UNDERGROUND
INNOVATIONS

NEWS FROM ROBBINS

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SOFT GROUND TRIUMPH IN SACRAMENTO

The Robbins EPB TBM broke through on November 21, 2009 with record advance rates of up to 210 m (690 ft) per week.

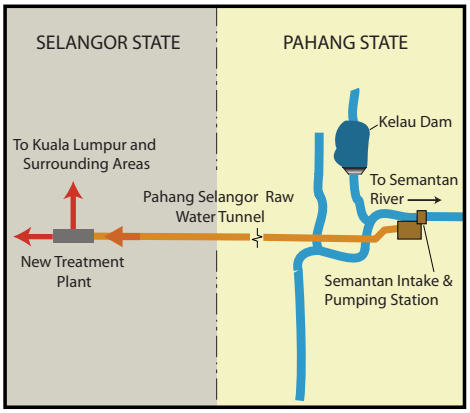
On November 21, 2009 a Robbins EPB elevated the industry standard for soft ground tunneling rates. The 4.25 m (13.9 ft) diameter machine excavated a 5.7 km (3.6 mi) long tunnel in Sacramento, California, USA, achieving rates of up to 210 m (690 ft) per week on multiple occasions. Daily rates, based on three 8-hour shifts, topped out at 50.3 m (165 ft)—among the highest rates ever recorded for an EPB TBM in the 4 to 5 m (13 to 16 ft) diameter range.

The machine made a final breakthrough several weeks ahead of schedule. "The availability of the TBM and subcomponents was very high for a tunnel heading operating 24 hours a day, 5 days per week. In addition, the Robbins-supplied tunnel conveyor system performed remarkably well throughout the drive," said Jeremy Theys, Project Manager for the Traylor/Shea JV (project contractor).

No final carrier pipe is required in the finished tunnel, as the 230 mm (9 in) thick concrete segments were designed with embedded PVC sheets. The 1.75 mm (0.07 in) thick PVC lining will protect the sewer tunnel from corrosive gases that can degrade concrete—the first time this type of liner has been used in the U.S. As the machine advanced, workers heat welded the joints between segments for a permanent seal. Gaps between segment rings were sealed together using four inch wide PVC strips, while radial gaps between segments were closed using one inch strips.

The EPB was optimally designed for ground consisting of clay and running sand, utilizing a spoke-type cutterhead and wear resistant plates. Muck was removed using a 500 mm (20 in) diameter shaft-type screw conveyor emptying onto a Robbins continuous conveyor system.

The Upper Northwest Interceptor (UNWI) sewer project will convey up to 560 million liters of wastewater per day for project owner Sacramento Regional County Sanitation District (SRCSD). By late 2010, the new tunnels will add capacity to existing interceptor systems in the area that are nearing their limits.



Three Robbins Main Beam TBMs will excavate sections of Malaysia's largest current infrastructure project: The Pahang Selangor Raw Water Tunnel.

TBM TRIO WILL BURROW BELOW MALAYSIAN MOUNTAINS

Since the 1980's, Malaysia's capitol Kuala Lumpur and surrounding areas have experienced rapid economic growth. The area sources most of its water from a network of local rivers, and is expected to run short of supply. To address forecasted needs, the Ministry of Energy, Green Technology, and Water has commissioned the 44.6 km (27.7 mi) long Pahang-Selangor Raw Water Tunnel.

The alignment will transfer water from the Semantan River in Pahang State to the Selangor / Kuala Lumpur region, traveling as far as 1,200 m (3,900 ft) beneath the Titiwangsa mountain range. Excavation is scheduled to begin in late 2010 using three Robbins Main Beam TBMs and continuous conveyor systems.

The 5.2 m (17.2 ft) diameter machines will be provided to the SNUI JV, a consortium led by Shimizu Corporation and Nishimatsu Construction of Japan, with local companies IJM Corp and UEM Builders Bhd. "Robbins' experience in hard rock ground conditions, together with their willingness to work together and be a reliable partner with us, were the main factors in choosing the Main Beam machines," said Mr. Kawata, Project Manager for the SNUI JV.

Robbns fabric belt conveyors will extend the full tunnel length behind each of the machines, and will be capable of transporting 400 metric tons (440 US tons) of muck per hour.

