapping the reef and providing a rail haulage route for the life of the mine.

Detecting the reef in relation to the TBM will require careful analysis.

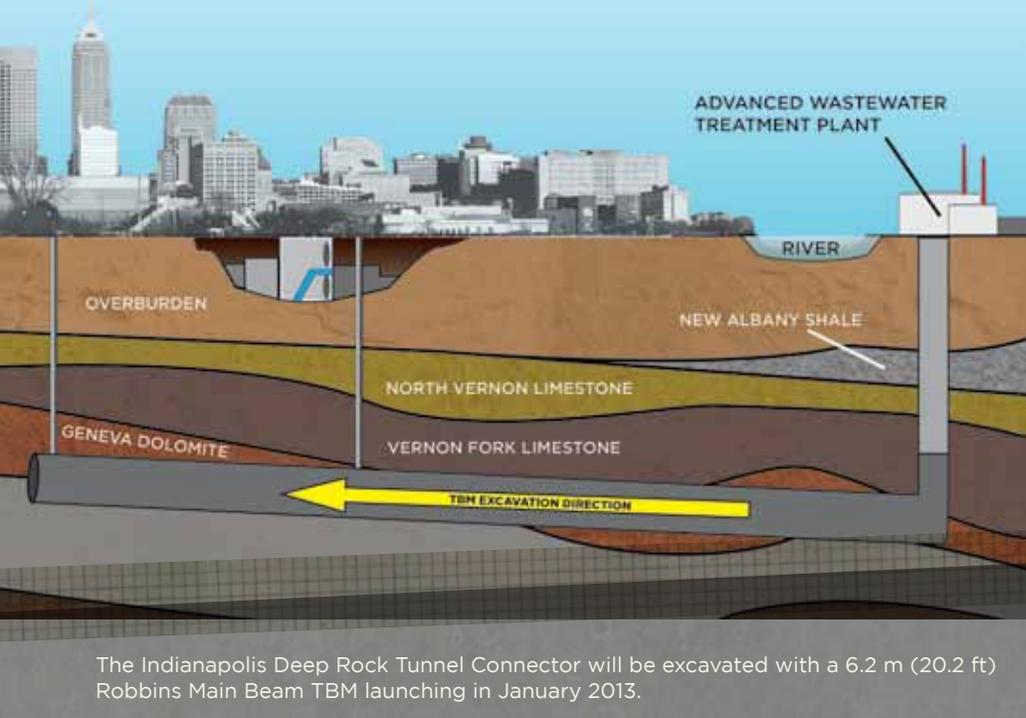
"Steering the machine is an interesting process because we have very complex geology here. We do diamond (core) drilling ahead of the machine, above the machine, and to the side after every 150 m (500 ft). We drill and log the core right there while we are drilling it, then interpret the results, so it's concurrent with boring," said Justus Deen, Manager of Technical Services at the Stillwater and East Boulder mines.

The TBM will excavate gabbro rock and will utilize a variety of ground support, ranging from ring beams, shotcrete, and rock bolts to McNally crown support consisting of continuous steel slats.

Stillwater will most likely use the machine for future projects, and may extend the Blitz tunnel if it proves successful. "TBMs offer faster advance rates than drill and blast, and the drives are easier to ventilate. It's also easier to train our TBM miners, as the required skill set is not as complex." For those reasons, says Deen, TBMs at Stillwater are here to stay.

The 5.5 m (18.0 ft) Main Beam TBM for the Stillwater Mining Company was manufactured and assembled at Robbins' Solon, Ohio, USA manufacturing facility in March 2012.





The Indianapolis Deep Rock Tunnel Connector will be excavated with a 6.2 m (20.2 ft) Robbins Main Beam TBM launching in January 2013.

## CHENNAI METRO CHALLENGE

### GRANITE, SAND, CLAY, AND BOULDERS

up to 300 mm (12 inches) in diameter make for highly variable ground at Chennai, India's new metro tunnels. A 6.65 m (21.8 ft) diameter Robbins EPB will tackle the challenging conditions below the densely populated city.

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) tunnels on Lot UAA-01 on Line 1, extending from the Washermanpet area toward Chennai International Airport.

The EPB, for contractor Afcons Infrastructure Ltd, features a mixed ground cutterhead with interchangeable 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 jobsite, the TBM will be assembled and launched from a 28 m (92 ft) deep starting pit.