TBMs 1, 2, and 3 will be used to excavate sections of tunnel 11.6 km, 11.6 km, and 11.2 km (7.2 mi, 7.2 mi, and 7.0 mi) in length, respectively. The machines will be uniquely designed with the smallest diameter cutterheads ever supplied using 19 inch disc cutters. The larger diameter disc size will allow for longer cutter life in granitic geology up to 200 MPa (29,000 psi) UCS.

Once complete in 2013, the tunnel will convey approximately 27.6 cubic meters of water per second (7,300 gallons per second) for use in domestic and industrial applications.

ROBBINS EPBs WILL MOVE MIXED GROUND IN GUANGDONG

In a residential area of Guangdong Province, two 8.8 m (28.8 ft) diameter Robbins EPBs will excavate difficult ground and mixed face conditions. The parallel 4.5 km (2.8 mi) long tunnels are part of one of China's epic rail projects involving 16 TBMs.

The machines will bore sections of the Sui-Guan-Shen (SGS) rail line using mixed ground cutterheads with 17 inch diameter disc cutters and carbide bits. Geology consists of mixed sections of silty clay, slightly weathered to weathered rock, hard rock, and gravel.

The EPBs will utilize bentonite additives to maintain a smooth flow of muck at the tunnel face. Each machine is designed with a 900 mm (35 in) diameter shaft type screw conveyor. As the TBMs advance, they will line the tunnels with 400 mm (16 in) thick concrete segments in a 6+1 arrangement.

Assembly of the machines is currently underway in a Chengdu manufacturing facility. Launch is scheduled for September 2010, and all tunneling is expected to be complete in 2011.

The 86.6 km (53.8 mi) long SGS lines will connect areas of Guangzhou, Dongguan and Shenzhen. The project is part of the Chinese government's Guangdong Pearl River Delta Inter-City Rapid Rail Project, which aims to connect nine major cities in Guangdong by 2015.

EPB CEREMONY HELD FOR SANTO DOMINGO METRO

The commissioning ceremony for a 9.6 m (31.4 ft) diameter Robbins EPB was held on December 19, 2009 in Santo Domingo.

A commissioning ceremony was held on December 19, 2009 for the 9.6 m (31.4 ft) diameter Robbins EPB excavating Line 2 of the Santo Domingo metro. The machine and Robbins continuous conveyor system are being provided to the Dominican Republic's Transit Reform Office (OPRET).

The custom-designed machine features a spoke-type cutterhead and two-liquid back-filling system to effectively excavate sand, silt and fragmented limestone while minimizing ground settlement.

The 22 km (13.7 mi) long, entirely underground Line 2 will travel from downtown Santo Domingo to Eastern parts of the city, connecting with the previously excavated Line 1. Currently the metro stretches 14.5 km (9.0 mi) and has 16 stations, transporting about 60,000 passengers daily.

Left: *Onsite assembly of major components for the Mexico City Metro's EPB was completed in about eight weeks.*
Above: *Two new 6.4 m (21.0 ft) diameter Robbins Main Beam TBMs will excavate under extremely low cover in Chongqing, China.*

ONSITE ASSEMBLY NEARS COMPLETION IN MEXICO CITY

Mexico's largest diameter EPB is nearing completion after undergoing Onsite First Time Assembly (OFTA). The new 10.2 m (33.5 ft) diameter Robbins Earth Pressure Balance Machine (EPBM) is planned to tunnel directly underneath high density urban areas for Mexico City Metro's Line 12. Robbins is supplying the machine, back-up system, and cutting tools to the ICA consortium (consisting of ICA, CARSO, and Alstom).

The machine represents the first time an EPB has ever been assembled initially onsite. OFTA was developed by Robbins as an effective method of assembling TBMs on location for the first time, rather than in a manufacturing facility. The process saves both time and money to the contractor due to reduced man hours and shipping costs.

As of late December 2009, the TBM had been assembled in a concrete cradle on the floor of the launch shaft. Testing of critical sub-assemblies, and configuration of the electrical systems, are ongoing. "The OFTA process results in a much faster delivery time. This machine has ultimately been assembled in about eight weeks," said Jeremy Pinkham, Robbins Field Service Superintendent.

By February 2009, the EPB will be launched from an abbreviated starting shaft. The machine will initially operate using umbilical cables connecting it to back-up gantries on the surface. Gantries will be lowered down successively as the TBM advances.

The Robbins EPB will excavate a 7.7 km (4.8 mi) long tunnel between Mexicaltzingo and Mixcoac areas in clay and sand, with boulders predicted up to 800 mm (30 inches) in diameter. A specially designed, 1,200 mm (4 ft) diameter ribbon-type screw conveyor will ensure efficient removal of the large boulders.

In 2007, the Mexican Federal District announced plans to build Line 12 of the Mexico City Metro—a 24 km (15 mi) long line with service to 22 stations in the southern area of the city. The metro is one of the world's largest, with over 200 km (125 mi) of rail and nearly 4 million daily passengers.

DUAL TBMs LAUNCHED IN WORLD'S MOST POPULOUS CITY

Two 6.4 m (21.0 ft) diameter Robbins Main Beam TBMs were launched in December 2009 beneath Chongqing, China--a megacity of over 35 million people. The two machines are excavating twin 12 km (7.5 mi) long tunnels for Line 6 of the Chongqing Metro.

Both High Performance (HP) TBMs started up from a common portal after shop assembly in Chongqing. The first machine was moved forward on a specially designed walking beam system, and began cutting rock on December 11. The second machine was launched in the last week of December.

Each machine must bore under sections of very low cover ranging from 10 to 60 m (33 to 197 ft) in sandstone from 12 to 50 MPa (1,700 to 7,300 psi) UCS. The geology will require a ground support program of rock bolts, ring beams, wire mesh and shotcrete.

The new rail line is part of a network of nine monorail lines under construction. The routes will be both above and below ground to accommodate the hilly terrain of the city. Currently, Chongqing relies on buses for the majority of its public transportation.

Left: *In December 2009, an all-time record of 600 ft (183 m) was achieved with a 42 inch (1.0 m) Robbins SBU-A.*
Top: *Two other contractors set records with SBU-As in 2009, citing factors including improved technology and field support.*

MAKING AN SBU PROJECT A RECORD-BREAKER

In 2009, three landmark Robbins Small Boring Unit (SBU-A) crossings brought trenchless auger boring to new lengths. But what factors led to the record-breaking trenchless projects?

The three projects achieved two size class records for boring distance -- 352ft for a 54 inch diameter machine and 545 ft for a 36 inch machine--as well as an all-time record for all SBU sizes. The standout Tigard, Oregon, USA project for contractor Gonzales Boring & Tunneling used a 42 inch (1.0 m) diameter SBU-A to excavate a 600 ft (183 m) long crossing.

"Record-breakers are determined by several factors," said Chris Sivesind, SBU Sales Manager - Western U.S. "These include improvements in auger boring machines and cutterhead technology. One of the most important aspects is often the contractor's confidence in equipment and crew, which eases the heightened risks taken on such demanding projects."

The Robbins SBU-A, a type of trenchless boring attachment for use with standard Auger Boring Machines (ABMs), has benefitted from improvements in ABMs including a three-fold increase in thrust capabilities and horsepower over the last 30 years. During a push, the ABM provides thrust and torque to the SBU-A.

The design of cutterheads for hard rock and mixed ground has also translated to less downtime for cutter changes and more efficient boring based on geology. The disc cutters are capable of excavating rock from 4,000 to over 25,000 psi (25 to over 175 MPa) UCS.

Optimal geology is also an important factor: consistent ground with little water and faulting contributes to high advance rates at long distances.

However, quality support and contractor willingness to attempt long crossings may be the highest predictor of success. All three contractors had over 25 years of experience in auger boring, and felt that field service was invaluable. "A combination of preparation, qualified crew, accurate machine design, and Robbins' unmatched support services made this a successful crossing," said Jim Gonzales, President of Gonzales Boring & Tunneling.

EVENTS CALENDAR

Robbins will exhibit at the following trade shows:

2010

UCT
January 19 - 21
Tampa, Florida, USA

Bauma
April 19 - 25
Munich, Germany

NASTT
May 2 - 7
Schaumberg, Illinois, USA

World Tunnel Congress
May 14 - 20
Vancouver, BC, Canada

INTERtunnel
June 8 - 10
Torino, Italy

NAT
June 16 - 23
Portland, Oregon, USA

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