## HARD ROCK HEAVYWEIGHT WILL DIG BELOW INDIANAPOLIS

### CLEANER WATER FOR INDIANAPOLIS.

That is the ultimate goal of the city's new Deep Rock Tunnel Connector (DRTC), which will be excavated below more than 76 m (250 ft) of limestone and dolomite. The DRTC will convey up to 2.1 million m<sup>3</sup>/day (550 million gallons/day) of combined sewer overflows to the Southport Advanced Water Treatment Plant.

The 12.2 km (7.5 mi) long tunnel, for the Shea/Kiewit JV, will be excavated with a Robbins Main Beam TBM and lined with un-reinforced concrete.

**"We're retrofitting a machine built in 1976 with the latest technology."**

-Dave Girard, Senior Engineer for J.F. Shea Construction, Inc.

The 6.2 m (20.2 ft) diameter Robbins machine is currently being refurbished and redesigned in Cleveland, Ohio and

Mt. Pleasant, Pennsylvania facilities. The contractor-owned TBM most recently excavated the Second Avenue Subway in New York City.

Its latest rebuild is complex, according to Dave Girard, Senior Engineer for J.F. Shea Construction: "We're retrofitting a machine built in 1976 with the latest technology--in particular, variable frequency drive motors." Other components include a back-loading cutterhead with 19-inch disc cutters and rescue chamber.

Despite the complexities of the redesign, the machine is scheduled to be launched from a deep shaft in January 2013, proceeding towards the Belmont Wastewater Treatment Plant in what is expected to be competent rock. Robbins continuous conveyors, including a horizontal and vertical conveyor, will aid in muck removal on the long drive.

Girard is working with a group of superintendents to ensure that the project proceeds smoothly, and is confident in Robbins' designs: "I like that Robbins TBMs are made in the U.S. with American labor and steel," he says.



# NANJING EPB FOURSOME FORGES AHEAD

## UP TO 40,000 VISITORS ARE EXPECTED

at Nanjing's upcoming Youth Olympic Games in 2014--a prospect that has the city preparing with a host of new metro lines being built with up to 40 TBMs.

Robbins provided four 6.5 m (21.4 ft) EPBs with mixed ground cutterheads for two metro lines under construction. The two pairs of EPBs are excavating Line 3 Lot 11 and Line 10 Lot 5, for China Railway Construction Corporation (CRCC) 13th Engineering Bureau and 23rd Engineering Bureau, respectively.

The two Robbins TBMs for Line 10 were launched in December 2011 and February 2012, while the Line 3 machines were launched in January and March of 2012. "Robbins is a special TBM manufacturer and the quality is good here. We have used one Robbins TBM previously in Chengdu, and there was very good performance at the Metro Line 2," said Li QuanShe, Nanjing Line 3 Project Manager for CRCC Bureau 23. At that previous Chengdu jobsite, a Robbins EPB achieved a project record of 129 m (423 ft) in one week through mixed ground.

Ground conditions on both Nanjing lines include soft soil, silty sand, manmade materials, small pebbles, and sandstone. Shallow cover of 8 to 10 m

(26 to 33 ft), a sensitive urban environment, and settlement limits of less than 10 to 20 mm (0.4 to 0.8 in) are requiring customized excavation methods.

"The earth is quite soft so we are keeping the thrust force very low (6,000 to 9,000 kN / 1.4 to 2.0 million lb). The operator is also employing continuous monitoring to maintain the proper alignment and earth pressure," said Jason Xiao, Robbins Project Manager.

**"Robbins is a special TBM manufacturer and the quality is good here."**

-Li QuanShe, Nanjing Line 3 Project Manager for contractor CRCC Bureau 23

As of June 2012 the Line 10 EPBs have excavated over 600 m and 500 m (1,970 ft and 1,640 ft), respectively. The TBMs are achieving 40 mm (1.6 in) advance per minute, while settlement is minimal. At Line 3, the Robbins machines have excavated over 500 m and 100 m (1,640 and 330 ft), respectively, with advances topping 60 mm (2.4 in) per minute.

## DOUBLE SHIELD TBM TO MOVE MUCK BELOW BLACK RIVER

A 7.0 m (23.0 ft) diameter Robbins Double Shield TBM and continuous conveyor system are currently being designed for a new project in the U.S. In January the city of Lorain, Ohio awarded the Black River Tunnel contract to a joint venture of Walsh-Super Excavators. The TBM and conveyors will be assembled using On-site First Time Assembly (OFTA) in the last quarter of 2012.

The wastewater storage tunnel will be 1,676 m (5,500 ft) long, and will be excavated 34 to 57 m (112 to 187 ft) beneath the city. Once complete, the tunnel will reduce stormwater overflows into Lake Erie and curb basement flooding during heavy rains.

## DUAL MODE TBM DESIGNED FOR DIFFICULT CONDITIONS

Robbins is designing a special dual mode TBM for both rock and soil conditions. The unique machine is customized for highly variable ground conditions including sandstone, mudstone, claystone, quartzite, schist and sections of soil and clay containing water.

The EPB TBM will feature a design optimized to switch seamlessly between pressurized and non-pressurized EPB modes, as well as hard rock mode. A retractable muck ring will allow the TBM belt conveyor to stay within the machine, so that in-tunnel conversions between belt and screw conveyor are not needed.

Robbins is hoping to finalize an order for this new machine design, which is ideal for road or rail tunnels in the 12 to 15 m (39 to 49 ft) diameter range.



LEFT: Chennai Metro's mixed ground Robbins EPB will excavate granite, sand, clay, and boulders.

TOP RIGHT: Workers transport segments at Nanjing Metro Line 10.  
BOTTOM RIGHT: The Robbins EPBs at Nanjing Metro have excavated at rates up to 60 mm (2.4 inches) per minute.



SUMMER 2012



LEFT: The Robbins 72-inch (1.8 m) Motorized SBU (SBU-M) broke through almost exactly on line and grade after 395 ft (120 m) of boring. RIGHT: The Robbins SBU-M was the largest machine of its kind ever made, and utilized a mixed ground cutterhead in clays as well as rock.

## SYNCHRONIZED SBUs **RIGHT ON SCHEDULE**

### FOUR SIMULTANEOUS OPERATIONS. SIX CROSSINGS BELOW ROADS AND RIVERS.

That was the challenge facing contractor L.J. Keefe Co. on the City of Clinton Contract B Force Main in Clinton, Iowa, USA.

The simultaneous construction required hard rock and mixed ground auger bores as well as TBM tunneling, all within a short construction schedule of just five months. "We had an extremely tight time frame, but we were able to work with the general contractor, engineer, and Robbins to encompass multiple soil conditions and tight tolerances," said Larry Keefe Jr., General Manager of L.J. Keefe Co.

Three crossings ultimately used hard rock Small Boring Units (SBU-As) as well as a 72-inch (1.8 m) Motorized SBU (SBU-M), the largest diameter ever made.

Testing of the 395 ft (120 m) crossing below Highway 67, the busiest roadway in the area, revealed a mixed face of silty, watery sand, clay, and 10,000 psi (70 MPa) UCS hard rock. "We opted to use SBU technology, even though other contractors said it could only be done with microtunneling," continued Keefe.

The machine, complete with mixed

ground cutterhead, began its excavation on January 3, 2012. About 15 ft (5 m) into the bore the machine hit hard clays, requiring water to be added through the cutterhead and to the casing. Despite the clay, crews were able to maintain line and grade using articulation cylinders, while monitoring the progress using laser targeting.

"We were within 0.75 to 1.0 inches (19 to 25 mm) of line and grade the entire time, there was very little drift. I'm used to steering articulated machines, because we use a lot of TBMs. Keeping on line and grade was easy, particularly when we got into the rock," said Steve Lilo, Operator/Foreman of the SBU-M for L.J. Keefe.

Ultimately, all of the contractor's bores were completed on schedule and within the required line and grade limits. "The biggest benefit is in being able to mold our current technologies with SBUs, using them in conjunction with ABMs, or in conjunction with our existing tunneling equipment. We can use our existing equipment with the specialized Robbins equipment to lower costs and shorten project schedules," said Keefe.

### EVENTS CALENDAR

Robbins will exhibit or present at the following trade shows:

#### 2012

**No Dig Turkey**  
October 4-5  
Sanliurfa, Turkey

**CityBuild**  
October 16-18  
Moscow, Russia

**TAC 2012**  
October 17-20  
Montreal, Quebec, Canada

**Bauma China**  
November 27-30  
Shanghai, China

#### 2013

**UCT**  
January 29-31  
Houston, Texas, USA



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